On knowing, problems, and inquiry: An exploration of the foundations of Doctoral cognition

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CERTIFICATION

The thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968.

Signed: Gavin Hazel Date: 28/11/2013

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Any intellectual journey worthy of the name is never undertaken alone. It is done with the support and encouragement of friends and family; sponsors and patrons provision it; and mentors, champions and companions help to guide it.

The path that led to the completion of this thesis has ranged over many years and different contexts. It commenced for me with the insight provided by two of my high school teachers, Mr John Steer and Miss Deborah Byron, who demonstrated to me that education is not reserved for a select few but open to anyone with an active mind. I remain indebted to these two outstanding teachers for allowing me the space in which to engage deeply with the act of learning.

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Prior to the completion of thesis my father passed away suddenly and it is to his memory and passion for knowing that I dedicate this work.

Savior c'est puvoir

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In the ongoing contestation about the nature and purpose of higher education, much of the middle ground in this debate has come to be dominated by a type of knowledge that can best be labelled as technical. The rise of a narrow instrumental and technical modality in higher education has contributed to an increasing neglect of the underlying, or fundamental processes, that shape thinking, learning and development within the university domain. The work presented herein is intended to contribute to addressing this gap by laying down a theoretical footing for Doctoral cognition.

Doctoral cognition is seen to involve, at is core, productive or constructive thinking. Productive thinking is thus construed as the creative and adaptive capacities that allow us to seek out solutions in circumstances where we are unable simply to apply pre-prepared responses.

This goal of this thesis is to contribute to the reinvigoration of pragmatic, phenomenological and constructivist lines of inquiry within educational thinking. This is an attempt to illuminate a problem in two theoretical dimensions – firstly the unnecessarily restricted nature of our standard model of cognition; and secondly to demonstrate the contribution that a rediscovery of the productive nature of thought would make to our capacity to explain cognition and learning. In doing so this work seeks to re-introduce the ideas of productive thinking, construction, intention and connotation.

This work seeks to identify within both philosophical and psychological traditions implicated in Doctoral activity. To do so has required the reviewing and integration of concepts, theories and research findings from diverse literatures including those relating to cognitive science, complex systems theory, intentional conceptual change, situational awareness, metacognition, and intelligence.

It follows that the philosophical perspective offered in this thesis, which accommodates both existential and phenomenological traditions, is aimed at gripping up smart moves, problems, intelligence, learning, agency, regulation and self-maintenance and applying them to a particular exemplar – Doctoral research activity. The use of a system's perspective is seen to be the most effective model for revealing the relationship between being, doing and meaning.

This work is proposed as a part of larger program of activity that seeks to provide a means of realigning basic and applied thinking to the question of higher education and learning. Put plainly this work should be recognised as a contribution to an ongoing conversation about the nature of cognition, mind and learning. This conversation stretches beyond the immediate to long held debates about the nature of thought, identity and being.

NOTE ON REFERENCING STYLE:

This thesis has been prepared using the American Psychological Association (APA) referencing style (6th ed.).

The author has augmented the APA style with the inclusion of *footnotes*. The information that is provided in the footnotes *serves primarily as a gloss for the analysis being conducted in the body of the text*. On other occasions, the footnotes provide important background information to allow for greater accessibility, on the part of the reader, to the approach, language, concepts and techniques being used in this work.

It is acknowledged here that this blending of referencing styles may not be to the taste of those who have a strong preference for a standard or pure APA, Oxford, Chicago or Harvard usage. The author requests the tolerance of the reader to accommodate the referencing variation used herein.

The hybrid format that has been used, while admittedly somewhat unorthodox, is by no means unfamiliar to scholarly literature. Furthermore, and more critically, this style remains faithful to the academic purpose and tradition of referencing in scholarly writing.

The references in this text have been prepared using Endnote X5 (for Mac) referencing software.

INTRODUCTION

1.1 Orientation

The primary concern of this work, at its most general, is how the individual comes to know and how the act or the achievement of knowing shapes one. More specifically, the question the work addresses is: "what are the knowledge-making processes, at the level of individuals, that underpin Doctoral work, knowing, and education?" In addition to some relevant preliminary empirical findings with respect to this question, the following contributions are also offered: firstly, a philosophical psychology based examination of the question of knowing, and because it is so inextricably linked, *being*; secondly, an application of a naturalistic lens to a particular instance of deliberative knowing, as represented in Doctoral research work; and thirdly, the outline of a proposed program of work to address the impoverished mainstream higher education understanding of Doctoral education in specific, and individual knowing in general, terms.

In higher education it is (self) evident that individuals' Doctoral experiences involve knowing, beliefs, desires, and dispositions; but debates about the *substantive* nature of the Doctorate often seek to move on quickly from these 'background factors' to examine instead credentialing, curricula, and training processes. It is argued here that this approach fixes our attention on the wrong problem and overlooks the essence of *Doctorateness*. This oversight speaks to a deeper, and even more concerning neglect in relation to the mind and education.

The problem is not how we codify and administrate the Doctorate. Instead we need to try to understand Doctoral education from the standpoint of *knowing* and *knowledge* growth. The Doctoral process is a particular way of *meaningfully* and *intentionally* manipulating and dealing with the world. To understand this we need to look into the Doctoral experience, its *raison d'être*, and determine the ways in which these can shape individual's thinking. To restate the question: on a fundamental level what does the experience of Doctoral education, and completing a thesis, do to those involved?

This is a tough problem – partly because there is the capacity to *trivialise* the issue, to take the stance that no one deeply believes that the Doctorate is a distinctively psychologically *transformative* or *developmental* process; that instead the Doctorate is a *credentialing* experience that involves the acquisition and application of largely procedural knowledge about research skills. It is arguable that this is the open secret of the Doctorate that the Academy glosses with cultural significance, when required to provide a more *positive* framing of Doctoral education (Park, 2007; G. E. Walker, Golde, Jones, Bueschel, & Hutchings, 2008).

An alternative view, and perhaps the one more consistent with the *spirit* or *intent* of current Doctoral education, is that the Doctorate is about the *formation* of scholars; the induction into a discipline; an intellectual apprenticeship leading towards eventual mastery of an area of knowledge, resulting in a substantive contribution to this knowledge base. Walker and colleagues (2008) characterise these processes as: "(1) progressive development towards increasing independence and responsibility, (2) integration across contexts and arenas of scholarly work, and (3) collaboration with peers and faculty in each stage of the process" (pp. 61-62).

Alongside this viewpoint, analysis has revealed that mastery of a discipline of knowledge leads to individuals understanding "the world in terms of the cognitive models they possess; they 'see' things differently. Disciplinary-based concepts are necessary for viewing the world in a certain way. In the normal course of events, of course, students learn these cognitive maps when they are inducted into a discipline. This is part of what it means to become 'educated'. Once this has occurred, it becomes difficult for those inducted to see things any other way" (M. Davies & Devlin, 2007, p. 5). Bourdieu's (1981, 1984, 1988, 1990, 1998) notion of *habitus,* is an example this kind of normative framework that individuals develop (and share with others) during this type of experience. Bourdieu construes that these frameworks establish a window of viability for actions – this framework sets out a set of constraints that must be met for the successful completion of a tasks and goals that are "visible" to the individual.

Human, social and cultural capital arguments have not got us very far in understanding *why* these maps, frameworks or structures become embodied with such persistent value to individuals or institutions. These kinds of analysis tell us *post hoc* about the Doctorate's value, but they do not always speak to *why or how this process imbues, for the individual, this value in an enduring way.* This is in our view, grounds for investigation.

This work offers an invitation to look at Doctoral education in a new way. We hope to convince you that some of the essential aspects of Doctoral experience are both profoundly psychological and transformative in nature. On the surface, a marriage between mind sciences and an exploration of Doctoral education may seem incongruous – especially if viewing the Doctorate from a technical or bureaucratic perspective. The notion of scientists in laboratories operating imaging machinery, building automata, writing code or preparing anatomical slides can seem to be far removed for the circumstances of a candidate completing a Doctorate at a university. Nonetheless there is growing connection between these domains – with increasing, but cautious, exchange of data, research methods, theories and models (Fischer & Daley, 2007). Given this, and the previous points made, it is only judicious that (at the very minimum) we review our understanding of knowing to see to what extent we may need to either revise or replace our current thinking.

1.2 The story as we know it

Doctoral education is commonly equated with the notion of becoming an Academic, Researcher or Scholar.[1] As the highest degree awarded by universities to a student for the completion of a program of study (Park, 2007), the Ph.D. is the *bona fides* for entry into institutionalised scholarship and the mechanism by which the Academy reproduces itself (G. E. Walker et al., 2008)[2]. The conferring of this degree to an individual has customarily implied that they have demonstrated, both functionally and symbolically, the particular qualities of mind and understanding necessary for scholarly work (Cude, 2001). In this sense then the Doctorate is emblematic of the getting of wisdom. Moreover, as proof positive of the mastery of a domain of knowledge[3], the capacity for doing research and being a Researcher, the Doctorate has spread throughout the academic world to become one of the most widely recognised rites of passage and is a *sine qua non* qualification in research and academic professions (although this has not always been so) (ABRC, 1996; Kiley, 2009b; Petre & Rugg, 2004; G. E. Walker et al., 2008).

The story of the Doctorate, and its role in higher education, is one marked by periods of continuity, contestation and transformation (Lee, 2009; Park, 2007; Simpson, 1983; UNESCO/CEPES, 2004; G. E. Walker et al., 2008). Generally described as being first established as a licence to teach in medieval Europe (Makdisi, 1981), the modern Doctorate

1 Recently there have come to be a wide variety of programs and awards associated with the epithet of 'Doctor' (T. Evans, Evans, & Marsh, 2005; McAlpine

2 Publication Manual of the American Psychological Association (6th ed.). - Citing references in text (6.14) Authors with same surname: If a reference list includes publications by two or more primary authors with the same surname, include the first author's initials in all text citations, even if the year of publications differs.

3 The UK Council for Graduate Education (1997) provides an informative parameterisation of *mastery*. The Council identifies the following domains: "mastery of the subject, mastery of analytical breadth (where methods, techniques, contexts and data are concerned) and mastery of depth (the contribution itself, judged to be competent and original and of high quality)" (p. 15) as key to defining this overall notion of academic *mastery*.

emerged in Germany, under the auspice of Wilhelm von Humboldt's reforms in the early 1800s. The Doctorate was a degree concerned with 'original' research or scholarship. The Germanic approach was later translated in the USA into a distinctly North American qualification (which reflected both European and American sensibilities with regards to scholarship and tertiary learning) (Noble, 1994).

In undertaking Doctoral education the Candidate or Researcher[4] applies their intellectual or cognitive powers (however we may wish to define them) through the actions of *learning* and *inquiry*. In doing so they demonstrate the capacity to acquire knowledge and engage in *Doctoral knowing*.[5] But, what is it about undergoing the Doctoral process that marks a transition in knowing (Jazvac-Martek, 2008; Lovitts, 2005; A. Taylor, 2007)? Is it merely a ritualistic rite of passage or is there a fundamental developmental course that runs through the Doctorate (and other professional learning) (Cude, 2001)? If there is a transition in knowing as part of the Doctoral process, where and how does it occur? Alternatively, if there is no transition in knowing, then what is the purpose[6] (and assumptions) that underlies the existence of this academic experience? Essentially the question at issue in these queries is - *what is it about the Doctorate that warrants its privileged place, and its epistemic authority, within the hierarchy of higher educational learning experiences?*

In other words – what is the *essence* of the Doctorate, the thing that distinguishes it in our judgement from other scholarly activities? The term *Doctorateness* has been proposed as a suitable descriptor for whatever we see to be the *essence* or nature of the Doctorate. Denicolo and Park (2010) explain "What is meant by the term 'Doctorateness' is a reflection of *the mix of qualities required of a person* who has or is acquiring Doctorateness, including such things as intellectual quality and confidence, independence of thinking, enthusiasm and commitment, and ability to adapt to changing circumstances and opportunities. As the pinnacle in the hierarchy of academic awards, in which the bachelor's degree denotes the

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[4] For the duration of this work these terms, unless otherwise explicitly stated, will refer to those undertaking Doctoral education.

[5] Trafford and Leshem (2009) propose that the concept of *Doctorateness* is crucial to understanding the Doctoral process. Park (2007) explains that Doctorateness is a descriptor for the set of characteristics which allow us to discriminate a Doctorate from other degrees. There is substantial debate as to what specific characteristics should be part of Doctorateness; but there is general agreement that the concept of *Doctorateness* is useful for drawing attention to the question of 'what is the *essence* of the Doctorate' (cf. fn 7)?

[6] As a thought experiment, could we credibly talk about the automated production of a thesis? If it were possible for a thesis to be generated independently of input by a learner, by a piece of software or some Maxwellian *daemon*, would we say that the program or daemon has shown Doctorateness and should be awarded the degree? Under these conditions our intuitions may suggest that without a learner, a researcher, or a student as *the subject* of the doctoral experience and author of the work that an automatically produced thesis may make a contribution but the purpose of a Doctorate has not been achieved. The purpose of the Doctorate then would seem to be linked to *Doctoral experience of an individual* not content in and of itself in isolation. If this is the case, then this thought experiment points our analysis towards the Doctorateness as a state that is experienced by *someone* rather than the characteristics of a *document sui generis*.

acquisition of a body of knowledge while the master's degree requires the *acquisition and application of knowledge*, the Doctorate additionally, and most importantly, requires the creation and extension of knowledge. *Thus it is different in kind rather than being the next in a simple, additive progression*" (p. 2, *emphasis added*). Our attention should be drawn to Denicolo's and Park's idea that in the final analysis Doctorateness captures more of a *transformative* rather than simply *additive* process; and that this transformation is of the *candidate* and occurs through the activity of knowledge creation. Moreover, we need to consider what does being doctoral look like? What do people do and how do they think when they are demonstrating Doctorateness?

If we were to define the Doctorate in purely administrative or technical terms then the response to this question is, perhaps, 'nothing'. While the Ph.D. involves a substantive commitment to the exploration of a particular issue, it is debateable as to whether it is unique in regards to its current pedagogy, organisation or assessment (Chaing, 2003; Cude, 2001; Cumming, 2009; Golde & Dore, 2001). Some higher education commentators have likened Doctoral pedagogy to the tutor relationships in undergraduate education (T. Evans, Evans, & Marsh, 2008). For example, Clark goes so far as to characterise Doctoral pedagogy as an "extension of the BA Hons with some research" (B. R. Clark, 1995, p. 79). On the other hand if we construe the Doctorate as principally being a cognitive and epistemic enterprise intended to bring about, or to develop, particular modalities of understanding and knowing in a person, then we may be closer to establishing a suitable justification for the privileging, by the Academy, of Doctoral cognition.[7] Let us examine this line of thought further.

1.3 The nature of the Doctorate and Doctoral cognition

In higher education we discriminate different stages of study (i.e., undergraduate, honours, and postgraduate) by requiring (or presupposing) of the student particular levels of autonomy, regulation, and learning (Denicolo & Park, 2010). This hierarchy of higher educational experiences allows for the acquisition of increasing levels of fine-grained self-regulatory control, perceptual virtuosity, productive thinking, and communicative competence that are needed to undertake advanced study and research (Beauchamp, Jazvac-Martek, & McAlpine, 2009; Denicolo & Park, 2010). As the level of study increases

[7] A distinction is drawn in this work between the type of self-regulation, creativity and depth of understanding required on the part of the Doctoral thesis as compared to an honours thesis. While these two activities may be construed as laying along the same continuum - so as an essay is to an honour's thesis, so to is an honour's project to a Doctoral project. As such, it is the view taken here that doctoral cognition does involve additional constraints and complexity. Kelly's description of continuums is helpful here in characterising this difference. Kelly (1991a, 1991b) explains it is still possible to make dichotomous distinction within scales. In other words a scale can exist between two poles (i.e., as in the idea of shades of grey between black and white). Thus following Kelly we can reasonably, and simultaneously, construe Doctoral and honours study in both relativistic and dichotomous terms.

so to does the cognitive complexity[8] of the tasks and the mental acuity and self-direction needed to be productive and competent in completing them (Entwistle & Ramsden, 1983; Entwistle & Walker, 2000; Long, 1994; Marton, Hounsell, & Entwistle, 1984; Zuber-Skeritt, 1992).

Doctoral education is best understood as both an act of learning and an externalisation or performance of the act of knowing.[9] The Researcher (or in the perspective taken in this work, the Learner), working in collaboration with a supervisor (or Teacher), explores a salient 'disciplined' question (and associated academic domain) over an extended period of time. The product of this exploration – a thesis – is the embodiment of the necessary interactions or conversations between the researcher, a discipline or field(s) of study, and a supervisor (Kamler & Thomson, 2007; McAlpine & Amundsen, 2008; Petre & Rugg, 2004; B. M. Walker, 2009). Doctoral research, to adapt Schoenfeld's (1999b) description of teaching, is a knowledge based activity; it is highly interactive; contingent on dynamically changing circumstances; and requires decision making in the service of multiple and changing goals.[10]

In general terms, the purpose of this activity or performance (and its associated social and cognitive scaffolds)[11] is for the Researcher to elaborate their question (i.e., implicit learning orientation) to a sufficient degree as to be able to articulate a defensible response to it (i.e., explicit performance orientation). There is a generic expectation that some form of observable (and therefore assessable) transfer, transformation and/or mastery will occur as part of this process. In essence, the researcher must demonstrate, via an extended process

[8] Cognitively complex tasks require the capacity to understand and think about problems in a multiplicity of ways and to integrate various types and kinds of information into a cohesive and coherent unit (cf. Rutter & Hay, 1994). For example, Long (1994) describes four ascending levels of research study, progressing from programmatic (where the researcher is introduced to the practice and principles of research) to self referential then to clarificatory and then to universal (where the researcher develops knowledge that is seen to be "true").

[9] Here learning is construed as an adaptive process through which interaction, in and with the world, modifies our pre-existing understanding, knowledge and behaviour. Learning plays a central role in the development and refinement of higher order cognition that is necessary for managing the cognitive complexity involved in academic research. The ascent to higher order cognitive processes/performance requires the self-regulatory capacity to 'pull oneself up by their bootstraps'. Refinement in self-regulation is not merely the process of *more* experience but rather how that experience interactively assists in developing better regulatory scaffolds. Hooker describes this as *superfoliation* and this is seen, in his view, as requiring both vertical and horizontal expansion in regulatory and knowledge frameworks. This theme will be taken up in Chapter 4.

[10] Doctoral study and supervision can usefully be framed in terms of teaching and learning. Connell (1995) observed that supervising higher degrees "is certainly one of the most complex and problematic" teaching tasks and yet, curiously, "[t]his complexity is not often enough acknowledged" (p. 38).

[11] In the context of education, Freire (1972a, 1972b) most notably took up the concept of activity in general and of *praxis* in particular (inheriting both Aristotle's original speculations and Marx's concern with the practice) to represent interconnection between theory, practice, action and reflection. Freire extended praxis by including in his description of reflexive activity the idea of *conscientization*. *Conscientization* refers to the intrinsically situational nature of relationship between people, actions and reflections. Moreover Freire expressed *conscientization* in terms similar to Aristotle's *phronesis* (wise judgement). Rather than being a static state or level, it is a process or mode of being that an agent engages in acquiring and expressing a critical capacity for judgement and reflection. It can be further claimed that construction of a thesis as 'research training' reveals a subtle reification of practical wisdom (*phronesis*).

of 'teaching back'[12] (*pace* Pask), their mastery of what they have 'learnt'. The subtle polysemity of the intent of the PhD – transformation, demonstration, performance, transaction, and exposition - means that the examination of the thesis needs to be simultaneously explicitly summative (at the level of the contribution made) and implicitly formative (the quality of the learning and skills manifest in the artefact) (Denicolo, 2003; Holbrook, Bourke, Lovat, & Dally, 2004; P. Powell & McCauley, 2002; S. Powell & Green, 2003).

Put simply what is argued here is that what makes the doctoral study or experience academically distinct is the type of thinking, and learning, required to make an original contribution to *institutional* knowledge[13] (Damrosch, 1995; Petre & Rugg, 2004; Trafford & Lesham, 2009; Winter, Griffiths, & Green, 2000). Yet, contained in the requirements of originality and knowledge contribution are beliefs about the nature of knowledge and knowing which codify the specific type of meta-knowledge claim that a thesis needs to be able to make.[14] The present work is an attempt to mine the relevant scholarly reflection on the nature of knowledge and learning so as to highlight the magnitude of the problems and prospects of doctoral work construed in the words *original* and *significant contribution to knowledge*. Concordantly, the thesis is an expression or performance of what it means to be *Doctoral*; it represent the student's answer to the question or an anticipation of what the examiners (proxies for the disciplines) require or expect of the student[15]. Doctorateness requires the student to manifest a distinct pattern of inquiry as evidenced in the product. It is this pattern of inquiry, or psychological process, that links Doctoral education across the span of academic disciplines.

The Doctorate is framed not simply as a technical demonstration – for example, showing the ability to source information and arrange it in a suitable and appropriate sequence – instead there is a presumption that the construction of the thesis will constitute an extension of existing wisdom rather than merely a recitation of the 'facts'. Even in this observation there is a sense in which primacy is given to originality and newness. Even if

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12 "Throughout [this text] the customary philosopher's distinction separates single from double quotation marks. Double quotation marks indicate direct citation or the use of a word or phrase in its traditional connotation; single or scare quotes indicate that the traditional connotation does not apply" (Weimer, 1977, p. 267) .

13 Schon (1983, p. vii) notes that "universities are not devoted to the production and distribution of fundamental knowledge in general. They are institutions committed, for the most part, to a particular epistemology, a view of knowledge that fosters selective inattention to practical competence and professional mastery."

14 Merton (1957) describes originality as the "socially validated testimony that one has successfully lived up to the most exacting requirements of one's role as a scientist" (p. 640).

15 This approach allows us to also draw into our analysis the debate regarding the nature of practice based or performance PhD programmes.

existing knowledge is to be used, it must be used in such a way as to bring something 'different' to what has gone before. But how do we discriminate when this is the case? What is the performance required to demonstrate Doctoral thinking? What would advanced Doctoral thinking look like and how might this be distinguished from a minimal performance? Should assessment of the Doctorate be about setting a lower, a mid point or upper threshold of performance? And, if we are required to determine the upper threshold then is the current format of the thesis (and supervision) sufficient to relate this?

There appears to be a tacit assumption (cf. Polanyi, 1983) that there exist some criteria, parameters, conditions or states that can be use to detected the capacity for a scholarly mode of thinking, and when a contribution has been made (Denicolo, 2003; P. Powell & McCauley, 2002; S. Powell & Green, 2003). If this is so, then the generation and detection of knowledge[16] would seem to be simply a matter of the application of some metric (i.e., quantity of information, rhetorical power, number of pages), epistemic calculus, algorithm or computational heuristic. But this largely technical perspective (of how to operationalise or formalise our criterion) fails to engage with the deeper epistemic, ontic and cognitive questions about the sources and limits of our knowledge as individuals (Barnett, 2009; Dall'Alba & Barnacle, 2007; Swann, 2009; Thomson, 2001).[17]

This technical perspective draws our attention to the 'content' of the thesis but in doing it encourages us to ignore the (subjective) experience of the Doctoral student, their learning and the intent of Doctoral education (L. Kelly, 2006; Schon, 1983, 1987). When we speak of a 'significant and original contribution' the obvious question is – a contribution to whom or what? The taken for granted response to this question is that the contribution is being made "to knowledge in general" or "to the discipline". This response seems to imply some kind of 'banking' style exchange (*pace* Freire). The student is required to metaphorically give (or perhaps deposit, repay or even return) knowledge in some way. But what

[16] Plato notes the paradox at the heart of learning, inquiry and knowledge. In the *Meno* Plato explains the issue in the following terms:

> *Meno*. And how will you inquire, Socrates, into that which you know not? What will you put forth as the subject of inquiry? And if you find what you want, how will you ever know that this is what you did not know?
>
> *Socrates*. I know, Meno, what you mean; but just see what a tiresome dispute you are introducing. You argue that a man can not inquire either about that which he knows, or about that which he does not know; for if he knows has no need to inquire, and if not, he cannot; for he does not know that about which he is to inquire.

[17] There is a suggestion of a *sorites*-like vagueness to notions of contribution and originality – at what point can we delineate the difference between having made a contribution and not? What constitutes an addition to knowledge? How much "new" knowledge is required? There is also something of the notion of calculative versus mediative thinking at work in the technical perspective. Habermas (1971) draws an important distinction between knowledge that serves a technical function and knowledge that empowers or emancipates individuals. The notion of a contribution can imply elements of both quantitative and qualitative 'additions' to knowledge, but as argued in this work there is perhaps a tendency, at present, towards the more calculative and technical measure of contribution.

contribution does the Doctorate (and the associated research/study) itself make to the individual (Leonard, Becker, & Coate, 2005)? How does the Doctorate impact on the student? What kinds of transformations, transitions or modifications are required of the individual before the Doctoral student can make a contribution?

These questions have been examined, to a limited degree, from socialisation (e.g., S. K. Gardner, 2008a, 2008b) and identity development (e.g., Colbeck, 2008; Jazvac-Martek, 2008; Kamler & Thomson, 2007; Sweitzer, 2009) perspectives – but the ontological and transformative analysis (e.g., Dall'Alba & Barnacle, 2007; L. Johnson, Lee, & Green, 2000; Wood, 2006) of the Doctoral student's experience per se also remains underdeveloped (Neumann, 2003).[18] It would seem that in trying to understand the Doctorate the institutional focus is far to often on the results themselves, and not on the (cognitive, epistemic or ontic) process of the individual that produced these results in the first place. Let us conjecture, for the moment, that Doctorateness is a mode of being rather than a state or outcome to be achieved. Moreover, let us suppose that, this way of being is the result of interactive, effortful and intentional meaning making behaviour of the individual; and that Doctoral cognition is a particular example of a generalised way of getting a grip on the world. In summary the Doctorate, although it is hard to say without sounding obvious and trivial, is the outcome of an intentional, meaningful and regulated interaction with the world. The Doctorate is not about becoming disconnected and indifferent to the world ('real' or 'academic'); instead the Doctorate is about engagement and interaction. It contains cognitive content and context. This engagement, or experiment, that may itself resemble, or be, an instance of a much more general process of knowing and adaption. To commence in developing a more nuanced understanding of the Doctorate let us begin by proposing a nominal description[19], or model, of the Doctoral process; so that we may set out our terms of reference for inspection and revision.

1. Doctoral education is composed of six elements: a thesis; supervision; a supervisor; a discipline; a candidate (or learner); and an assessment of the thesis.

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18 Accompanying the research on the Doctoral experience, there is growing *genre* of Doctoral memoir and 'self help' literature. This *genre* typically describes the Doctorate as a journey, and often draws heavily on metaphors of voyages, discovery and hardship (e.g., Bowen & Rudenstine, 1992; Denholm & Evans, 2006; Frost & Taylor, 1996; Orton, 1999). At this stage the doctoral memoir is the predominant voice speaking to student experiences.

19 This descriptive model is aimed at providing a 'general' rather than 'standard' model of Doctoral activity. It aims to provide an inclusive description of the *process* of the Doctorate in terms that can accommodate the study for a PhD across creative, technical and theoretical domains. In basic terms it is an attempt to capture what we would see when people are engaged in *typical* doctoral activity and what assumptions does this analysis make about the nature and purpose of this activity.

2. As an activity, the research PhD is purposeful. The student is engaged in the activity in a meaningful and goal directed way[20].
3. That the goals of the PhD are shaped by particular parameters (both individual and institutional/discipline).
4. That the act of completing PhD research is a productive one – that an artefact or performance of some kind is produced as a result of this research.
5. This artefact or performance embodies the experiences and transformations of the student to a sufficient degree that a determination can be made as to the relative performance of the candidate.
6. That the PhD process is construed as a process of learning or at the very least of change (or refinement) for the candidate.
7. That Doctoral learning/research is of a sufficiently complicated nature that it requires not only scholarly resources but also direction and guidance from established researchers (both directly and indirectly).
8. That the provision of guidance, called supervision, serves an educative purpose rather than merely an administrative one.
9. That the *raison d'etre* of Doctoral process is one of education (as opposed to schooling, training or indoctrination). As such, it involves more than merely technical or instrumental exercises (although this may constitute a component of the finished product or activities undertaken) rather that there is some degree of transformation (or emancipation to borrow a Habermassian phrase) as an ideal.
10. The process of Doctoral education is cognitive, interpersonal and social in nature.

These assumptions lead us to converge on an approach that examines the processes of *self directed change, learning or adaptation of individuals*. If these suppositions are correct then understanding Doctoral education may be approached from an entirely different path to that commonly proposed. So practically how would this type of approach work?

The key here is to attend to the productive and constructive requirements of Doctoral research, which mean that *Doctoral cognition* falls within a set of intentional activities (or processes) that are characteristic of intelligent responses of an agent (or individual) to open problems.[21] Here we wish to use the term 'intelligence' in a very particular way[22]. Intelligence is taken to be a descriptive term that encompasses, in Hooker's (1995) words, "the sum total ways in which adaptive systems adapt, including marshalling feeling,

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20 Meaningful activity as stated here should be read to encompass the possibility of both instrumental and non-instrumental objectives. As identified in learning and metacognitive research (J. Biggs, 2003), learners can adopt approaches across a spectrum of surface to deep engagement with activities and goals. Additionally issues such as problematicity (i.e., the threshold above which a leaner must switch from fast problem solving techniques to actively constructing a heuristic to deal with the task) also need to be kept in mind when applying these reference conditions.

21 A general distinction is being made here between intentional, deliberative and thoughtful actions and those actions that are more 'reflex', 'unthought' or accidental responses. This is distinction and related definitional issues are examined further in the following note (cf n. 20).

22 Intelligence, as a concept, has always been contentious and subject to ready debate. From the outset it is important to acknowledge that intelligence is far too complex a notion to be easily captured by a simple definition (Pfeifer & Scheier, 1999). Given these constraints – why then adopt this term here? Because in the view taken here the notion of *intelligence* can usefully be construed to encompasses those aspects that move us beyond the clever but mechanical interactions of 'reflex' (*pace* Dewey) into the domain of the intentional, the willed, the goal directed - to the realm of decisions, rumination, meaning and emotion. Moreover, that when we speak of the "intelligent agent" or "intelligence" we mean something more than simply some index of rationality or anthropomorphism. Instead, what is meant here is that *intelligence* is concerned with the autonomous, purposeful, regulatory and intentional nature of agency in the world.

volition, and evaluation (cognitive, moral, and aesthetic)" (p.12). By association, the notion of cognition refers to the "thinking aspect or dimension of being intelligent, to the action and faculty of thinking, including perception and conception" (Hooker, 1995, p. 12). Under this view, the adaptive conditional requires that intelligence needs "the generation of behavioural diversity while complying with rules" (Pfeifer & Scheier, 1999, p. 32). For Hooker, agents[23] (or autonomous systems) are adaptive[24] when there is an interactive and open relationship between the environment and the agent.[25] These three constructs - *cognition, adaptive regulatory processes (control), and intelligence* - are core to characterising an interactive, intentional and constructive approach to being, doing and learning in the world (Barnett, 2009; Thomson, 2001). It will be contended here that these constructs are equally appropriate for use in developing a rich and nuanced understanding of Doctoral cognition.

In short, Doctoral cognition encompasses the full range of psychological processes and mechanisms involved in conducting autonomous academic research.[26] The act of doing research requires of us the adaptive and creative capacity to seek out solutions to ill-defined problems, in circumstances where we are unable simply to apply pre-prepared responses. It is the complementarity of seeking, finding, knowing, thinking, acting with

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[23] The term *agent* has been widely used in both philosophy and psychology. Unless otherwise specified the term *agent* shall be taken to mean a discrete and autonomous individual who has the capacity to produce effects in the service of goals. This has some similarities with the notion of *individuality*, but agency is seen here intrinsically involve purposeful activity. Bandura (2001) defines an agent and agency in the following way:

"To be an agent is to intentionally make things happen by one's actions. Agency embodies the endowments, belief systems, self-regulatory capabilities and distributed structures and functions through which personal influence is exercised, rather than residing as a discrete entity in a particular place. The core features of agency enable people to play a part in their self-development, adaptation, and self-renewal with changing times" (p. 2). Rychlak (1994) presents a similar position describing agency as "the organism's capacity to behave/believe in conformance with, in contradiction to, in addition to, or without regard for perceived environmental or biological determinants. In other words, an agent has something to say about what will happens to him- or herself as life unfolds" (p. 1).

[24] Within the adaptive processes Hooker (1995) makes an important distinction between adaptation (having a good fit with particular circumstances) and adaptability (capacity for modification to different circumstances or change).

[25] In Hooker's (1995) idiom "Systems are adaptive if their environment is of the kind that the dynamic sequence of system states is a nontrivial systematic function of the state of the environment" (p. 13).

[26] George Kelly's *Personal Construct Psychology* extensively informs this work and as such a note regarding the use of term 'cognition' is warranted. Kelly (1979b) saw the use of the term cognition as problematic – preferring instead the *construct of* 'psychological processes'. Although this stance can be understood as part of Kelly's reaction against the behaviourist and emerging cognitivist paradigms (he consistently eschewed their terminology and compartmentalisation), Kelly was more deeply concerned that this distinction had reached the end of its usefulness (Mahoney, 1988). Warren (1990a) explains that although Kelly saw little use in the term 'cognitive', rejecting the notion of a pure or clearly differentiated process, he did retain the common-sense usage of this term. While mindful of Kelly's point (which will be taken up further in this thesis) the terminology of *Doctoral cognition* has been selected as having the broadest applicability across discipline boundaries. That being said it is acknowledged that this terminology does bring with it some unsuitable associations in some discipline contexts – in particular the idea that cognition is or can be separate from connation and affect (cf. J. Anderson, 1962). Although there are some disadvantages that come with the notion of 'cognition', these have been accepted for the time being in order to allow an exploration of the connections between different theoretical and research lines of activity. But we must be vigilant to remember that when the term thinking or cognition is used what is being construed is that thinking is *something done by someone*.

reason, intention and volition that directs us to a view of Doctoral cognition as a constructive and interactive process.[27]

In summary, Doctoral education, research, and learning involves an active, intelligent (as characterised by Hooker above), purposeful and self-directed agent, who is committed to a process that requires the meeting of specific criteria. These criteria serve as a success or failure condition, that in some way are available to the agent (or can be acquired over time). To assist in this process, both the discipline (or profession) at large (indirect) and a supervisor (direct) provide some form of apprenticeship or guided instruction (Halse & Malfroy, 2010; Orton, 1999; Petre & Rugg, 2004; Schoenfeld, 1999a). Importantly, completing the Doctorate is a real world problem and the skills, knowledge and attitudes required to successfully complete a Doctorate are those that which will be needed to conduct future research (this fact has greatly contributed to the promulgation of the 'research training' view of the Doctorate). Thus, the doctoral process, however potentially stochastic in behaviour, is primarily driven by a goal or end state (again, however ill defined). The PhD is nominally about on the one hand, the production of knowledge (Barnacle, 2005; T. Evans, 2002)[28] and on the other, the learning of the individuals associated with this production (Adkins, 2009; Ashworth & Greasley, 2009; Chaing, 2003; Dall'Alba & Barnacle, 2007; Jazvac-Martek, 2008; Swann, 1999).

But is the scholarly thinking of the Doctorate sufficiently distinctive[29] to be able to separate out the Doctoral from non-Doctoral modalities? This question goes to the heart of the interventionist and structured nature of formal or institutional education and its conferring of epistemic and cognitive authority. There is at least a tacit acceptance of a discernable difference between the cognitions of everyday life and the cognition of academic activity (J. Biggs & Telfer, 1981; Cianciolo & Sternberg, 2004; Cude, 2001; Sternberg et al., 2000).[30] While the degree of divergence is contestable, it nonetheless also seems reasonable to agree that the intensity and duration of abstract thought, planning, symbolic manipulation,

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27 Vaihinger (1952) captures this idea when he asserted that "consciousness is not to be compared to a mere passive mirror, which reflects rays according to purely psychical law, but "consciousness receives no external stimulus without moulding it according to its own nature." The psyche then is an organic formative force, which independently changes what has been appropriated, and can adapt foreign elements to its own requirements as easily as it adapts itself to what is new. The mind is not merely appropriative, it is also assimilative and constructive" (p.2).

28 As James (1903) cautions us, the institutionalisation of the Doctoral process inherently contains the risk of becoming mere 'busy work' and credentialism.

29 A deep question for assessment of the Doctorate is the degree to which 'Doctoral cognition' needs to be included in any determination of competence and excellence criteria with regards to the thesis.

30 This observation goes particularly to the *reproductive* notion of the Doctorate – that there is something in the Doctorate that is necessary for the *formation* of future scholars (G. E. Walker et al., 2008).

literacy and learning make Doctoral cognition dissociable from some other types of cognition (but of course not all). In addition to these functional demarcations, in terms of cognitive process, there are also the *supra* individual factors. Of particular relevance here is how the Doctorate (along with journals, conferences and the like) provides a means for the social legitimisation of particular institutional modalities of academic work (and knowing) (Bourdieu, 1981, 1988, 1991; Merton, 1957). For these reasons it will be argued here that we can reasonably speak of Doctoral cognition as a discernable, if somewhat amorphous, feature of learning in higher education.

This being said, Doctoral cognition is also just one example of a type of (self) regulated knowing which is within a class of activities that are deeply implicated in our understanding of what it means to be rational[31] and intelligent (Auyang, 2000; Hooker, 1995; Johnson-Laird, 1983; Pollock, 1993, 1995). So, this brings us to the question "beyond institutional grounds, why is it useful to separate Doctoral from non-Doctoral cognition?" Why should we separate our perception and knowledge about Doctoral research from perception and knowledge about thinking in general?

One reason to differentiate Doctoral cognition is that it squarely reveals the underground argument that the Doctorate serves as a veridical testament of the cognitive capacity for scholarship (i.e., the ability to make original and substantial contributions to the advancement of institutional knowledge). Doctoral cognition is an exemplar of legitimised cognitive behaviour within the Academy. In opening up Doctoral cognition we expose the role that perception, memory, recognition, discrimination, learning, planning, organisation, conceptual thought, symbolic manipulation, imagination and creative capacities play in undertaking the cognitively complex tasks of doing research and becoming a researcher.[32] One reason, then, for isolating Doctoral cognition as a separate domain of study, is to investigate if, and to what degree, intelligent agents use qualitatively different modes of inquiry, problem solving, and learning when dealing with the open problems[33] that characterise research work and study. In particular, the open problems of 'acquiring' Doctorateness (and its associated modalities of thinking), becoming a researcher (and the

[31] The term *rational* carries with it significant cultural and intellectual baggage (Ralston Saul, 1993). Chapter 9 explores this further and offers a critique of traditional uses of *reason* and *rationality*.

[32] Kelly's (1963) *experience cycle* provides one clear model for how we can construe the iterative of nature of anticipation, engagement, investment and revision that underlie meaning making activity. This framework will be taken up in Part B.

[33] Pretz, Naples and Sternberg (2003) propose that there are two basic problem types – ill defined (open) and well defined (closed). Closed problems require a discrete, decomposable, and molecular response. Alternatively, open problems have no single path, universal plan or algorithm that can be prepared for the comprehending and obtaining their solution. The distinction between open and closed problems is discussed further in Part B.

associated modalities of thinking) and making a significant and original contribution (Merton, 1957; Petre & Rugg, 2004).

A second, and related reason for studying Doctoral cognition in its own right is to investigate how this style of productive thinking develops within the context of higher education. The doctoral experience presents us with a means of tracing the cognitive, conative and volitional aspects involved in responding to the open or ill-defined situations that typify autonomous research. It is reasonable to argue that high-level research, as is stipulated for the completion of a doctoral thesis, should provide us with good visibility of the concatenation of these aspects for the achievement of purposeful, intentional and directed activity.

A third, related reason for studying Doctoral cognition comes from findings about the dynamic and interactive nature of self-regulation, volition, self-efficacy, and metacognition. We are currently being presented with an increasingly rich characterisation of the constructive and regulative dimensions of intelligent behaviour (Auyang, 2000; Cantwell, Scevak, & Bourke, 2010; Cantwell, Scevak, Cholowski, Bourke, & Holbrook, 2011; Carver & Scheier, 1998; Pfeifer & Bongard, 2007; Pfeifer & Scheier, 1999). Some, such as Hooker (1995, 1996; Hooker & Christensen, 1998), have argued that we are facing a revolutionary change in how we conceive of the mind, reason, and agency. This alternate view of intelligence, rationality, consciousness and intentionality requires, in turn, a careful consideration of how our understanding of complex tasks like the Doctorate, which depend on these regulatory dimensions, may need to be revised. With these three reasons as a broad background justification, we will now turn to the question of why developing an understanding of doctoral cognition is of particular importance, and value, for higher education and professional learning?

1.4 Why focus on the Doctorate?

The fact that the Ph.D. is more about understanding, inquiry, and knowledge than it is about testamurs may be said to be self-evident. Nonetheless it will be contended that the 'cognitive' aspects of the Doctorate, and their philosophical underpinnings, are often needlessly being overlooked. Opening up doctoral thinking and learning allows us to trace the aetiology of Doctoral cognition. It also allows us to consider the theoretical tensions, which the current bureaucratisation of higher education (cf. Harris, 2005) has created, in our ideas about the Doctorate.

For instance, in the ongoing contestation about the nature and purpose of higher education (cf. Ball, 2008; Barnett, 1990, 2005; Marginson, 1993, 1997, 2007; Marginson & Considine, 2000; Pearson, Evans, & Macauley, 2008; Rowlands, 2006; Schuller, 1995; P. Scott, 1995; Tapper & Salter, 1992), much of the middle ground in this debate has become dominated by a discourse that can, at best, be labelled as technical[34] (Ball, 2008; Callahan, 1962; J. Habermas, 1987; Thomson, 2001) or calculative (Heidegger, 1968; Warren, 2008) in basis. In particular, we have witnessed the emergence of the idea of the 'Doctorate as a form of research training' (Kalantzis, 2005; Kenway, 2002; Marginson, 2002; G. E. Walker et al., 2008). Concordantly, scholarly debate about Doctoral education has become overly focused upon the question of what type of credential the Doctorate is (e.g., Cude, 2001; Green & Powell, 2005, 2007; James, 1903; Park, 2007; Pearson et al., 2008; P. Powell & McCauley, 2002; S. Powell & Green, 2003). This is arguably a confusion of means and ends at best, and an obsession with form over substance at worst. Perhaps in allowing this narrow view, we are also guilty of mistaking the institutional and administrative instantiations of education and learning for the actual lived experience of learning and knowing (Dall'Alba & Barnacle, 2007; Dewey, 1962; Halse & Malfroy, 2010; Long, 1994; Thomson, 2001; Warren, 1997, 2008).

The rise of this narrow instrumental and technical discourse in higher education has contributed to an increasing neglect of the underlying, or fundamental processes, that shape thinking, learning and development within the university domain; thus limiting the encroachment of emergent disciplines, such as the neuro and cognitive sciences for example, on our view of the Doctorate.[35] This instrumental stance has encouraged an impoverished use of concepts such as: practice, supervision, reflection, skill, training, and knowledge.[36] These powerful notions, which have rich philosophical and psychological traditions, have often been reduced to the level of mere slogans.[37]

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[34] For example, Thomson (2001) applies Heidegger's use of the *technological* (in particular the dominance of one mode of thinking or *being*) to higher education to reveal a trend towards "an increasingly instrumentalize, professionalize, vocationalize, corporatize, and ultimately technologize education" (p. 244).

[35] Although caution is advisable when translating neuroeducational work into the domain of practice, there is substantial theoretical benefit in looking to the question of how this emerging research domain can enrich and deepen our understanding of complex neurological and psychological processes like learning (Battro, Fischer, & Lena, 2008).

[36] This statement is made with an awareness of the critical and radical traditions within education and schooling in general. There is obviously a commitment within the educational scholarly community to seeking wide discourses in educational practice and theory. Nonetheless it is the view taken here that higher education policy and practice has undergone what might be called *colonisation* by bureaucratic discourses.

[37] See Warren's (1998a) critique of academic leadership for discussion of the impact and consequences of adopting an approach that reduced philosophical concepts to slogans.

What is more, there is a strong positivist and economic rationalist viewpoint determining what counts as legitimate claims (Ball, 1994; Gaukroger, 2006) with regard to higher education. Accordingly, there is a widespread misapprehension that it is only bureaucratic or administrative knowledge claims that should have currency in higher educational decision-making (Elmore, 1993; R. J. Evans, 2007; Kerdman & Phillips, 1993; Kliebard, 1993; Laurillard, 2002; L. E. Shulman, 2007; L. S. Shulman, Golde, Conlkin Bueschel, & Garabedian, 2006).

Reinforcing this economic imperative is the discursive weight and prominence that has been given to globalisation and market forces in higher education policy. We are now more frequently discussing the processes of higher education in terms of administration, assessment, ranking, key performance indicators and credentials rather than in terms of reason, knowledge, wisdom, judgement, agency, identity, cognition, affect or conation. This bureaucratic notion of education (Warren, 2008) can only be held out of an indifference to, or dismissal of, the deep scholarship surrounding the foundations of learning and knowing as interactive, adaptive, constructive and social processes.

If the current debates surrounding professional Doctorates and other related tertiary qualifications (ABRC, 1996; J. A. Armstrong, 1994; Burnard, 2001; Cumming, 2009; Green & Powell, 2005, 2007; McAlpine & Norton, 2006; A. Taylor, 2007) are any guide we appear to have largely set aside the question of 'how can we, in a principled and systematic way, understand (Doctoral) learning, thinking and inquiry?' in favour of a much more mundane concern with the comparability of credentials. Without some comprehension of what is involved, at a deeper level in this mode of learning, we will be unable to make principled discriminations between the different modalities and degrees of quality that appear to be presupposed by the credentialism debate.

In summary, the ascendance of this narrow technical and instrumental orientation appears to have come at the cost of our desire, and perhaps our capacity, for undertaking ambitious and large-scale theoretical analyses of the life world of higher education (Barnett, 1990, 2009; Lee & Green, 1995). Indeed it appears, in more general terms, that scant regard is being given by administrators, instructors and researchers to the philosophical and psychological heritage of many of the most fundamental and pervasive elements of education as they apply to learning in higher education. In disregarding these doctrinal and methodological traditions we are ignoring a rich source of ideas that have yet to be fully exploited by higher educational learning theory (Haggis, 2009). Moreover we are failing to squarely address the processes that are assumed by the very notion of 'further study'.

Without a thoroughgoing formulation of the phenomenon (behaviourally, socially, and cognitively) that characterises thinking and learning at the Doctoral level how are we to meaningfully and systematically answer educational questions about this domain? A case in point is the standard view of learning and cognition used within the higher education sector (Haggis, 2009). This view leaves many formative questions unanswered (and in some cases the questions themselves even remain unasked). For example consider the questions we have raised thus far: what is the nature of Doctoral thinking and inquiry? What are the cognitive and behavioural processes that enable researchers to complete their studies and make an original contribution to knowledge? To what degree is it similar to or different from our everyday modes of thought and action? What is the developmental course of Doctoral cognition? And more programmatically, what are we to do with the answers to questions like these? The Doctorate when defined purely in technical terms is silent on these types of questions. Silence on such question might be expected if the study of education and learning had only just begun; clearly, it has not.

As a discipline, Education has exhaustively devoted itself to understanding the fundamentals of learning, thinking, development and instruction so as better to inform theory and practice. It would seem conceptually and convictionally inconsistent if we fail to pursue deeper understanding of Doctoral cognition and learning. Without robust theories of cognition and learning in the context of higher education, we lack the deep foundations necessary for identifying the appropriate instructional, supervisory and assessment processes (Bickhard & Campbell, 1996; J. Biggs, 2003; Entwistle & Ramsden, 1983; Laurillard, 2002; Marton et al., 1984; Schommer, 1998) that are needed for the facilitation of Doctoral education.

Of course such a polemic observation will quickly draw the counter claim that this is a straw man argument and that in truth substantive work *is* being done. Yet a majority of even the most progressive and large scale work in psychological and philosophical theorising in higher education, particularly in Australia, appears to be occurring at the margins and is not penetrating into the 'hard core' (cf. Lakatos, 1978; Lakatos & Musgrave, 1970) of mainstream higher education practice, policy and theory (Australian Qualifications

Framework Advisory Board, 2007; PMSEIC Expert Working Group, 2009; Standing Committee on Industry Science and Innovation, 2008). This observation is not made in an effort to diminish what work is being done; but instead this is an acknowledgement that the impact of theoretical work is tending to be dissipated or fragmented in the tertiary sector as a whole. This has left the standard technical or instrumental view of higher education intact and largely unchallenged. Perhaps there are instrumental reasons for co-opting the techniscist paradigm, and a tactical advantage to be gained by doing so; but we need to have both tactical and strategic vision of this issue.

In conclusion, it is the view taken here, that there is a need for a coherent theoretical program in higher education in general, and Doctoral and professional education in particular, that pays due consideration to both foundations and functions[38]. It is the absence of a programmatic response in higher education theorising that is responsible for a lack of an efficacious reaction to the ascendant technicist paradigm of Doctoral education. In Husserlian terms we have lost sight of the real matter of interest.

1.5 Project rationale

The work presented herein will contribute to addressing this situation by laying down a theoretical footing for conceptualising Doctoral cognition and inquiry. This thesis will be proposed as part of a *larger program* that will seek to realign basic and applied thinking about higher education and learning. This work will seek to identify within both philosophical and psychological traditions the constitutive *cognitive*, *affective*, *conative*, *epistemic* and *ontic* processes implicated in Doctoral education. This work aims to be relevant to researchers and theorists in higher education and provide a construct that can take into account people's ability to acquire knowledge, to construct meaning, to act and to learn. To achieve this will require the development of a distinctive theoretical document - at once analytic, descriptive, synthetic and subversive. Let me briefly explain each of these distinct lines of activity.

This work is both *analytic* and *synthetic* in that it incorporates a wide range of literature including that relating to cognitive science, complex systems theory, intentional conceptual change, and metacognition and teases out the interconnections and the

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[38] Brumbaugh (1973) identified philosophy as having a pivotal role in this kind of reform. He explains "it is only with philosophy that one can recognize the framework of presuppositions in the higher levels of generality of the system, and judge their adequacy by the degree to which they are realistic. Such judgement must combine philosophical analysis and metaphysical speculation, since to determine what is or is not realistic requires a prior knowledge of what is real" (p. 7).

conceptual integrity in that literature. To distil from this diverse literature the foundational elements of Doctoral cognition will require the use of insights gained from pure and applied psychological theories about *regulation*, *cognition* and *intelligence*. This analysis is undertaken with the overall goal of illuminating, from multiple points, Doctoral cognition. The intent of this exposition then is to identify a set of *integrating concepts*, which could then be used to guide our thinking about and clarify the doctoral experience. Thus it might provide a more sophisticated analysis of the common criteria for the Doctorate such as: a substantial contribution to knowledge and having demonstrated an understanding of the relationship of the investigation undertaken to a wider field of knowledge by establishing a research question of significance; demonstrating the ability to clearly conceptualise and articulate the research objectives and associated hypothesis; demonstrating a detailed, critical and comprehensive knowledge/understanding of the literature and the theoretical constructs pertinent to the stated research objectives and clearly enunciating the nature and extent of their supposed original and significant contributions to the body of knowledge[39]. In other words, what do supervisors, candidates, and, indeed, the Academy mean when this type of statement is made?

This work is also *descriptive* in two ways. Firstly, it offers a theoretical account of the processes associated with cognition in open or ill-defined circumstances (which are taken here to be endemic to research (cf. Dunbar, 2001)). This will essentially be a characterisation of the productive and intentional aspects of intelligence as it relates to research. Secondly, this philosophical description will be augmented by a small series of representative anecdotes. These anecdotes, drawn from the accounts of Doctoral students and supervisors, will be used to sharpen the contribution that this type of analysis can make to our understanding of Doctoral cognition and education (Ihde, 1984). These anecdotes might be considered a form of 'qualitative data'. The goal in working with these data is to identify generalisable features of Doctoral cognition that can contribute to our understanding of the 'cognitive' processes that produce Doctoral research.[40] In these terms, this work is deeply concerned with regularities, themes, constructs, patterns, and change.

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[39] Adapted from guidelines for examination of Doctor of Philosophy – University of Ballarat. Such guidelines are relatively consistent across Institutions

[40] Kelly advocated the view of a person as forms of *motion* and as such attempts to identify stable or unchanging features become problematic at the very least. Kelly (1969) stated that, "accurate prediction, then, can scarcely be taken as evidence that one has pinned down a fragment of ultimate truth, though this is generally how it is regarded in psychological research. The accuracy confirms only the interim utility of today's limited set of constructs. Tomorrow's genius will erect new dimensions, open up unsuspected degrees of freedom, and invite new experimental controls. And yet, however useful prediction may be in testing the transient utility of one's construct system, the superior test of what he has devised is its capacity to implement imaginative action. It is by his actions that man learns what his capacities are, and what he achieves is the most tangible psychological measure of his behavior. It is a mistake always to assume that behavior must be the psychologist's dependent variable. For man, it is the independent variable" (p. 33).

Finally, this work is envisioned as serving a *subversive* function by energising the debate about the fundamentals of higher education (theory and practice). This work is intended as a challenge to channalised modes of understanding, and is a call for an expansion in our notions of Doctoral cognition and inquiry. In other words, this work represents a philosophic *intervention* into the debate surrounding higher education in general and learning and cognition in particular.

In doing so, this work will contest rigid, idealised and dehumanised models of education and learning, in favour of approaches that recognise cognition and learning as context-depended, constantly evolving, constructive, and the product of dynamic human interaction. This element of the work is conducted with the presumption that in disrupting stable or 'hardened' views that there is predictably some form of push back, resistance or conflicting viewing. Notwithstanding this specific issue, we are also well served to remember that higher education is but only one circumstance in which we can meaningfully talk about supervision, learning and training (Lave, 1988; Schon, 1987). We must ensure that we are prepared to look across the whole gamut of these phenomena. In this we are moving from the specific case of Doctoral cognition toward a generalised understanding of cognition as it is involved in self-directed learning, in response to dynamic and open circumstances.[41]

This document then, as a whole, is best understood as a philosophical and psychological[42] unlocking of the processes of Doctoral cognition. It draws together various traditions, paradigms and concepts for consideration; and it demonstrates the value for educational theory in opening up the notions of cognition, intelligence, intentionality and agency. There is much under-labourer work (*pace* Locke) that needs to be done in higher education to 'clear the ground' before we are free to set out the conceptual foundations necessary to build a compelling account of Doctoral cognition. This work is in that tradition, with similar, but humbler, ambitions as had Locke.

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[41] Additionally, by seeking to describe the doctoral experience in terms of *being* and *thinking* we should be able to see what points of similarity there are with cognition in of other domains of experience.

[42] The intersection of these two disciplines will be referred to as *philosophical psychology*. This approach is also labelled philosophy of psychology (Bermudez, 2005). Of course the conjunction of these disciplines seems *natural* but this ease of association disguises some deep questions about what is psychology and by extension what is philosophical context of this domain. See O'Donohue and Kitchener (1996) for examples of the different types of work conducted under the banner of philosophy and psychology and Harriman (1946) for an example of the early definitions of this domain. It is helpful also to be reminded of the differentiation Pellegrino and Thomasma (1981) drew between philosophy *and*, *in*, and *of* a particular field. Philosophy *and* a discipline refer to collaborative investigations or discussions between two disciplines. Philosophy *in* looks at the application of philosophy to a particular problem, task, theme or issue in a discipline. Philosophy *of* is concerned with critical analysis of concepts, theories and structures of a discipline.

1.6 Objectives, pitfalls and risks

In commencing this under-labourer work, four interconnected objectives will be pursued herein:

- One is to develop and vindicate a set of analytical tools for thinking about intelligence, cognition, reason and problem solving (which have been identified as fundamental elements of Doctorateness)
- A second is to develop a substantive theory of research problem solving or productive research thinking. It is the view put forward in this thesis, that the processes of meaning making and problem solving are central to building models of cognition and learning. Furthermore, exploring inquiry and critical reflection should offer insight into both everyday cognition ('in the wild') and institutionalised problem solving. To this end, it will be proposed that a normative model of problem solving that is based on (perceptual) interaction and active construction of the world provides constructive possibilities for expanding our understanding of higher order cognition. The mechanism of conceptual change, personal epistemology, gnosiology[43] and ontology lie at the heart productive thinking. This resonates deeply with aspects of both Piagetian and Vygotskyian notions of change, development and regulation, and Dewey's views on inquiry and knowing. Moreover, it will be argued that in developing an understanding of research problem solving, we can also begin to explore how we might go about empirically testing the efficacy of the upper modalities of cognition proposed in Piaget's and Vygotsky's developmental models.
- A third is to advance a critique of, and alternative to, idealised models of cognition, intelligence and reason. That is, to offer a view of intelligence that is interactive and grounded in the lived world (and in doing so linking with the phenomenological and hermeneutic traditions). Under this view, self-directed learning (as a form of intelligence behaviour) is construed as fundamentally an interactive process of dialogue and construction.
- The fourth is to explore, from this interactive-constructivist perspective, Doctoral cognition. What emerges from this exploration is a demonstration of how a naturalised account of Doctoral cognition (with an emphasis here on problem solving and gnosiology) can be read off from basic and applied research. This

[43] Kelly (1963) defined *gnosiology* as "the systematic analysis of the conceptions employed by ordinary and scientific thought in interpreting the world, and including an investigation of the art of knowledge, or nature of knowledge as such" (p. 16).

understanding can then be used in the development of philosophical frameworks for education. In doing so, this thesis will lay down the groundwork for considering where and how further empirical support for a conception of productive thinking would be gathered.

One risk in undertaking work that addresses such broad objectives as these stated above is that in the final analysis the work will not be sufficiently comprehensive for its arguments to be judged as satisfactorily compelling. This risk must remain because not every relevant contribution to the ongoing discussion of philosophy and psychology of the mind and learning will be able to be considered (Warren, 1998b). However where this occurs, it should be framed in terms of an oversight rather than deliberate exclusion. The intention of this work has been to identify, as broadly as practicable, the possibilities offered by a far-reaching array of research and theory[44] strands.

Another risk is that in trying to draw such a wide collection of concepts and constructs into focus that this might, by the nature of breadth of the investigation, leave many connections impoverished, undeveloped or muted. Yet if this work is to be generative then it must, by its nature, provide some room for speculative rather than exhaustive explication. Concordantly, this work should be recognised as a contribution to an ongoing conversation[45] about the nature of mind, cognition, and learning. This conversation stretches beyond the immediate issues to long held debates about the nature of thought, identity, consciousness and being. By its very nature, philosophical debate will tend to involve questions that resist resolution, and that instead continue to remain both open and under contestation. This work is by definition provisional and as such subject to future elaboration as we test our understanding against our experiences and ideas. Clarity, thoroughness, and rigour rather than appeals to some arbitrary notion of 'completeness' are thus the most appropriate requirements to be read down, in the first instance, into this work[46].

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[44] Inspiration is taken here from Larmor's description of the progress of scientific ideas, in his introduction to Poincare's (1952) *Science and Hypothesis*, "new ideas emerge dimly into intuition, come into consciousness from nobody knows where, and become the material on which the mind operates, forging them gradually into consistent doctrine, which can be welded on to existing domains of knowledge. But this process is never complete: a crude connection can always be pointed to by a logician as an indication of the imperfection of human constructions" (p. xviii).

[45] As a participant in this discussion, this work seeks to add its voice, rather than replace all other voices in the debate.

[46] This issue will be taken up in more detail in Part B. The aim of this work is to better understand or deepen our knowledge of, rather than explain (i.e., offering a mathematic prediction of outcomes or a fixed law), doctoral cognition. In the spirit of Kelly's (1991a, 1991b) *constructive alternativism* it is necessary to see the theoretical work done here as being subject to future development, elaboration and validation. "In this respect we are reminded of earlier observation concerning Stirner's instance that no abstract concept be held so firmly that it cannot be given up, no concept reified such that they own you more than we own them" (Warren, 1998b, p. 109). Lincoln and Guba (1985) advocate this kind of work needs to be assessed differently. They propose that *credibility* (replacing internal validity), *transferability* (replacing external validity), *dependability* (replacing reliability) and *conformability* (replacing objectivity) are defensible criteria for evaluating research of this type (Guba & Lincoln, 1982).

Following on from this line of thinking, there is also a need to guard against fallacious, biased or privileged adjudication and application of evidence. Determining the validity of constructs put forward here is dependent on both the judicious evaluation of the work of other thinkers and the cautious application of their evidence and arguments. Care must be taken to ensure that neither evidence nor concepts are stretched beyond their *range of convenience* – that we avoid the trap of privileging metaphor and allegory over argumentation. This will require us to keep an eye out for equivocation and the substitution of our *explanandum* (that which is explained) with our *explanans* (that which does the explaining). As such, it is critical to the integrity of the project that that our theorising is bound within a meta-philosophical structure (in this case interactive constructivism) that aims to empirically constrain or regulate our constructs where necessary[47]. These comments have particular application to Part C of the thesis where we work with the interview data for the project.

This work also faces the challenge of being, to some degree, self-referential. How does a doctoral project exploring Doctoral cognition objectify the very experience being used to conduct the research? As Bourdieu (1988) notes, any attempt to study the world in which we are involved, obliges us to acknowledge the epistemological problem that this presents. This acknowledgement entails confronting the issue of difference between the lived knowledge and experience of the researcher, and the requirements of scholarship (Dall'Alba & Barnacle, 2007; Delamont, Atkinson, & Parry, 2000; Petersen, 2007).

In doing this kind of work we are our caught on the horns of a dilemma. Firstly we need to be wary of the rhetoric of *ad hoc* explanations, based on covert subjective experiences that seek justification in *ad hominem* arguments. Secondly, we need to consider the important differences between, what Bourdieu terms, the 'empirical' and 'epistemic' artefacts that are created by the research process. In this sense Doctoral cognition is both a construct to be read off from experience, and an empirical process in the world. It is through the application of reflexive practices and careful explication of our constructs that we can make explicit our understanding; and in doing so we are assisted in the task of passing between the twin dangers of folk knowledge on the one hand and reification on the other.

[47] "Metatheories are like perspectives or vantage points: they provide a point of view from which a domain may be scrutinized. In providing such conceptual underpinning to a domain of inquiry a metatheory is in itself all but invisible: one "sees" the domain through the conceptual glasses that constitute the metatheory, but one does not see the metatheory itself" (Weimer, 1977, p. 269). Kelly by requiring a credulous attitude on the part of those wanting to make use of his theory of personal constructs, aimed to guard against the danger of losing sight of "glasses" we view the world by (Rychlak, 1994; Warren, 1998b).

Consequently, our inquiries must be seen as part of an ongoing constructive interaction, or as Kelly (1991a, 1991b) describes it an experiential cycle (anticipation, investment, encounter, confirmation-disconfirmation and constructive revision) that marks our engagement with the world (be it either epistemically or ontologically). This cycle of engagement is, in Paskian terms, a conversation between the world (and the affordances it offers), being, and meaning. This process of construction is ongoing and subject to review and critique is a key strategy in offsetting the epistemic challenge of studying Doctoral cognition[48]. To summarise what has gone before, what should be foremost in our mind is to provide a generative program that constructs thought and action in different terms. In seeking out these (new) possibilities we should strive to hold our constructs lightly, being ready to both follow them where they lead and to surrender them if they prove to be false friends (Stirner, 1842, 1845; Warren, 1991, 1998b).

In relation to the central 'problematics' of this work – the role of *knowing* and *knowledge production* in the Doctoral inquiry – there is a concern that our questions about the nature of the Doctorateness may only be applicable if we accept an idealised view of the Ph.D. over that of much more prosaic images. Perhaps in speaking of 'Doctoral cognition' we are freighting the whole process of Ph.D. study and supervision with too much philosophical and psychological significance.

For example, in doing so we may be losing sight of the various instrumental motivations that drive a student to study. In reality, Doctoral activity can be reasonably argued to occur across a spectrum that ranges from instrumental to transformative in scope. Moreover, we can adopt either a surface or deep approach with regards to our engagement with learning tasks and be motivated by extrinsic or intrinsic factors[49]. Nonetheless even the most instrumental of projects involves the negotiation of the topic and a resolution to the

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48 In other words, we are trying to come to grips with Doctoral cognition. Although Kelly was sceptical of phenomenology (possibly based on a misapprehension of the discipline) (Warren, 1998b) there is useful connection between Kelly's cycles of engagement and Merleau-Ponty's (1962) notion of maximal grip. Merleau-Ponty discussed the way in which we seek to try and grasp or grip up the world, but he noted not just active nature of this process, but also that in doing this we were striving for a point in which we have maximum grip. He explains this in the following terms: "For each object, as for each picture in an art gallery, there is an optimum distance from which it requires to be seen, a direction viewed from which it vouchsafes most of itself: at a shorter or greater distance we have merely a perception blurred through excess or deficiency. We therefore tend towards the maximum of visibility, and seek a better focus as with a microscope" (Merleau-Ponty, 1962, p. 271).

49 Atherton (2008) offers an interesting idea in regard to this issue. He sketches a matrix of willing/unwilling practice and witting/unwitting practice. This matrix frames four kinds of practice: intentional, survival, shallow and driven. There is face validity to these categories, which seem to fit the *types* of approach to Doctoral study. Leont'ev (1981) distinction between *activity* and *action* also provides a useful lens to view Doctoral student behaviour. Leont'ev concept allows us to differentiate the *actions* a student may undertake from the social motivation or goals of the student (*activity*), which may not be immediately discernable or even directly associated with their actions – what we do may not be obviously connected to our goals (e.g., J. C. Clark, 2003). Furthermore, individuals may engage in similar actions but with different activities driving them.

practical requirements for conducting research. These activities, independent of motivation, involve the acquisition and application of knowledge. However, different motivations could imply different conative, cognitive and affective transactions on the part of the student, but this situation is viewed here more as a difference in type than kind.

Of course, as previously noted, this mode of productive and constructive thinking is not limited to Doctoral education – instead it is a fundamental process for change, and regulation, in response to all and any ill-defined problems. Productive thinking is in fact a key component of that domain labelled professional in contrast to the technical and technological domains. The Doctorate is but an exemplar of a type of ill-defined activity that can require us to respond by productively thinking about, and inquiring into, the world.

Accordingly, the possibility that our understanding of the Doctoral process proper may only be partial does not necessarily serve as a fatal blow to this analysis. In fact, this work will advocate that it is often the very the process of attempting to answer the question itself which allows us to better understand the problem in the first place. Consequently by examining the goodness of fit between the proposed view of Doctoral cognition (which applies at the very least to some if not a majority of Doctoral work) and alternative views we are in a stronger position to extend and revise our position.

Associated with the risk of how we view the Doctorate – there is the question of how we view the Doctoral student. This work will blend idiographic and nomothetic concerns. The focus of study is not to develop an in depth understanding of specific individuals or groups, rather it aims to understand individual or personal meaning, gnosiology and being. However to develop this understanding we will need to sharpen it against the experiences of individuals. In adopting this approach we will be combining idiographic sensibilities with process and realist metaphysics.

Realism, constructivism and individualism do not always sit easily alongside each other. In fact some would argue that they cannot be reconciled, but this work will suspend or bracket off these hard division, and look to benefits of illuminating the issue of Doctoral cognition from a variety of points. Exploring the implications of this work here, therefore, does not require a denial of tensions that exist between realist and constructivist thinking. Instead it requires of us, in the words of Kelly, a *credulous attitude*.

Finally, perhaps the biggest risk is that the gap between the theoretical and the applied[50] aspects of this discussion will be too wide. By placing cognition and intentionality at the centre of this work, we are protected against this kind of division to some degree. The use of descriptive data drawn from within the Doctoral process itself, also affords us the opportunity to test our ideas against the litmus of lived experience. Now let us briefly outline the structure of the subsequent chapters.

1.7 Structure of the thesis

The structure of the thesis will be as follows. The work is broken into four main parts: Foundations (Part A), Elaboration; (Part B), Application (Part C) and Revision (Part D).

Part A provides the background for the theoretical framework to be developed in the thesis: first, by discussions the notions of cognition, intelligence and regulation; and second, by discussion some basic philosophical assumptions about the connection between agency, intelligence and meaning. At the close of Part A the reader should have a clearer understanding of cognition and intelligence, and their role in agency and identity. This section is intended to set out the preconditions of Doctoral cognition – intelligence, self-regulation/control and learning – as well as the key enablers or catalysts for these conditions – autonomy, agency, and normative behaviour.

Part B undertakes to build upon the baseline understanding acquired in Part A. This section exposes the process of Doctoral cognition by drilling down into the idea of research as the act of productive problem solving. The engaging with ill-defined or open problems serves as instance where both anticipation and experience (both validating and invalidating) is key to adaptive processes. The elements of productive problem solving – reason, intentionality, meaning and construction - are separated out from the processes, and then examined each in turn. The objective of Part B is to elaborate a model or framework of normative and naturalised open problem solving.

Part C pursues the sharpening of this formulation against ideographic data collected from Doctoral Students and Supervisors. This section contains a technical discussion of

[50] Similarly to concepts introduced earlier, the distinction between *theoretical* and *applied* domains is a distinction of convenience. It has been taken up here more to reflect the prevailing discourses in the broader Education field than a firm conceptual commitment on the part of the author. Concordantly these labels are used with at least a small degree of skepticism. The distinction could also be rendered as the gap between what is argued to be the '*real*' world and that of theorizing or '*navel gazing*'.

research methodology, data collection and analysis. Key themes and patterns are examined for their utility in validating and refining the argument set out by the previous sections.

The purpose of **Part D** is to draw in and weave together the various strands from the previous three sections. This section directs us towards the ways in which we need to revise the standard understanding of the Doctoral process. Part D provides an examination of the results of empirical and theoretical investigation as seen through the theoretical lens of Doctoral cognition. The subsequent course of action takes account of the need for both educational relevance and utility. In particular, space is given over to unfolding a programmatic response to the current channelized modes of thinking. What is argued for is not simply the substitution of one concept for another, but rather the revision of our construct of higher education. This course of action sees both the identification of further analytical work, in addition to setting out practical strategies for implementing the outcomes of this work. This part takes further the conjectures set out in the opening sections, and speaks to how we might imagine the Doctoral process as an instance of an adaptive and generative thinking rather than technical and calculative exercise.

1.8 Concluding comments

The chief contention of this thesis is simple; *knowing* is at the core of the Doctorate and Doctorateness – but this is a particular kind of knowing. At the most basic level this work is seeking to extend our fundamental understanding of the Doctorate as a learning experience. The Doctorate is an attenuated exemplar of productive thinking, as it applies to the doing of academic research. But the specificity of this exemplar does not imply a narrow view of cognition. It is the intention of this work to consider the phenomenon of thinking and learning as holistically as practicable, and to identify the possibilities for expanding our understanding of Doctoral cognition by bringing together disparate fields of inquiry. Rather than merely adding to the heap of information we have about psychology and the mind, this work is looking to organise it in some more effective and accessible way.

This exploration of knowing and doctoral cognition has grown out of an on-going interest in psychological processes, cognition, and learning in general. This project seeks to expansively investigate how as beings in the world we locate and share information; develop levels of understanding about this information in the world; and then, in the final analysis, act on this understanding. These can be seen as evergreen issues that underlie the domains of knowledge, reason, cognition, intelligence and skilled behaviour. In seeking to understand any one of these domains we are insistently drawn into acknowledging the others.

The key positions of Doctoral cognition can be summarised in the following terms:

1. Existing research has overlooked the "essence of Doctorateness", a neglect of the mind and education.
2. The Doctoral process has inherent value in changing the nature of knowing and understanding.
3. Identifying and describing this allows for explanation of the privileged place of the Doctorate through its 'epistemic authority'.
4. Thus the 'epistemic authority' derives from a specific form of Doctoral cognition: the intelligent response to an open problem complementarity of seeking, finding, knowing, acting with reason, intention and volition that direct us to a Doctoral cognition as a constructive and interactive process.

What follows then in the subsequent chapters is a gradual opening up of knowing by exploring *cognition, intelligence, control, reason,* and *knowledge*. This exploration will unfold under the auspices of a programmatic concern with Education. This work will be conducted with reference to the *philosophical psychology* tradition. Given the complexity and interdependence of the objectives of this study, a gradualist approach will be taken, with each constituent element of the object of our concern – Doctoral cognition – being taken in turn. We will build up the foundations of our understanding and then move on to refine this appreciation by considering it against experiences drawn from the life world of the Doctorate.

PART A

FOUNDATIONS

The concrete is concrete because it is the concentration of many determinations, hence the unity of the diverse. It appears in the process of thinking, therefore, as a process of concentration, as a result, not as a point of departure, even though it is the point of departure in reality and hence also the point of departure for observation [Anschauung] and conception. ... [T]he method of rising from the abstract to the concrete is only the way in which thought appropriates the concrete, reproduces it as the concrete in the mind (Marx, 1978, p. 237).

CHAPTER TWO

PROLEGOMENA: FOUNDATIONS OF THE MIND

2.1 Orientation

Since the concern in this section is with foundations, it would seem only fitting that prior to opening up the problem of Doctoral cognition that a few words be said about the conceptual antecedents of this research project. Neither research, nor researchers, spring forth fully formed (Long, 1994); instead there is a process of experimentation, approximation, accommodation and assimilation of concepts, constructs and identity over time[51].

Roughly speaking, we come to *our understanding* by trying to understand. To help guide our understanding we make pragmatic use of our past attempts at making meaning and choosing actions. The psychological processes that constitute us, and allow us to adapt, cannot be indifferent to the world. As individuals *we are tacitly invested and interested* in our attempts to make meaning (Warren, 1998b).

One way in which we can relay our 'meanings' is the through the use of metaphors, motifs, analogy, intuition pumps and 'just so stories' (Lakoff, 1990; Rorty, 1989). In this prolegomena we will make use of four distinct, but related, motifs as conversation starters: The more difficult problem (the fundamental and pervasive nature of thinking and acting); driving force (the role of intelligence in characterising our discussions about thought and action); productive thinking (the constructive and productive nature of our cognitive engagement with the world); and finally, moving into the borderlands (the need for a return to *hetrodoxical* and dynamic modes of theorising). These heuristics are not a replacement for thinking on the part of the reader, far from it. Here we wish to stimulate and help the reader to better understand the direction of this work.

These images have been selected to express the essential themes within this work. They are also a demonstration of the outlook adopted in this work. Accordingly, the prolegomena is intended to provide an intellectual orientation for the thesis. It is more than simply 'another' introduction[52]. The aim here is not merely to pass on information; instead it is to

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[51] Kelly's (1979a) *autobiography* of personal construct psychology is an example of this point. Kelly explains the various experiences, speculations and formulations that informed the development of his position of constructive alternativism and his theory of personal constructs.

[52] The usage of a prolegomenon here is intended to fall within the tradition of its usage by philosophers rather than the more spurious usage that Merton (1969) parodies in his *Foreword to a preference for an introduction to a prolegomenon to a discourse on a certain subject.*

offer both an explication of the direction of the argument as well as the tendency of thought that has shaped this direction. In doing so it augments the more procedural discussion sketched previously in the Introduction, by elaborating on the conception of the domain in question. This prolegomena is intended as a means of commencing a deeper conversation; to serve as a *conceptual aperitif*[53].

2.2 The more difficult problem

Einstein (1936) observed that the more difficult problem faced by scientists was not the examination of concepts within their own field of study, but rather the problem of analysing everyday thinking. Everyday thinking involves interactive and contingent knowledge-based activities that are enacted in highly dynamic circumstances in the service of multifaceted goals (Auyang, 2000; Dewey, 1929, 1997; Dreyfus, 1992; Johnson-Laird, 1983; Klahr, 2000; Lave, 1988; Schoenfeld, 1999b)[54]. In fact, everyday thinking, in whatever circumstances we choose, involves significant *finesse* and context sensitivity. This complexity is not exclusively the purview of what we might typically, or even pejoratively, identify as 'advanced' 'intellectual' or 'scholarly' thought – it is instead a fundamental truism of higher order thinking regardless of the content of these cognitions.

The irony of scholarly activity is that while there is a professional tendency towards the primacy of understanding, this attitude has stereotypically been limited to discipline based content. The need for understanding is rarely reflexively extended to the context or the means through which disciplined knowledge is obtained (Bourdieu, 1990, 1991, 1998). A case in point is the commonly held opinion in higher education settings, that cognition and learning are transparent or self-evident processes (this could be labelled as a 'folk theory of education') and that discipline knowledge is the only requirement for providing instruction in the higher education domain (Entwistle & Ramsden, 1983; Marton et al., 1984; Olson & Bruner, 1998; Zuber-Skeritt, 1992). This would be merely an amusing academic peccadillo, if it weren't for the fact that this view is so pervasively held and is used to consistently underwrite much of the instructional practice that is currently occurring in the name of higher education (J. Biggs, 2003; Laurillard, 1999, 2002; Prosser & Trigwell, 1999). Indeed

[53] Although possibly superfluous, it is worth explaining that independent reflection and criticism on the part of the reader is tacitly implied here and throughout this work (Poincare, 1952).

[54] Schon (1987) provides a good example of this in his description of a carpenter at work. "If a the carpenter asks himself, what makes this structure stable? And begins to experiment to find out – trying one device and now another – he is basically in the same business as the research scientist. He puts forward hypotheses, and within the constraints set by the practice context, tries to discriminate among them – taking as disconfirmation of a hypothesis the failure to get the consequences predicted from it. The logic of his experimental inferences is the same as that of the researcher's" (p. 147). Dewey (1917) proposes that "all thinking has its origins in what is uncertain in the subject matter of experience, which aims to locate the nature of the perplexity and to frame hypotheses for its clearing up to be tested in action" (p. 387).

there is an important story to be told about the role of folk theories of education in the domain of higher education.

Psychological theory has long explored the difference between our folk or intuitive understanding of the familiar, and what can be revealed through systematic inquiry (Geary, 2005a). It is the masking effect created by our background assumptions about the nature of thought and behaviour (i.e., folk psychology), that in many ways makes understanding the cognitive, conative and affective dimensions appear to be simultaneously self-evident and inaccessible. It also perpetuates the notion that these 'functions' are discrete from one another rather than integrated, and, consequently, that they can be studied in isolation. As Kelly (1979b) notes: "the classic distinction that separates these … constructs has, in the manner of most classic distinctions that once were useful, become a barrier to sensitive psychological inquiry" (p. 140).

Both Brentano (1960, 1973, 1981) and Husserl (1965) have instructed us on the importance of separating the analytical attitude we use in comprehending the world from our natural attitudes (and folk understandings) towards the world. Husserl advocated suspending our natural attitudes, by bracketing off our object of interest, so that we can effectively begin the process of reflecting on it by setting aside our presumptions (Ihde, 1984; Valle & Halling, 1989). The notion of 'bracketing' offers us a powerful epistemological tactic for trying to build an understanding of thinking (regardless of whether this thinking is construed in terms of either mental or embodied states). Bracketing allows us to examine the everyday world reflexively and systematically (Ihde, 1984). In this style of reflexive practice there is no privileged or protected status awarded to any particular type of knowledge or action – all phenomena are open to this strategy for understanding. The complexities and subtleties of this approach result from its acknowledgement of the primacy of particular circumstances and individuals' interactions, rather than some idealised modality or rationality[55].

With this broad reflexive paradigm in mind, we can see at the heart of Einstein's observation is the challenge posed by the ubiquity and opaqueness of cognition. We need as compelling an understanding of thinking as we do of the particular mechanics of any specific domain of content or research. We have to be able to bridge the gap between 'how

[55] It is around this issue of transcendentalism that many phenomenologists have tended to break with Husserl's doctrine, but nonetheless his ideas are compelling methodological and conceptual points of departure.

we think', 'what we think' and 'what we do'. For much of the last century the primary responsibility for tackling this question has been shared between philosophy and psychology. Considerable effort has been recently invested into the transformation of the questions of reason, mind and knowledge into those of intelligence, brain and cognition. Yet further reconciliation and transformation is needed, primarily in the areas of epistemology and agency, to ensure that the momentum gained so far does not dissipate. Thus we return to where we began with the motif of the difficult relationship that exists between problems, knowledge, and understanding. For the present work the difficult question is about how to best understand Doctoral cognition.

2.3 Driving force

To meaningfully talk about Doctoral cognition requires us to build an understanding of the mechanisms and processes that constitute this phenomenon. What is Doctoral cognition? How does it allow us to achieve our goals?[56] It would seem that it would be useful for us to be able to talk about the forces (or as Cattell (1971) would have it, our capacities and powers) that are at play in this process[57]. We also need to be wary of approaches, which move us too far away from the context in which these forces take place. Accordingly, we should give careful consideration to the intent of asking questions about Doctoral thinking. Are we seeking to illuminate the cognitive process, and in doing so understand its deep structures? Or, alternatively are we seeking to make predictive claims, using some abstracted law, about Doctoral thinking?

In this manner let us explore these issues, and how they serve as an aid to our thinking, by applying them to a well-known metaphor of mind as a type of machine or engine (P. M. Churchland, 1999; Dreyfus & Dreyfus, 1986; Saljo, 2002; Sternberg, 1990). The image of an engine has often been used in trying to describe what we mean by cognition (P. M. Churchland, 1998, 1999; Dennett, 1984a, 1997, 1998b; Sternberg, 1990). Philosophical psychology and cognitive science are replete with the mechanistic metaphors (engine of reason, difference engines, semantic engines, analytical engines and syntactic engines to name but a few). These images allude to notions of complexity, predictability, control and work. An engine is a means of applying power, converting effort more effectively into

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[56] By goals we don't mean technical, instrumental and 'base' motivated (e.g., status, power, money) goals .

[57] This discussion of psychological mechanisms and forces draws inspiration from Kelly's (1963) examination of difficulties of importing the notion of energy from physics. Kelly explains that co-opting the notion of energy comes at a cost of certain assumptions (i.e., a commitment to a closed system view). To balance out this cost Kelly recommend that any psychological theory should "be considered ultimately expendable" (p. 44). Thus just because a theory can be profitable in generating ideas this does not mean that it will never reach the end of usefulness.

motion or action. These representations of an *engine* also suggest a freedom from a 'limited' capacity.

There is a seductive simplicity in the idea that the mind or brain is some kind of engine. Like Newton's clockwork universe, the notion of mental machinery seems to hold out the promise of great explanatory power. We can readily conceive of the mind in very mechanistic ways, with modules, components or parts working together to produce particular effects (Pinker, 1997; Sternberg, 1990). It is a short step from this 'assemblage' view to the idea that if we understand the nature of this construction then we can identify the categories or types of actions possible. Essentially, if we can reverse-engineer the design of the mind or brain then we will know how it works. What's more, we can go one step further once we have this knowledge and strip away the particular amorphous details and go on to discuss the essential or idealised process.

We can approach the problem of how best to characterise the 'engine of cognition' in two directions – top down or bottom up (Bermudez, 2005; Dennett, 1998b; Hayek, 1952; Mahoney, 1991; Marr, 1982; Weimer, 1977)[58]. The process of working from the general to the particular and imposing fixed or pre-established categories is commonly referred to as a 'top down approach'. The physical and engineering sciences have demonstrated the efficacy that this type of explanation can offer us. In fact, in this thesis there will be considerable attention paid to the usefulness of this approach. But the contra position will also be put - how much do we lose of 'the thing in itself' when we reach this level of idealisation? Are people and particles the same thing when it comes to understanding action?

For example, while the notion of 'work' can allow us to calculate particular probabilities and outcomes, it tells us nothing of the context and purpose for which the engine is being used (admittedly because in this type of analysis of work these factors are construed as being superficial to understanding). But if we want to understand 'How and why an engine is used?' 'Who is using it?' and 'What is the relationship between that use and context?' then we need to embrace a wider connotation, a more interpretative rather than literal understanding of this image. Working from the particular, with the emphasis on action

[58] Bacon (1898) characterised these two approaches or directions in the following way: "There are and can be only two ways of searching into and discovering truth. The one flies from the senses and particulars to the most general axioms, and from these principles, the truth of which it takes for settled and immovable, proceeds to judgment and to the discovery of middle axioms. And this way is now in fashion. The other derives axioms from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms at last. This is the true way, but as yet untried" (Novum Organum, I, Aph. XIX).

embedded in context, is typically referred to as a 'bottom up' approach. In trying to capitalise on the potentiality offered in the idea of the cognitive engine - many scholars have become deeply engaged with the psychological equivalents of combustion, torque and work – and have lost sight of the idea that these forces operate within a particular context and in relation to particular interaction. This has resulted in an overrepresentation of top-down models[59].

The idea of a cognitive 'engine' has come to be about the interplay of abstract and context free forces. The purposeful nature of cognition, outside of a small group of philosophical traditions, has largely been lost in common usage. Along these lines then, the cognitive 'engine' has been removed from the vehicle and dismantled in an attempt to find the essential characteristics. We no longer readily considered these forces as being applied by something. This is partly as a result of the over zealous exorcism of the 'ghost in the machine' and the need to 'scientise' the philosophy of mind. Strong artificial intelligence (SAI) is the paradigm of what happens when the metaphor of the cognitive engine becomes the reality of intelligence understood as an engineering problem and we try and build a cognitive engine guided by top down principles[60].

In discussing how best to represent thinking we have revealed a deeper issue – the distinction between a metaphor that seeks to be an aid to our understanding or alternatively a metaphor that serves as an explanation of the world. Dilthey (1976) offers us an extensive assessment of the difference between explanation (*Erklärung* – which is concerned with predictive power through the identification of generalisations and abstracted laws) and understanding (*Verstehen* – which is a mode of interpretive and context sensitive investigation that is concerned with revealing the basic structures of lived experience).

For Dilthey the role of context, and in particular historical circumstances, was the key for descriptive and analytical understanding of psychological processes. Dilthey observed, "in the final analysis reality itself cannot be explained logically, but only understood" (in

59 As Withagen and Michaels (2005) observe: "The influence of the mechanistic metaphor on the conceptualisation of perception and action is far-reaching. Metaphors are not ontologically neutral; instead they influence the conceptualization of the phenomena to be explained and the concepts that are brought to bear to explain them" (p. 608).

60 The early work in artificial and synthetic intelligence reminded researchers and theorists of the centrality of intelligence in our understanding of mind and cognition. The role of intelligence (whether conceived as some vital force, spirit, capacity for reason, or heuristic preconsciousness) has long been a lightening rod in psychological debates. Historically theories of intelligence have been the driver of much of the research in the domain of learning. The main reason for this prominence is because intelligence has been conceived as underlying sophisticated behaviour, reasoning, problem solving and higher order thinking.

Marias, 1967, p. 383). What was crucial for this understanding is the role of context. For example, as Marias (1967) explains, intelligence to Dilthey was not something that could be extracted or isolated from the world; rather he saw it as a vital function, which only had meaning within the totality of living. Essentially, intelligence must be derived from, rather than extracted out of, the experiences of living[61]. In Dilthey's view it is only by appreciating the real as an aspected totality that we can begin to understand and describe such notions as mind and intelligence.

Lewin (1931) offers us a similar framework to that of Dilthey's, for the notions of understanding and explaining as they apply to psychology. Lewin posited two models of the ways in which the (physical) sciences have tried to form concepts about the world. He labelled these two modes of thought: Aristotelian (top down fixed categorisation focused on classification of the essential nature of things) and Galileian (a process and interaction centric view with a focus on the derivation of general principles by examining the total forces acting on an organism). Lewin's argument was more concerned with the broad orientation of these two archetypes than the specific scientific methods employed by these two iconic individuals. He wanted psychological researchers to more carefully consider the relationship between the underlying modality of thought to the way in which they engaged with their phenomenon of interest. Of particular importance was the need to move from an essentialist mode of causation and classification (Aristotelian) to a more comprehensive appreciation of the totality of forces (internal and external) at play in any particular circumstance (Galileian).

Dilthey and Lewin provide us with two axes along which we can plot our discussion – the first is the degree of process orientation (Aristotle – Galileian) and the second the degree of comprehension (Explanation – Understanding). For example, one quadrant within the space of possibilities framed by these axes is concerned with universal or transcendental laws of intelligence (AE). The opposite quadrant is concerned with intelligence as a process that occurs within an agent moving through some particular environment (GU). In the Aristotelian - Explanation (AE) quadrant, theorists and researchers seek to ascribe laws and predictability to 'intelligence' by the identification of its essence. This is intelligence seen as a type of fundamental metric or quality of mind. By contrast, in the Galileian – Understanding (GU) quadrant, theorists and researchers are concerned with deriving from the moment, the dynamics of intentionality and understanding. This is intelligence as part

[61] This view has found expression in the psychological work of Howe (1990, 1998), Bronfenbrenner (1979) and Ceci (1996).

of the process of being as mode and means of interaction. Here cognition is purposeful and contextualised. While positions within these quadrants are not necessarily incommensurate they are definitely not reducible to each other[62].

Regardless of whether we aim for explanation or understanding, we can meaningfully engage with the notion of cognition as being one of the processes, or forces, that empowers us to action. Thinking is the fundamental intellectual or cognitive resource available to us in interacting with the word (Holyoak & Morrison, 2005; Holyoak & Spellman, 1993; Oden, 1987). Of course how this 'resource', 'force', 'drive', 'machinery' or 'engine' is harnessed, fine-tuned and controlled may be of significant variety, but the essential position remains that our explanations must commence with the fact that our cognitive capacities are constrained within the world.

Yet we also know about cognition in a unique personal, tangible, yet abstracted way (Dennett, 1996). It is the distinctiveness of this knowledge that orientates us towards a privileging of how we cope with the world. Merleau-Ponty (1962) describes how we are not simply surrounded by the material world, on the contrary we are part of it. This is a critical point in the overall thesis, that the thing doing the perceiving, knowing and action is a body – an integrated being, an individual seeking and making meaning through their transactions with the world. This does not preclude the emergence of higher order capabilities, but it does exclude appeals to dualistic or transcendental accounts. There is no room in the account offered here for a disembodied and indifferent mind or spirit. In this this project shares a consistency with the Andersonian view that there is but 'one way of Being', but the exact nature of how individual beings are driven remains a much more open question.

To review, we need to begin with how cognition presents itself to us (as well as how we represent cognition to ourselves)[63]. At a basic level, cognition is about how we cope with the world. This coping is an essentially embodied and embedded phenomenon. It is also an intentional, purposeful, interaction – one characterised by an orientation towards action and meaning. Accordingly the point of departure for understanding Doctoral cognition is

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62 We could continue to build up a multi axial system by adding in more dimensions (i.e., applied-basic research, material-ideal, etc.).

63 Derrida (1976) instructs us to "begin wherever we are" (p.162) and allow our analysis to take this, the manifest present, as our point of departure. He cautions us not devalue nor seek to overturn the everyday or the commonplace as insufficient grounds for analysis of the deep questions. Instead Derrida recommendation is that we can work towards issues rather than have to seek out the ideal starting place. This view shares a degree of empathy with pragmatism.

the fact that we are embodied, perceptual and constructive beings. But this is only one side of equation – we also need to select the appropriate philosophical attitude for this work.

There are diverse ways in which we can illuminate our interactions with the world, and our preference for a particular style of description will be shaped by our ontological and epistemic commitments. As discussed in this section there is a distinction between the aims of prediction (explanation) and revealing underlying structures (understanding). We need both perspectives. In the context of this discussion of Doctoral cognition the decision has been made to focus, in the first instance, on depicting the underlying structures of productive thinking. This is part of a larger descriptive program of work that argues for a philosophical attitude or orientation towards cognition and being. Even so we still need a degree of interest in explanation and prediction, but this must be wedded to a "degree of detachment that is necessary to avoid entrapment by the partisan, the ideological, the 'one correct answer'" (Warren, 1992, p. 18).

2.4 Productive thinking

How this 'way of being' manifests itself in terms of our experience is a significant question in its own right. It presents us with the challenge of understanding the confederate roles played by perceptions, sensation, connation, volition and affect in shaping our world. As discussed in the previous theme, we have tended to link engagement with the world to a driving force or need. This imperative is often said to be one of change, growth, or adaptation.

Piaget (1970, 1971, 1972, 1980a) certainly held a profound commitment to an internal locus of control (down even to the genetic level) that impelled adaptation and organisation in individuals. The notion of self-directed and regulated activity was also represented in a weaker form in the Gestalt idea of productive thinking[64]. The Gestalt tradition was particularly concerned with the idea of higher order thinking and how this expressed itself in complex tasks such as problem solving. A key aspect of problem solving, in this tradition, was the self-initiated nature of cognitive engagement. Productive thinkers or problem solvers are able to 'pull themselves up by their bootstraps'.

Duncker's (1945) Psychology of productive thought (published originally as *Zur Psychologie des produktiven*) directs us towards how the organization and structural

[64] Remaining cognisant of the fact that Piaget and the Gestalt movement were contemporaries. Piaget (2001) provided an extended discussion of Gestalt concepts (particularly those concerned with perception) in his *The Psychology of Intelligence*.

understanding of a problem situation[65] is central to our response to open or ill-defined problems. In Duncker's analysis we must understand 'problem solving' or 'productive thought' to be part of our overall cognitive processes. Productive thinking is thus construed as the creative and adaptive capacities that allow us to seek out solutions in circumstances where we are unable simply to apply pre-prepared responses.

In the Gestalt tradition, the capacity to 'work the problem' and to navigate a path towards closure (by reformulation and restructuring of a problem) is the defining characteristic of 'productive thinking'. This form of problem solving is about fitting solutions to the problem as opposed to using a prepared or 'mechanical' strategy. Although the idea of productive thinking encompasses creativity, flexibility, intuition and innovation it also includes *Einstellung* (attitude) and fixedness. As problem solvers our perceptions of problems (which includes our perception of the role and circumstances the problem solver themselves) play a significant part in our solutions. There is a clear association between the transferability and flexible notions of productive thinking and the notion of heuristics and insight. As Polya (1957) observed solving problems is a fundamental cognitive activity. From the Gestalt perspective solving ill-defined problems (which should not be confused with the more superficial activity of solving puzzles)[66] is at the heart of adaptive behaviour and flexible learning and an expression of thinking and being.

At an essential level the Doctorate experience has both creative and transformative requirements. Applying the lens of productive thinking to the cognitive work done during Doctoral education allows us to foreground the constructive and productive nature of our cognitive engagement with the world. Productive thinking is suggestive of how we might begin to more effectively describe the connection between being or becoming Doctoral and the refinement of behavioural, cognitive, conative, affective and perceptual repertoires (Trafford & Lesham, 2009).

2.5 Moving out into the borderlands

As put forward in the Introduction to this work (where we briefly assessed the landscape of higher educational theorising of the Doctorate) there are certain canonical or fortified positions that appear to dominate the terrain of higher education. While sheltering within

65 In this work Duncker uses Wertheimer's (1959) *gestalt* precepts to inform his analysis of problem solving.

66 . Heidegger (1996) made a distinction between *puzzles* - trivial or everyday situations or questions that although difficult, and perhaps without a clear immediate resolution, such as how to find a job, can be largely resolved by the application of procedural or technical responses; and *problems* - more non-trivial or bigger issues that are by their nature opened ended and ill defined situations or questions, such as, the nature of existence or *being*. He allocated the notion of problems to the domain of philosophical work.

the walls of an established position can offer us a sense of certainty - we also need to look to the hinterlands and to those who travel beyond these fixed or walled positions. To pursue a generative agenda we need to source theorists and researchers who are able to traverse the philosophical and psychological divide (especially if we hope to link the different territories of educational thought).

Deleuze and Guattari (1987) relentlessly advocate this mode of thought in a *Thousand Plateaus* - demanding of us that we elucidate our concepts from multiple points, with the aim of revealing alternative narratives for things and ideas which we feel are well understood. It was perhaps this reflexive attitude that gave birth to the earlier pragmatic and phenomenological traditions. Deleuze and Guattari's mode of theorising demands that we rediscover and grapple with the world and being.

To gain an entree into this alternate mode or style of theorising we are required to be comfortable in working from a chart rather than a map. This kind of work requires us to move out into a landscape infrequently travelled and, as such, it is to some degree either unknown or forgotten. In making this transition from the fixed and static positions to one of movement and change we are required to adopt the dual role of cartographer and explorer.

Nonetheless, exploration of this kind serves to enhance both our understanding of places that we know well, while it also offers the capacity for expansion and growth. Of course, as with any speculative adventure, there is the possibility of becoming lost along the way or arriving far from the intended destination – but even these outcomes provide us with an addition to our knowledge. In the movement from the unknown to the known, even the most speculative of activities can still make a powerful contribution.

However the freedom offered by going beyond the edge of the known, also contains the danger of becoming bereft of direction. We need to discover the path of our journey in the act of moving. We need to adopt a modality that is capable of displacement and adjustment. Accordingly, and out of necessity, we have to be able to embrace a position that is capable of switching direction, and modes of activity, in response to the terrain and our goals. We have to be willing to overcome obstacles by shifting modes, stepping off from one point to reach another, moving around or over barriers – all the while looking for the route through a dynamic landscape[67]. We essentially have to become capable of moving seamlessly between philosophy, psychology, theory, practice, research and reflection. This is the process of theory building, where the thinking behind the theory is developed through the acts of doing and being.

Bearing in mind the earlier identified risk of self reference there are four modes of thought or positions that can be used to assist in avoiding the trap of solipsism: constructive alternativism (Kelly), complementarity (Rychlak), naturalism (Dewey) and interactive constructivism (Hooker and Christensen). We shall briefly examine each of these in turn.

2.5.1 Constructive alternativism

Kelly (1979a, 1979c, 1991a, 1991b, 1995) proposed the philosophical position of constructive alternativism as a means of framing his theory of personal constructs[68]. Kelly (1991b) identified the core postulate of this mode in the following terms: "We assume that all of our present interpretations of the universe are subject to revision or replacement" (p. 11). He saw this position as being deeply entrenched in his observation of people and informed by a long view of human activity. Interestingly, Kelly was at pains to distance himself from the interpretation that constructive alternativism was a philosophical system proper. He disavowed all construal to that end and instead advocated that this was a dispositional stance to be adopted for understanding the world.

For Kelly (1991b), his philosophy was "rooted in psychological observation of man" and psychology was "concerned with the philosophical outlooks of individual man" (pp.11-12). Guided by this view, the analysis presented in this document moves to a large degree outside of conventional philosophical and psychological analysis. There is a commitment, in this thesis, to construing thinking as dynamic (possessing stable and transient aspects). Moreover, this dynamism is best revealed through a philosophical-psychology stance. Thus, here we look to Kelly to provide us with a methodology for combining philosophic

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[67] Like the *traceurs* we will need to practice the 'art of displacement' (*Parkour*). Practitioners moving from one place to another, negotiating the obstacles in between.to gain ground on our illusive destination.

[68] Numerous comprehensive surveys and descriptions exist of Kelly's work, for example Banister, Fransella and Agnew and Dalton and Dunnett. Kelly's work will be discussed in more detail later on, but given the relative unfamiliarity of his work in mainstream education a brief summation seems appropriate here. The fundamental postulate of Kelly's work is "a person's processes are psychologically channelized by the ways in which he or she anticipate events". As Warren explains this is a beautifully articulated statement that is both cohesive and understandable. " It captures a number of different things about our psychological functioning most significantly it emphases that the individual does not just react in terms of past experiences but rather evaluates events or situations in terms of predictions about the future" (p. 5). Kelly further elaborates this postulate through a set of eleven corollaries: Construction, Individuality, Organization, Dichotomy, Choice, Range, Experience, Modulation, Fragmentation, Commonality and Sociality.

and psychological traditions (Warren, 1998b) into a consolidated, but revisable, position. Kelly described this as a credulous approach.

2.5.2 Complementarity

In accepting the kind of dynamic characterisation proposed by Kelly, we can benefit from a strategy for reconciling complexity (both in terms of theory and behaviour). Rychlak's principle of complementarity provides an effective means of bringing together different components of action and thought. By adapting Bohr's (1999) original notion of complementarity for psychology, Rychlak identifies four grounds or perspectives from which behaviour can be viewed – *Physikos, Bios, Socius* and *Logos*[69]. Rychlak's approach draws together a set of interconnecting areas that are customarily examined, if not in isolation, as discrete domains that do not typically share a common ground.

Rychlak was also informed by Kelly's idea of a range of convenience[70] and describes the perspectives offered from each type of ground as appropriate for certain questions and not for others. Moreover, each perspective is necessary for a complete picture. It is through the interplay between these groundings that Rychlak believes we can build up more adequate understanding, and increase explanatory power of our analysis (both empirical and theoretical).

Rychlak advocates that explanatory gains can be made by considering the complementarity of each grounding to the question at hand, rather than simply seeking to reduce all phenomena to a single grounding (which could be seen as a kind of 'greedy reductionism' – pace Dennett). This complementarity implies a particular relationship to the world. The principles put forward in Kelly's and Rychlak's work generally correspond with Dewey's naturalism, and as such offer us the principal elements of a meta-philosophical stance.

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69 In broad brush strokes *Physikos* examining process at the physical level drawing no distinction between the animate and inanimate; *Bios* examines the processes of the animate; *Socius* is concerned with processes at the level of groups and culture; *Logos* is concerned with organised meaning and intentionality. See Rychlak (1994) for a sustained discussion of these terms.

70 Kelly (1991a) defines "A construct's range of convenience comprises all those things to which the user would find its application useful. A construct's focus of convenience comprises those particular things to which the user would find its application maximally useful. The context … is somewhat more restricted than the range of convenience … somewhat more extensive than the focus of convenience" (p. 2).

2.5.3 Naturalism

Dewey's particular brand of psychology[71], which is sometimes characterised in terms of being a 'wide psychology' (Godfrey-Smith, 2002), requires us to take an inclusive and expansive approach to making claims about thought, mind and intelligence. He enjoins us to construe the mind in terms of a system, which includes context, action and consequences. Godfrey-Smith summarises the constituent elements of Dewey's naturalism in the following terms: "Humans are biological systems inserted into a common natural world with a definite structure. Human thought has real contact with various parts of the world beyond it, via natural channels described by biology and other sciences" (Godfrey-Smith, 2002, p. S3).

Dewey distinguishes his particular philosophical view of the world, by emphasising the role of *action*. He moves from traditional connotations of epistemology and instead introduces the phrase 'theory of inquiry'. Dewey by privileging *action*, and *inquiry*, implies the centrality of *praxis* in intelligent behaviour.

The essential link between thought and action, with a particular emphasis on the transformative role of *action*, is the most obvious connection between his instrumentalism and the broader pragmatist doctrine. The relevance of Dewey's thinking to this discussion is that he establishes a naturalist position within which both actual and potential paths of action are incorporated; thus preserving both the emergent and actual prosperities of natural systems. Dewey firmly espouses a continuity of the mind and the world. There is no room in this picture for a disembodied and disinterested observer[72].

2.5.4 Interactive constructivism

Finally, drawing together these positions in the notion of interactive constructivism (I-C). This interpretative stance offers us a powerful epistemic tactic for describing intelligent behaviour in intelligent agents and the growth of their knowledge about the world. Hooker and Christensen (cf. Christensen, 1999; Christensen & Hooker, 1997a, 1999a, 2000c; Hooker, 2009) have articulated the fundamentals of intentionality and agency (within a dynamic framework) that looks to the principle of autonomy as the turnkey condition in the

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[71] The discussion of Dewey, Rychlak, Kelly and Hooker work does not occur in chronological order. Dewey's work predates that of the others. In the case of Kelly and Rychlak their work draws on Dewey's ideas.

[72] It is worth noting that the Frankfurt school distinguished between substantive and instrumental reason, and as is discussed else From drew a distinction between intelligence and reason (Doniela, 1984). Both these perspectives provide a fine grained appreciation of the dialetic or tension between tyeps of interaction with the world that allows for *disinterested* inquiry.

development of intelligent behaviour[73]. I-C gives us a means of building up, from first principles, the notions of intelligence and cognition within the world. I-C also provides us with an orientation for thinking, action and learning that do not require some idealist slight of hand. Yet there are important limits, at this time, to the I-C theorising – particularly in terms of offering deep understanding of individuals or persons. Nonetheless this is a useful combination of philosophical strands that allows construing the mind, intelligence and cognition within both a realist and constructivist framework.

These four viewpoints demonstrate how phenomenological, constructivist, pragmatist, interactionist and existentialist traditions can be interpreted or understood in ways that do not inevitably commit us to relativism or solipsism. We can progress an account of Doctoral cognition that is fertile in producing new ideas; that connects with being, meaning, and change; that expresses abstractions drawn from what we know empirically of cognition; and that avoids an appeal to spirits or disembodied minds.

2.6 Concluding comments

In closing it is vital for us to be reminded that philosophical analysis 'writ large' has consistently devoted itself to understanding the human condition[74]. Indeed, natural philosophy was one of the earliest systematic methods for revealing the processes and constructs that contribute to understanding how and why we experience the world as we do (Brumbaugh, 1973; Marias, 1967). The remnants of this critical concern with essentials can be seen in the physical, social and human sciences that have grown out of natural philosophy. Given the sustained period of fragmentation and deconstruction in educational theory we may well benefit from a reconsideration of education from the perspective of the *long duree*. This attitude may also been the first necessary step in rapprochement of Education with its parent disciplines (Warren, 1990b, 1992, 2002).

From this starting point we are able to traverse the intellectual territory by moving between, around and through a variety of conceptual and theoretical impediments that have snared previous accounts. The approach offered here aims to circumvent the unnecessarily restricted nature of our standard model of cognition. It seeks to demonstrate the contribution that a rediscovery of intentionality, epistemology and ontology can make to our capacity to understand cognition and learning. By taking this path we are able to re-

[73] On this point they share common ground with Maturana and Varela (1980, 1998) – the distinction between these two positions is what constitutes autonomy and the nature of the interactive cycles involved.

[74] For example, Kant's (1961, 2004) four fundamental questions: What can I know? What ought I do? What can I hope? What is Man (sic)?

introduce, into the standard view, the ideas of productive thinking, *praxis*, construction, intention and connotation.

The position will be put in this work, that we need to widely reacquire the practice of seeking answers to difficult questions from across a broad spectrum of inquiry. To do so we need to ensure that we have a sufficiently broad and deep analytical approach to higher education. We need to have a balance between *episteme, praxis, techne, phronesis, Physikos, Bios, Logos* and *Socius*. This is not an appeal for a return to Arcadia or some Halcyon period of theoretical preconsciousness; it is instead an acknowledgement that we should not neglect, in Cronbach's (1957) words, the enduring need for "concepts that will help people use their heads" (p. 126).

To free ourselves from the standard picture of cognition we need to break down the familiar, and simplistic, distinctions between mind, body and reason. The first step in this process is a critique of the dualistic formulations that have informed the standard model. We need to develop an account of cognition that provides for a more nuanced depiction of the embodied and embedded nature of thinking. To do this requires awareness that we not detached spectators, but rather active and intentional agents - composites of mind and body - within our life world.

As a whole, this work through its process of theoretical consolidation and integration is intended to contribute to the reinvigoration of pragmatic, phenomenological and constructivist lines of inquiry within higher educational theory. It reintroduces the importance of context, construction and agency in our theorising; while at the same time serving as a demonstration that Educational theory has always been at its most compelling when concerned with the fundamental processes of being (Brumbaugh, 1973). It does this through a specific lens of what is commonly – and arguably justifiable as – the epitome of intellectual activity – the Doctorate in higher education.

In essence we will be assessing Doctoral cognition in terms of its composite of what have been customarily taken as psychological elements, philosophically. Thus is this work located generally in the area of philosophical psychology in all of the aspects previously noted: philosophy *in* psychology, philosophy *of* psychology and philosophy *and* psychology.

CHAPTER THREE

PSYCHOLOGY AND THE MIND: TRADITIONS AND TRAJECTORIES

3.1 Orientation

In this Chapter we will commence the process of setting out the required background or foundational concepts that will be instrumental for our analysis of knowing in Doctoral education. Any discussion that intends to concentrate on psychological matters, and especially issues in contemporary psychology of the mind, requires that psychology be placed in its historical and conceptual context (Warren, 1998b). Depictions of this type can be drawn up at different levels of specificity. For this analysis we will opt for a global description with the aim of charting patterns of development, innovation and constraint in the psychology of the mind. The mind that is in play at the highest level when one presumes to make an original contribution to knowledge through Doctoral work.

This chapter will be first and foremost an outline for those whose primary point of reference is more likely to be the discipline of Education - the discipline in which this work is located - than it is the discipline of Psychology (or Philosophy). The intention of this outline is also to provide a common starting point from which we can then build up our appreciation of Doctoral cognition. This knowledge base of psychological theory is also a necessary precondition for identifying the limitations of the standard model(s) of the mind and appraising the ongoing attempts that are being made to offer alternate paradigms of the mind.

A key assumption of this chapter is that Education, as an applied discipline, has at times been neglectful both of its antecedent paradigms and traditions, and the current developments in its underpinning disciplines[75]. There has been a latent tendency of disassociation or neglect[76] between Psychology and Education with regards to learning, perception, cognition, reasoning, and memory. The same can be said of Philosophy and Education. The primary consequence of this situation is that psychological and

[75] Acknowledging that there are difficulties characterising across a discipline we will adopt an approach that represents a majority view. Here we are speaking of the dominant or prevalent narratives or ideas within the field of education within Higher Education in general. Reviewing the contents of the most widely used educational textbooks, the course structures in educational degrees, and conference proceedings can reveal exemplars of this narrative. The Australian Education context is in the author's view a particularly pronounced case of this set of circumstances.

[76] To be balanced, this is probably more often an act of omission than commission, although if we set aside the reasons for this behaviour, the consequences or effects are largely the same.

educational analyses of the mind have come to be typically construed as being concerned with separate domains and issues.

In practical terms this means that the theoretical background, as well as the current status, of many of the central constructs in the psychology of the mind are not generally well known or appreciated within standard Educational Psychology[77] narrative. This has led to a widening of the gap in Education between the theoretical and the functional knowledge of mind. Given this situation it is necessary that we begin by establishing a common understanding of the psychology of the mind (in terms of both its concepts and history).

Using this common understanding we will be able to build up, over the subsequent chapters, a broad theoretical palette. This palette will allow us to create a more nuanced picture of Doctoral cognition. It will also be instrumental in allowing educational theorists to rejoin the broader conversations about the mind and thinking. Furthermore, this theoretical immersion in the psychology of the mind will provide us with an effective, and highly pertinent, counterpoint to the arguably more narrow view of thinking and learning as bureaucratic and technical functions.

In summary, this chapter will supply us with a coarse-grain reading of the history of the psychology of the mind, with an emphasis on how cognition and intelligence have been construed (within mainstream psychology). This examination will seek to reveal the subtle shifts that have occurred, over time, in how the mind and thinking have been conceptualised. To do this we will examine the orthodoxies and transitions that have characterised previous psychological models of the mind.

3.2 Mind, matter and mechanisms

Psychology, as a science of the mind, has sought to both develop and transcend its connections with the philosophy of the mind. William James (1890) advocated in *The Principles of Psychology* an explicit doctrine that orientated Psychology towards the study of the mental in general and the mind in particular[78]. He identified the centrality of

[77] This is particularly the case when we consider educational psychology as part of pre-service teacher preparation. Even taking into account the constraints imposed by the credentialing process for teachers, the consideration of the foundations of learning, cognition and mind remains at a prosaic level.

[78] James' definition of psychology was widely disseminated both in in his texts and also in textbooks written by others (e.g. Woodworth's (1949) *Psychology: the study of the mental life*). Spencer's (1855) earlier description of *objective* and *subjective* psychology is also worthy of note here as he also sought to identify the kinds of discipline knowledge that would be required to analyse psychological phenomena.

consciousness, cognition, (inter)action, perception and goals to developing an understanding of the human mind.

> Psychology is the Science of Mental Life, both of its phenomena and of their conditions. ... The *pursuance of future ends and the choice of means for their attainment are thus the mark and criterion of the presence of mentality in a phenomenon*. We all use this test to discriminate between an intelligent and a mechanical performance. We impute no mentality to sticks and stones, because they never seem to move for the sake of anything, but always when pushed, and then indifferently and with no sign of choice (James, 1890, 1 – emphasis added).

James can be seen as standing at the crossroad between the previous philosophical analysis of the mind (e.g., Descartes, Spinoza, Leibniz, Kant, Hobbes, Locke, Berkley, Hume, etc.) and the development of a modern 'science of the mind' (e.g., Herbart, Muller, Ribot, and von Helmholtz). This developing science of the mind, as described by James, adopted methods with an emphasis on experiment and observation as much as abstract analysis and introspection (somewhat akin to the natural philosophy of the pre-Socratics). For James, psychology was to be a natural science of both objective and subjective experiences. In striving to encompass these elements the emerging discipline of psychology was to be confronted by the enduring problem of the relation between mind and body (Viney, 1989, 2001). James' pragmatism moved him towards a strategic use of dualism and functionalism as a response to this challenge.

Wundt's (1894) *Ganzheit* psychology provided an introspective counterpart to James' functionalism. Wundt was concerned with the fundamental elements or components of thought, perception and volition (Viney & King, 1998). This differed with James' focus on the experientially unified nature of consciousness. Although these two competing approaches shared much in common, they did differ in their ontological and epistemological sub-structure. James' radical empiricism drew on associationism's dualism and Peirce's (1878, 1934) pragmatism (which was an integration of the empiricist and rationalist traditions). Wundt on the other hand was influenced by a combination of Leibniz's (1982, 1989) apperception, Spinoza's (1876) parallelism, Kant's (1961) transcendental idealism and Hegel's (1969, 1977) unity of experience. Wundt and James saw observation and experiment, in different combinations, as the appropriate basis for understanding the mind (Blumenthal, 1977; Crosby & Viney, 1992; Viney & King, 1998).

The ensuing debate between these two schools of thought[79], about experimentation and the mind, provided the necessary momentum to eventually move Psychology towards a positivist, rather than a speculative, mode (Ash, 1980; Blumenthal, 1977; Boring, 1942; Hearst, 1979; Reiber & Robinson, 2006). Interestingly, the reaction against James' "traditional associationist" focus (Harnish, 2002) was driven in a large part, not by Wundt's ideas but instead, by the emerging school or program of behaviourism.

> There is unquestionably, a movement a foot in which interest is centered [sic] in the results of conscious processes, rather than in the process themselves. This is peculiarly true in animal psychology; it is only less true in human psychology. In these cases interest is in what may for sake of a better word be called 'behavior'; and analysis of consciousness is primarily justified by the light it throws on behavior, rather than vice-versa (Angell, 1911, p. 47).

Behaviourism had its foundations with Ebbinghaus's (1885) early writing on stimulus and response. Ebbinghaus's approach was refined by Thorndike (1998) in his analysis of animal learning. Thorndike's research provided a clear methodological alternative to the introspective and associationist examinations of consciousness (Kehoe, 1988)[80]. Behaviourism would eventually grow to become the psychological orthodoxy, particularly in North America, during the first half of the 20th century (Harnish, 2002; Novak, 1993).

Watson's 1913 article set out the behaviourist manifesto. In the following quote we can see how Watson sought to reframe the prevailing notions of the mental life.

> Psychology as the behaviorist views it is a purely objective branch of natural science. Its theoretical goal is the prediction and control of behaviour. Introspection forms no essential part of its methods, nor is the scientific value of its data dependent on the readiness with which they lend themselves to interpretation in terms of consciousness. The behaviorist, in his efforts to get a unitary scheme of animal response recognizes no dividing line between man and brute. The behaviour of man, with all its refinement and complexity, forms only part of the behaviorist's total scheme of investigation. … The time honored relics of philosophical speculation need trouble the student of behaviour as little as they trouble the students of physics. The consideration of the mind-body problem affects neither the type of problem selected nor the formulation of the solution of the problem (Watson, 1913, p. 158).

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[79] It is convenient here for the sake of brevity to use the metaphor of *schools of thought*, but of course there was already a diverse range of approaches developing within the Germanic psychological tradition. Oswald Kulpe, Karl Buhler and Otto Selz for example made significant contributions to the widening of Wundt's approach to psychology. Similarly, James' approach would continue to grow beyond his initial ideas even as he moved into other areas of intellectual inquiry.

[80] In this discussion *associationism* is defined as a doctrine concerned with the relation between sensation, experience, ideas and thought. *Introspection* is to be understood as a doctrine concerned with the structured observation and analysis of an individual's mental experiences and processes. *Associationism* provides a 'positive' account of how ideas and thoughts form, whereas introspection is concerned with trying to observe these processes *sui generis*.

We can read in Watson's manifesto an explicit attempt to separate out previous philosophic concerns with the nature of mind (i.e., James and Wundt) from the scientific study of the mind[81]. Watson clearly wanted to break with James' idea of consciousness and sought instead a physiologically[82] based approach that focused exclusively on behaviour. Pavlov's (1927) experiments would provide further support for the efficacy of this approach, and Skinner's (B. F. Skinner, 1938, 1948, 1953, 1957, 1969, 1971, 1974) high profile work on behaviour and learning was able to secure behaviourism as the mainstream, or orthodox, mode of psychological analysis (at least within North America)[83]. Yet for all their attempts to break away from the speculative activity of James, the behaviourist program inherited many of the underlying principles[84] of associationism (in particular the relationship between sensation and behaviour) into its conception of cognition, intelligence, behaviour and physiology (Gormezano & Kehoe, 1981)[85].

The behaviourist program provided significant progress in our understanding of learning and behaviour (Kehoe, 1988), but it was not without limitations (A. Clark, 2001; Gormezano & Kehoe, 1975; Harnish, 2002; Nelson, 1969, 1975). By revealing the relationship between stimulus and response in behaviour and learning, behaviourism challenged many intuitive assumptions about the nature of intelligence and learning. Yet it was the basic inability of the stimulus-response model to adequately accommodate the complexity of internal states that proved to be behaviourism's fatal weakness. Lashley's (1951) serial processing criticism[86] of the basic tenet of stimulus-response and Chomsky's (1959) critique of Skinner's work on language, serve to traditionally mark the beginning of the decline of behaviourism as the dominant doctrine in mainstream Psychology.

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81 Ironically the world of physics would eventually turn to the study of the mind and begin to wrestle with the types of issues that Watson argues are not of concern to the realm of physics (see Bilodeau, 2000; Gell-Mann, 1994; Kelso, 1995; Morowitz, 1968; Morowitz & Singer, 1995; Nuallain, Mc Kevitt, & Mac Aogain, 1997; Penrose, 1999; Prigogine & Stengers, 1984; Rosen, 1991; Schrodinger, 1992; Zurek, 1990). Furthermore, Carter (2007) distinguishes between psychological behaviourism and philosophical behaviourism; in which philosophical behaviourism is a theory of what mental states are.

82 On this point James, Wundt and Watson were not necessarily in opposition – they proposed the importance of neurology in understanding mental processes. It was their means for analysing the impact and role of the brain that differed significantly.

83 The *Gestalt* school of Psychology served as an important counterpoint to Behaviourism. American psychology tended to be influenced by both the pragmatists and behaviourist traditions, where European psychology was more directly influenced by the *Gestalt* theories (Boring, 1942).

84 Behaviourism would seem to be open to Hegel's notion of an immanent critique (cf. Warren, 1998b for further discussion of this form of critique) – in that it is logically committed to the features of a position that Watson and other's sought to oppose.

85 In fact, the themes of associationism, and the issue of the relationship between the external and internal worlds, still remains one of the core questions for Psychology.

86 In brief, Lashley identified that the sequential organisation of behaviour could not be adequately accounted for by moment-to-moment response to the environment but rather it is the result of the internal control. The burden on the S-R model and the requirements of the necessary order/stimulus in the environment were, in Lashley's view, too high and could not account for responses that appear to occur without the presence of the prerequisite stimulus sequence (e.g., performance of skilled behaviour independent of the 'required' associated chain of stimuli).

The shift away from behaviourist paradigms of the 1950s and 60s saw the emergence of the information processing model and the Artificial Intelligence (AI) program (Leahey, 1994, p. 284)[87]. This move was part of conceptual transition from behaviourism to cognitivism[88]. The new doctrine of cognitivism focussed on the internal organisation of cognitive processes and the role of information in these processes (cf. Steels, 2007; Veron & Furlong, 2007).

The main orientation of the cognitivist program (and in particular the information processing models of cognition) was initially put forward in Miller, Galanter and Pribram (1960) *Plans and Structure of Behavior*. In a practical sense Miller et al.'s model was seeking to realise Craik's (1943) hypothesis that

> … thought models, or parallels, reality – that its essential feature is not 'the mind', 'the self', 'sense-data', nor propositions but symbolism, and that symbolism is largely the same kind as that which is familiar to us in mechanical devices which aid thought and calculation (57).

By connecting with debates about the internal structure of organisms' processing of information (i.e., the paucity of experience conjecture[89]), and Craik's ideas about symbol processing[90], Miller et al. offered a cognition centric, rather than behavioural, program.

> They [cognitivists] believe that the effect an event will have upon behavior depends on how the event is represented in the organism's picture of itself and its universe. They are quite sure that any correlation between stimulation and response must be mediated by an organised representation of the environment, a system of concepts and relations within which the organism is located. A human being – and probably other animals as well – builds up an internal representation, a model of the universe, a scheme, a simulacrum, a cognitive map, an image … actions are controlled by an organism's internal representation of its universe" (Miller et al, 1960: 7-11).

From within this milieu[91] - where the nature of consciousness, language, communication, information, learning, intelligence, and reason were being debated alongside the

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87 Interestingly at the same time in which the foundations of the AI perspective were being laid down, Piaget's work was also on the ascendance in Europe.

88 In this discussion the author shall adopt Christensen's (1999) description of cognitivism as a perspective based in the "language based logico-symbolic processing paradigm" (2).

89 Chomsky coined the phrase "poverty of the stimulus" to describe the circumstances faced by children in language acquisition. Chomsky speculated that given the external stimulus, or linguistic data, available to children, grammar should be in principle unlearnable. Chomsky argued that these circumstances suggested some innate language capacity.

90 Hilbert's *Entscheidungsproblem*, and the associated work of Russell, Whitehead and Moore have important consequences for the viability of symbol processing and formalisms as means of modelling cognition. Hilbert's question can be summarised as follows: is there a process (i.e. in mathematical parlance - an algorithm) or system that will determine the validity of a first-order logic problem in a finite number of steps? Investigations of this question lead to the position that this problem is unsolvable in principle. The result of this finding was a body blow to pre-eminence of axiomatic tactics and formalism in general and symbol processing in particular. Gödel's Incompleteness Theorem expressed this situation by stating that in any sufficiently complex system where it is required that all statements be proved or disproved (i.e. the system is complete) there will be contradictions.

91 From the late 1960's onwards there was a notable trend in the publication of theoretical and empirical work on cognition, consciousness and mind. Authors such as Dennett, Searle, Chomsky, Churchland, Fodor, Penrose, Hofstadter and Dretske have made significant contributions to this general milieu

emergence of computational technologies - there was an increasing interest in how researchers might construct, rather than simply observe, intelligent action. Hutchins (1995) describes this aspiration as a desire to study 'cognition in captivity'.

The work of Herbert Simon, John McCarthy, Claude Shannon, Allen Newell and Marvin Minsky on Artificial Intelligence (AI) [92] and cognitive simulation offered the first concrete steps towards the goal of capturing and 'taming' cognition. Although cognitivism had come forward as a replacement to the behaviourist orthodoxy, both of these programs shared the requirement to simplify the problem of intelligence and cognition by determining a particular centre of gravity. For behaviourism this had been a focus on externalised processes, and in the case of AI it was a context independent or insensitive (internal) computational process of encoding and symbol manipulation of information (Haugeland, 1985; S. J. Russell & Norvig, 1995; Steels, 2007).

The shift towards AI was marked by a fundamental transformation of the previous psychological debates on mind (which, as discussed before, had been framed largely in terms of behaviourism) into the language and practice of engineering (Steels, 2007; Veron & Furlong, 2007)[93]. Essentially we can comprehend the 'Good Old Fashioned AI' program (Dreyfus, 1992; Haugeland, 1985) as seeking ways, in the first instance, to instantiate the central principles of reason, intelligence and agency described by Descartes, Spinoza, Leibniz, Hume and Kant (Veron & Furlong, 2007). But to do this, AI researchers needed to resolve the issue of "what is the best to way to represent mind and matter (and the mechanisms that links the two)"? The solution to this question[94] was initially believed to be found in a commitment to an essentialist and formalist doctrine of which 'strong artificial intelligence' (Searle, 1980) is a paradigm example.

Luger and Stubblefield (1998) contend that a definition of intelligence is a necessary prerequisite for the development of a coherent concept of Artificial Intelligence. While this

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by promulgating a range of doctrines about the importance of understanding the mind. Of note is that some of these authors have made their arguments in public as well as academic domains. Many of these authors adopted a strategy of publishing their work in both popular or general science texts as well as scholarly formats. This has assisted in a public or popular discourse of *mind science*.

92 Artificial Intelligence has had an assortment of different characterisations, including for example: Strong/Weak, Narrow/Wide.

93 Indeed, the AI program would come to be seen by wide array of commentators as an over compensation for the externalist perspective that had dominated during the behaviourist program (e.g. Bickhard & Terveen, 1995; R. A. Brooks, 2002b; Dennett, 1998a; Dreyfus, 1992; Fodor, 1998; Haugeland, 1985; Searle, 1984).

94 This methodology involves the identification of the essence of the phenomena of interest (in this case intelligence) that can be represented independently of contextual and other factors. This could be understood as involving a top-down perspective. This method is common to large amount of western scientific tradition (including philosophy and psychology).

seems trivial, Luger and Stubblefield reveal the fundamental challenge faced by the cognitivist program in general - researchers required a viable model of intelligence as a starting point[95]. Given the engineering and computational paradigms that informed it, AI has always been susceptible to conceptualising intelligence in ways that are consistent with the capacity and tools of computation and symbol manipulation (Bickhard & Terveen, 1995; Hooker & Penfold, 1995). AI originally defined intelligence as machine implementable operations[96], or computations, which are able to be analysed independently of the context of their implementation (Hooker, 1996). Effectively this top-down method involves the stripping away of context and focusing exhaustively on symbol processing. This method assumes that this can be done without losing any essential elements, and the resulting model can then be reinserted into particular contexts and scaled up to provide predictive and analytical insights (Bickhard, 1996; Bickhard & Terveen, 1995; Harnish, 2002).

In this regard AI appears to be at odds with nature which "does not separate the functions of perception, abstraction, reason, dynamic function and conception" (Hooker & Penfold, 1995, p. 281). Christensen (1999) identifies this fracturing of agency into "computation (cognition) and interaction (the other sub system which forms the body of the agent)" (p. 42) as deeply problematic and fundamentally fatal to the cognitivist modelling of intelligent behaviour. This concern similarly resonates, for example, with Ryle's (1949), Searle's (1992), Damasio's (1996) and Devlin's (1997) critiques of dualism and its negative impact on our understanding of the mind and reasoning. In the Artificial Intelligence paradigm, as with behaviourism, we are confronted by the role that philosophical assumptions and methods can play in determining the overall orientation of meta-concepts like intelligence (Dreyfus & Dreyfus, 1986; Haugeland, 1985, 1997, 1981b; Veron & Furlong, 2007)[97].

From a 'design' perspective there were basic inconsistencies between the finite, ignorant and fallible nature of creatures (Hooker, 1996) and the resource intensive and expansive nature of the AI computational models (Christensen, 2004b). These design limitations combined with the consequences of Chomsky's (1980, 1988, 2000) 'poverty of stimulus'

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[95] Reber (1995) observes that "few concepts in psychology have received more devoted attention and few have resisted classification so thoroughly" as intelligence. Artificial Intelligence moved discourse of intelligence out of the previous eugenic debates (e.g. Galton) and attempted to frame this domain as a more generalised property. In a sense this was a return to the *res cogitans* of Descartes – an irreducible and indivisible process that although instantiated in the behaviour of things was in fact in a different ontological category to that of *res extensa*.

[96] Newell and Simon's (1972) physical symbol processing thesis is a paradigm example of operations that are machine implementable.

[97] A meta-concept corresponds with the principle of an integrative concept (Laszlo & Margenau, 1972; Margenau, 1971). An integrative concept transcends the perspective of individual disciplines and provides a means integrating or connecting disciplines by providing a basis of a common terminology or code. In network analysis these concepts are equivalent of connectors or hubs that link together an array of nodes (either concepts, disciplines or theories).

conjecture, Godel's (1931) incompleteness theorem, and the halting problem (Browder, 1976; Church, 1935, 1936; M. Davis, 1965; Post, 1936; Roser, 1939; Turing, 1936) presented significant constraints for the formalist ambitions of AI[98]. Ironically it was this same class of issues – the inability to adequately account for the basis, function and nature of intelligent behaviour - that had eventually undermined the behaviourist program.

In response to these challenges, Hooker (1996) explains the development of AI theory, as moving along a trajectory from what he terms narrow AI theory (NAIT) to wide AI theory (WAIT). In NAIT cognition is theorised as a logical device[99]. This approach serves to provide the workings for the 'black box' of behaviourism. Unfortunately while the Narrow AI program proved to be initially successful, especially for problems that were context independent, it was not able to provide adequate resolutions to either the 'frame problem' (cf, Bickhard, 1996; Dennett, 1984a, 1998a; Dreyfus, 1992; McCarthy & Hayes, 1969; Minsky, 1987) or Searle's (1980) 'Chinese Room'. Both the frame problem and Searle's thought experiments (Searle, 1980, 1984, 1992) revealed the limitations of NAIT in adequately reproducing key aspects of intelligence like learning, creativity and reasoning involving ambiguity. Additionally, there was also the open question of 'how does symbolic manipulation instantiate behaviour'?

Wide AI theory (WAIT) was developed to make use of a different type of organisation (e.g., connectionism, parallel processing, neural nets, etc.) to that of the formal inference models that characterise NAIT[100]. Significantly learning (or training) was a substantially new feature in WAIT models. But to create these types of outputs, which had been largely absent in NAIT, required a different type of computational arrangement based more on associations and probabilities than formal logical relations (P. M. Churchland, 1989, 1999; A. Clark, 1989; A. Clark & Karmiloff-Smith, 1993; Cotterill, 1998; Harnish, 2002; Hooker & Penfold, 1995; Hookway, 1984; Pyslyshyn, 1984).

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98 AI thinkers did not always readily accept these limits. For example, John von Neumann in a lecture at Princeton in 1948 observed: "You insist that there is something a machine cannot do. If you will tell me precisely what it is that a machine cannot do, then I can always make a machine which will do just that!" (quoted in E. T. Jaynes, 1995, p. 4). Perhaps, and ironically, this is in itself a good example of the benefits of not seeing closed system as the answer – von Neumann felt he should be able to go outside of the current system and find an alternative path.

99 The Universal Turing Machine (UTM) is a paradigm example of this approach. A Turing machine, named for Alan Turing its inventor, is a theoretical device that manipulates symbols on a strip of tape according to a table of rules. A universal Turing machine is one that simulates the behaviour of any discrete Turing machine. This would be a machine that could implement different tables of rules and produce the appropriate output. In essence this is the kernel of the computer, as we know it now.

100 See McCulloch and Pitts (1943), Rumelhart and McClelland (1986), Rumelhart (1989), Clark (1989) and Smolensky (1998) for detail examples and description of the type of organisation used in WAIT.

The different organisational and computational arrangement opened up by connectionism provided the opportunity for models that were much more sensitive than NAIT to implementation requirements (P. M. Churchland, 1989, 1998, 1999; Cotterill, 1998). In particular, Neural nets (nnets) appear to be much more 'brain like' in respect to their developmental, resilience and degrading behaviours (Cotterill, 1998; Dawson, 1998; Smolensky, 1998). For example, Hooker (1996) characterises nnets as being comprised of:

> an array of connected nodes, each node and connection carrying a numerical measure or strength, so that a set of values imposed externally on some input nodes is propagated iteratively through the net until a well-defined set of activation values appears on some output nodes (189).

In this description we can observe in nnets promising features that are similar to Hebb's physiological descriptions of learning (Hebb, 1961, 1980). But there still remains a significant distance between nnets and neurons (P. M. Churchland, 1989, 1999). Additionally, nnets are plagued by consciousness, context sensitivity and control problems (Edelman, 1988, 1992; Haugeland, 1981a) – they require a 'ghost in the machine', *homunculi* or *Deus ex machina* to assist in their operation[101]. Intelligent behaviour and thought was proving to be as difficult to build, as it was to capture in vivo.

3.3 Cognitive science: generational change in the science of the mind

With the inability of cognitivism to break through the 'hard questions' of consciousness (Chalmers, 1996; Dennett, 1984a, 1991, 1997, 1998a; Pfeifer & Scheier, 1999; Shear, 2000) a new approach began to emerge – cognitive science – which sought to leverage off the advances of the AI perspective while also adopting more multidisciplinary theoretical drivers[102] (A. Clark, 2001; Robert Cummins & Dellarosa Cummins, 2000; Dawson, 1998; H. Gardner, 1985; Gazzaniga, Ivry, & Mangun, 2002; Harnish, 2002; Johnson-Laird & Watson, 1997; G. A. Miller, 2003). This program turned away from the formalism of AI/Information processing approach and sought to set out a more expansive and integrated model (Neisser, 1976). Nonetheless, mainstream cognitive science initially maintained a logic-centric approach, based on top-down abstraction and idealisation (Auyang, 2000; Christensen, 1999; A. Clark, 1997a), as its primary analytical lens. In Figure 1, Varela, Thompson and Rosh (1993) map the divergent activities within the sub disciplines of cognitive science and their associated commitments to cognitivism, emergence or enactive

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[101] Note that distributive adaptive control, Hebbian learning and Kohonen maps are forms of 'non-supervised' control (Pfeifer & Scheier, 1999, p. 168). These approaches and the resultant behaviours have strong neurobiological plausibility. See Kohonen (1988) and Pfeifer and Scheier (1999, p. 25) for detailed discussion of self organising behaviour.

[102] Svedberg (2004) provides a useful demonstration the benefits that can be gained by adopting a multidisciplinary approach within the AI domain.

philosophy. The core of Figure 1 represents the initial legacy of the cognitivist perspective within cognitive science.

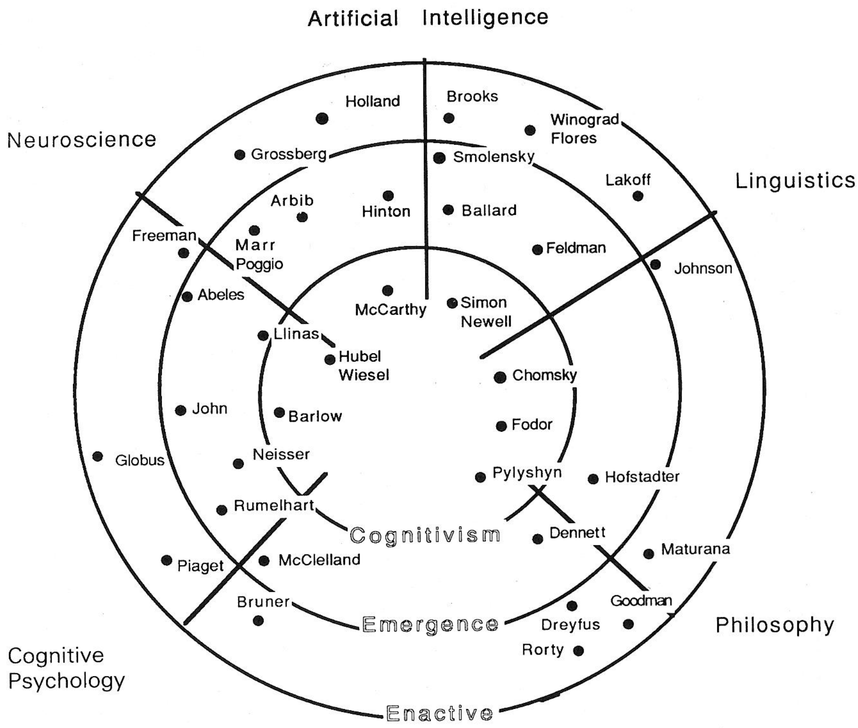

Figure 1. Map of cognitive science (Varela et al., 1993, p. 25).

Lakoff and Johnson (1999) differentiate between what they term first and second generation cognitive science. First generation cognitive science emerged during the decline of the behaviourist program and was directly shaped by Anglo-American analytical philosophy. Lakoff and Johnson propose that in the first generation of cognitive science there was a good fit between "early artificial intelligence, information processing psychology, formal logic, generative linguistics, and early cognitive anthropology" (p. 75). This arrangement enforced a strict dualism in the cognitivist program (Haugeland, 1985, 1997; Veron & Furlong, 2007) by drawing from the disciplines of psychology, linguistics, neuroscience, computer science, anthropology and philosophy only what could be represented in symbolic terms[103].

By the mid 1970s philosophical debate and empirical findings began to turn cognitive science away from its strong cognitivism (with its focus on computation, representation and dualism) towards an embodied (and biological) perspective (A. Clark, 1997a; Dreyfus,

103 See Pfeifer and Scheier (1999, p. 55) table 2.3 for an overview of the overall principles that had currency with 'classic' or first generation cognitive science.

1992; Dreyfus & Dreyfus, 1986; Lakoff & Johnson, 1999; Norman, 1980; Pfeifer & Bongard, 2007; Steels, 2007; Varela et al., 1993).

> We used to argue whether a machine could think. The answer is, 'no'. What thinks is a total circuit, including perhaps a computer, a man, and environment. Similarly, we may ask whether a brain can think, and again the answer would be, 'no'. What thinks is a brain inside a man who is part of a system which includes an environment (Bateson, 2000, p. 202).

The weak cognitivist trajectory of second-generation cognitive science encompasses research in the areas of ethology, neuroanatomy/biology, robotics, dynamic systems analysis and embodiment. The next step in understanding this trajectory is to consider the opportunities provided by three analytical approaches that align more directly with the anti-formalist and non-essentialist foundations of second generation cognitive science – Maturana and Varela's *autopoiesis*; Van Gelder's dynamical systems theory (DST); and Brook's autonomous robotics.

3.3.1 Autopoiesis

Maturana and Varela (1980) offer a radically different approach to first generation cognitivism, which combines insights from dynamics, systems theory, biology, chemistry and evolution (A. Clark, 1997a, 2001; Collier, 1998; Hooker & Collier, 1999). They put forward a process doctrine[104], called *autopoiesis*, which describes cognition as an extension of the act of living. There are three core conjectures upon which this approach is based. Firstly, that living systems are dynamic structures that are maintained by the flow of energy. These energy flows are the drivers of chemical processes necessary for life. Secondly, that living is a particular type of organisational pattern or arrangement that involves the capacity for a system to be self generating, self bounding and self renewing; and thirdly, that cognition is a process of dynamically coupling with the world – where a living system constructs internal organisational changes and patterns as a consequence of its self maintainent interaction with the environment.

Maturana and Varela reframed cognition in terms of a 'bottom up', biologically grounded concept (Maturana, 1969, 1975, 1978; Maturana & Varela, 1980, 1998; Varela, 1979, 1981; Varela et al., 1993). As Schrodinger (1992) argued, the question of 'what is life?' is open to

104 See Ellis (2000) for further discussion of the concept of process metaphysics. As the name suggests, process metaphysics aims to explain existence in terms of processes rather than static 'things'. While often most directly associated with recent dynamic systems thinking, process metaphysics or philosophy, in broad terms, was also championed by much earlier philosophers (for example this stance can be found in the writing of Whitehead). Process metaphysics in some ways is a replacement of Aristotle's perspective with that of Heraclitus'.

all natural sciences. By casting human understanding as a biologically grounded problem Maturana and Varela were able to break away from the logico-symbolic orthodoxy[105].

The meta-philosophical opportunities offered by *autopoiesis*, and its organisation, process and goal orientation, are arguably a useful starting point for the development of a genuine alternative to cognitivism. It is enough for our purposes to note here that by moving the debate into the biological domain (while retaining a sensitivity to system theory and embodiment) Maturana and Varela have required us to consider the role of interaction, autonomy and intentionality in the process of living (Maturana, 1975; Maturana & Varela, 1998). Symbol processing models, and their associated dualism, have avoided any real consideration of these domains. As such, we need to look "towards the evolution of dynamic interaction with the environment in circumstances involving finite resources, ignorance and fallibility" (Hooker and Penfold, 1995, 282) as a source for constructing our concepts. Maturana and Varela's work clearly requires us to shift away from symbols and encoding and instead adopt flows, coupling and organisation as the focus of our analysis. Yet the question as to whether this approach is capable of being scaled up to the level of higher cognitive processes (Brockman, 1995; A. Clark, 2001) still remains open.

3.3.2 Dynamic systems

Van Gelder embraces a more generic orientation within cognitive science in his use of dynamical systems theory (DST)[106]. He maintains that DST provides a transformative approach for determining the methods and content required to build alternative cognitive theory to that of cognitivism (van Gelder & Port, 1995). Responding to both the implications of Prigogine's and Stenger's (1984) work on self organising systems and the general critique of computationalism (Bickhard, 1996; Bickhard & Terveen, 1995), van Gelder has argued that DST offers the most compelling alternative to symbol processing models of cognition (van Gelder, 1995; van Gelder & Port, 1995). In this spirit, van Gelder puts forward a 'Dynamic Hypothesis' (articulated in the character of Newell and Simon's physical symbol system hypothesis) that 'natural cognitive systems are dynamic systems and are best understood from the perspective of dynamics' (van Gelder & Port, 1995, p. 11).

In a nutshell, van Gelder has characterised DST as being receptive to the temporal, interactive and embedded nature of cognition (which he sees as lacking within the

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105 Varela and colleagues (1979; Varela & Bourgine, 1992; Varela et al., 1993) have further extended this work and have created a comprehensive argument for *embodiment*.

106 See Clark (2001) for a general introduction to this area of cognitive science.

computational hypothesis). Additionally, he believes that DST (and in particular the principles of self organisation) has the capacity to capture the emergent properties that seem to be part of our everyday sense of cognition.

> Dynamics provides a vast resource of extremely powerful concepts and tools. Their usefulness is in offering the best scientific explanation of phenomena throughout the natural world has been proved again and again. It would be hardly a surprise if dynamics turned out to be the framework within which the most powerful descriptions of cognitive process … We know at least, these basic facts: that cognitive processes always unfold in real time, that their behaviours are pervaded by both continuities and discreteness; that they are composed of multiple sub systems which are simultaneously active and interacting; that their distinctive kinds of structure and complexity are not present from the very first moment, but emerge over time, and events at different time scales interact; and that they are embedded in a real body and environment (van Gelder & Port, 1995, p. 18).

For van Gelder these facts provide a justification for the usefulness, and the necessity, of a dynamic systems approach. Indeed, Port and van Gelder (1995), Thelen and Smith (1995) and Kelso (1995) have supplied an extensive array of empirical applications of DST concepts to psychological phenomena. Additionally, there is also a range of antecedent theorists (i.e., Ash, Lewin, Hebb, Gibson, etc.) who have demonstrated the benefits of system and dynamic thinking in understanding cognition[107].

Yet for all the possibility offered by Dynamic Systems research there are some serious constraints on the Dynamical Hypothesis (DH) proposed by van Gelder (Bechtel, 1998; A. Clark, 2001; Davids & Bennett, 1998; Jaeger, 1998). Christensen (1999), for one, identifies the failure of DH to provide a viable model of a cognitive agent as fatal to the aspiration of providing an alternate paradigm to that of computationalism. Although DST can explain many aspects of cognition the DH that van Gelder proposes lacks the necessary detail, with regards to agency and intentionality, to adequately characterise cognitive systems. It is the inability to differentiate, at a fundamental level, between the cognitive and non-cognitive dynamic systems that, Hooker and Christensen (1998b) argue, makes the DH unacceptable as an alternative paradigm to cognitivism. Nonetheless the introduction of dynamical systems thinking into psychology's methodological and theoretical repertoire has contributed to our ability to capture previously marginalised aspects of cognition[108].

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[107] We will return throughout this work to consider the potentialities offered by both the most recent theoretical models as well as earlier thinkers who are not immediately associated with systems, dynamic, embodied or embedded paradigms.

[108] This could be compared, as van Gelder and Port (1995) suggest, to the impact of the introduction of the computer on how scientists came to think about the mind.

3.3.3 *Autonomous robotics*

The domain of autonomous robotics research shares the view that intelligence is not sufficiently captured by logico-symbolic models. This style of robotics research (largely shaped by the work of Brooks, Beer, Maes and Smithers) has been concerned with modelling intelligence in ways which do not require representation; but rather emphasises the interactive capacities of autonomous agents in generating knowledge about their world – in essence, representation without recourse to symbols. Brooks (1991) has laid out the foundation for this approach by turning away from cognitivism's concern with computation per se and he has looked instead to the connection between intelligence and evolution. It is the "ability to move around in a dynamic environment, sensing the surroundings to a degree sufficient to achieve maintenance of life and reproduction" (R. A. Brooks, 1991, p. 140) that is at the forefront of modelling intelligence. As the 'frame problem' demonstrates, fine-grained interaction is fundamental to good choices (Dennett, 1996; Dreyfus, 1992; Minsky, 1987; Pylyshyn, 1987). For Brooks, AI needs to break with the physical symbol processing dogma of abstracted procedures, and instead look to behavioural instantiation – again there was the view that we need to build from the bottom up.

In adopting this approach Brooks has literately taken evolution as his model (R. A. Brooks, 2002b; R. A. Brooks & Stein, 1993) and built a series of what he called creatures. Using these robots Brooks is attempting to avoid the 'representational bottleneck problem'[109] (when the increasing demand for fidelity results in a reduction in the speed of response) by taking out the need for symbols. Brooks began with a functional decomposition approach – taking the whole system as both his starting and finishing point (which is comparable with van Gelder's holistic approach) he identified sub systems that were responsible for producing particular types of activity. His subsumption architecture is based on levels or layers of interactivity[110] whose interdependence/interaction allow the creatures to display complex behaviours without needing to make use of a central symbolic representation of 'the problem'. Instead the problem is represented by the environment (Bickhard, 1993; Bickhard & Richie, 1983; Bickhard & Terveen, 1995; A. Clark & Toribio, 1994) in which the creature is interacting. Using this approach Brooks hoped to demonstrate intelligent behaviour comparable to insects. Although he eventually abandoned his creatures they had

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[109] For a more detailed and extensive discussion of this issue see Bickhard and Terveen (1995); Feldman and Ballard (1982) and Christensen (2004b).

[110] "The general design features of subsumption architecture are: (1) multiple parallel active subsystems (in contrast to passive subsystems which await external command), (ii) task coherency at every active level, (iii) modulation relations between activity generating systems (rather than command relations), (iv) response subsystems to functional aspects of situations (rather than representations of function-independent things in the environment), (v) a focus on behaviour production, with global coherency of the robot state, including goals, being largely or entirely implicit in the operation of the robot" (Christensen, 1999, p. 47). For further detailed examples see also Pfeifer and Scheier (1999, pp. 199-225)

demonstrated the viability, via an embodiment or embedding tactic, of capturing some of the 'wild' cognitive behaviours that escape traditional AI work (R. A. Brooks, 1991, 2002a, 2002b; Bryson, 2000; A. Clark, 1997a).

3.4 Biology and mind: the next phase in cognitive science?

What Brooks, van Gelder, Maturana and Varela have shown us is that at some point there has to be connection between our understanding of cognition, intelligence and biology and context. Without this, second generation cognitive science argues, we are fundamentally disconnected, in essence causally separated, from the world we inhabit and from our biological history (Berthoz, 2000; A. Clark, 1997a; Damasio, 2000; Gazzaniga et al., 2002; Hendriks-Jansen, 1996; Luria, 1973). Moreover, in ignoring the embodied nature of cognition we would be failing to capitalise on what leverage dynamic and biological constructs could offer us on the mind and body problem. We also avoid the question of evolution and what role this should play in our theorising about the mind and learning.

From James onward the predominant conceptual vector in the psychology of the mind has passed through introspection to functionalism to behaviourism to formalism (Boring, 1950; Gregory, 1981; Hearst, 1979; Leahey, 1994; Valentine, 1982; Viney & King, 1998). Although this direction appears to have involved transitions in methodologies and analytical lens, there were enduring characteristics, such as the notion of a rational agent and cognition as symbol manipulation that run beneath mainstream, or orthodox, psychological theory about the mind [111]. The behaviourist-computational path had lead to abstracted formal models that were purposely separated from the biological (Christensen & Hooker, 1997a). This has proved to be both an empirical and theoretical weakness (see Lashley, 1951 for an example of this kind of critique).

Theorists of the mind such Chomsky (1968, 1980, 1988, 1993, 2000, 2002a, 2002b), Searle (1983, 1984, 1992, 1999), Dennett (1996, 1997, 1998a, 2003), Popper and Eccles (1977), and Churchland (1991, 1998, 1999) have all explored the limitations of the computational approach in explaining intelligent action. Their investigations have contributed to a 'naturalistic turn' (Bhaskar, 1998; Callebaut, 1993; Giere, 1988; Rouse, 1996) in the theory of

[111] For example Fodor (1981) has commented that the computational or logic-symbolic representation model of the mind was in use well before the first 'computers'. In Fodor's view Locke and Descartes both subscribed to computation in their description of the mind. It is reasonable to argue that the computational theory of the mind is an iteration of the more general representation theory of mind (which can be seen in Aristotle's thinking).

the mind[112]. The influence of this shift in perspective can be seen in the increasing input, interest and influence from biology[113], physics[114], and ethology[115] in contemporary models of cognition, intelligence and autonomy (Blakemore & Greenfield, 1987; Sternberg, 1998, 1999b; Sternberg et al., 2000). The increasing multi-disciplinarity of the mind sciences has lead to an appreciation that "nature does not separate the functions of perception, abstraction, reason, dynamic function and conception" (Hooker and Penfold, 1995, 281).

Embedded and embodied cognitive theories (i.e., Brooks, Maturana and Varela) are leading the calls for the empirical and theoretical reconnection of the functions of perception, abstraction, reason, dynamic function and conception. This kind of reconnection will demand that we redefine many psychological attributes in terms of their connection to the biological world.

> From the viewpoint of its origins, cognition has the biological "metafuction" of allowing the adequate realization of the rest of the biological functions. Although cognition does not define the set of biological needs (biological functions), it is directed to the optimization of their realization. Therefore, even if cognition cannot be studied apart from biological functions, it has a different specificity: the optimization of those through mechanisms that imply informational processes (Moreno, Merelo, & Etxeberria, 1992, p. 68).

Yet pursuing this path is not without its difficulties. Biologically grounded approaches are reductionist in principle and are often eliminative materialist[116] in practice (M. R. Bennett & Hacker, 2003; P. M. Churchland, 1998; Goldblum, 2001; Searle, 1992). This places the bar significantly higher in relation to consciousness and agency. Chalmers (1996) argues that this requirement goes too far and is unable to adequately account for the fundamental aspects of consciousness. Dennett (1995) is more optimistic seeing that it is not reductionism that is at fault, but rather 'greedy reductionism' – when we explain away the object of interest[117] - that is the danger. Let us briefly examine three responses to the challenge of bringing mind and biology together: evolutionary psychology, biopsychology and embodiment.

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[112] While there is debate as to exactly where some theorists sit in relation to "naturalism" (see, Chomsky, 2000), their various frameworks can broadly fit with the description of naturalism given here.

[113] (cf. Boden, 1981; Lewontin, 2000; Loewenstein, 1999; Marcus, 2004; Zeiler & Harzem, 1983)

[114] (cf. Bilodeau, 2000; Clarke, 2000; Elvee, 1982; Hameroff & Penrose, 2000; Schrodinger, 1992; Stapp, 2000; Wickens, Gordon, & Liu, 1998)

[115] (cf. C. Allen & Bekoff, 1999; Bateson, 2000; Houston & McNamara, 1999)

[116] This is a particular position taken within the materialist philosophy of the mind. The primary claim made by eliminative materialism is that our common sense understanding of mind – sometimes called folk psychology – is false and that the basis of the mind needs instead to be from behaviours and experiences that are able to reduced to the biological level.

[117] Dennett (1996) provides an accessible discussion of this process in relation to top down and bottom up techniques – where what goes missing in the middle is the object of our concern. Skinner's behaviourism could be seen as a type of 'greedy reductionism' with his exclusion of mental states from his model.

Evolutionary psychology[118] is broadly a combination of the disciplines of cognitive psychology and evolutionary biology. As with other domains within the science of the mental, evolutionary psychology contains an array of theoretical models and analytical techniques. Pinker (1997, 2002) characterises evolutionary psychology not as a unified theory but rather as a set of hypotheses about the relationship between brain-mind and evolution. As such, Pinker sees this type of psychology as being concerned with "particular ways of applying evolutionary theory to the mind, with emphasis on adaptation, gene-level selection and modularity" (in Benson, 2002, p. 1).

The common principle, or conjecture, that links all evolutionary psychological analysis is that psychology is based on biology and as such is subject to the same evolutionary process as any other biological function[119]. But even this shared starting point can lead thinkers into very different directions. To simplify this situation for discussion we will draw apart two lines of evolutionary psychological analysis: firstly, there is the research that seeks to connect psychological traits with the mechanism of evolutionary theory (i.e., variation, adaptation, fitness, selection and heritability) and secondly there is the evolutionary research that seeks to connect psychological traits with an evolutionary context (i.e., what is the connection between extant behaviours and their evolutionary path or history?). The obvious difference between these approaches is one of emphasis – the first approach examines the process for the development of functions (e.g., Goldblum, 2001; J. Langer, 1998; McKinney, 1998; Parker, 1998; Torey, 1999) and the second attempts to place those functions within an evolutionary trajectory (e.g., Bradshaw, 1997; Donald, 1991, 2001; Dyke, 1988; Goertzel, 1997; Hull, 1998; Jantsch, 1981; Plotkin, 1994)[120].

Evolutionary psychology is distinct from biopsychology, which adopts a strong position on the biological conjecture in relation to mind (i.e., that the basis of psychology is to be found in biology) but is not reliant upon evolutionary models to frame its answers. For this discussion we shall consider that biopsychology encompasses neuropsychological, neurological and cognitive domains[121]. To better understand the distinction between bio and evolutionary psychology, we need to examine cognitive neuropsychology. This approach seeks to build a "theory about normal cognition from a study of abnormal cognition" (Coltheart, 2001, p. 7). Luria (1966, 1973, 1976, 1987), Goldberg (2001), Sacks

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118 For one of the first uses of this idea see Ghiselin (1973).

119 This conjecture provides the basis for a multidisciplinary input from the fields of ethology, behavioural ecology, and socio-biology.

120 One way of representing this distinction is to see an evolutionary biology focus being concerned with Tinbergen's (1963) ultimate mechanism (function and phylogeny) and the evolutionary psychology being concerned with proximate mechanisms (ontogeny and causation).

121 There is similar relationship between neuropsychology and neuroscience as exists between cognitive psychology and cognitive science.

(1985, 1995), and Damasio and Damasio (1994) have demonstrated the efficacy of this approach in understanding mental processes such as executive control[122].

Fundamentally there is a view in neuropsychology that "complex systems often reveal their inner workings more clearly when they are malfunctioning than when they are running smoothly" (McCloskey, 2001, p. 594). While there is an anatomical aspect to cognitive neuropsychology (in particular a commitment to modularity of the mind) the focus is not on the brain but rather the mind. This approach provides support for both embodied and eliminative materialist approaches. It also implicates the role of interaction with the environment, regardless of the timeframe (evolutionary or individual life span), in characterising cognition as an adaptive process. Evolutionary psychologists like Donald (1991, 2001) and Goodson (2003), are concerned with biological research to the degree it supports their observations, but by and large they focus on arguing for the necessity of placing evolutionary concepts within our orthodox understanding of psychological constructs such as cognition, learning and consciousness[123]. Donald and Goodson offer us insight into how psychological traits, and their interaction with the environment (organic and social), have allowed humans to respond to evolutionary pressures (of the acute, chronic, and novel types).

Of course, the role of environmental impacts is not exclusively a concern of evolutionary psychology. Bowlby (1982), Barker (1968), Lorenz (1997), Lewin (1935), Tolman (1925, 1948), Gibson (1966), Neisser (1982), Bronfenbrenner (1979) and Vygotsky (1978) have all connected their models of cognition with an environmental frame or impact of some kind. This body of thinking offers a critical mass around the issues of environment, adaptation, interaction and cognition. But the philosophic infrastructure needed to use this critical mass is still largely underdeveloped.

Cognitive processes, from an embodied perspective, are embedded in a living 'system' (C. Allen & Bekoff, 1999; Bronfenbrenner, 1979; P. M. Churchland, 1998; A. Clark, 1997a; Damasio, 2000; Hendriks-Jansen, 1996). From this perspective, the primary function of cognition (and perhaps 'minds') is to facilitate the continued survival of the living 'system'

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122 These authors identify with a broad range of specialisation (i.e., neurologist, neuroscientist, neurobiologist, neuropsychologist) and we have differentiated their contributions in this case because of the particular concerns they have with trying to understand the functions of the brain-mind by working with those who have some form of impairment or damage to their brain.

123 This approach is similar to the mode of analysis found it in socio-biology (E. O. Wilson, 1975). Functionally, both evolutionary psychology and socio-biology are concerned with the same class of problems, but socio-biology's orientation is towards behaviour rather than development of functional modules or elements.

of which they are a part (Christensen & Hooker, 2000c; A. Clark, 1997a, 2001; Damasio, 1996; Goodson, 2003; Hendriks-Jansen, 1996). The embodied approach, because of its embedded nature, is more directly amenable than the symbol processing model, to bottom up modelling of agents; which in turn allows greater responsiveness to the issues of biological and cultural change. By adopting this approach we draw cognition back into the world – not as a feature of a detached, disinterested and disembodied observer, but rather as an active, engaged and embodied participant. Yet there is also detachment and distinctiveness at other levels.

3.5 Concluding comments

To commence our analysis of knowing and Doctoral cognition we have turned to look at the psychology of the mind. In this chapter we have examined a variety of lines of research into the nature of the mind. This examination has provided us with a wide-ranging disciplined background, against which we can sketch the analytical work being proposed in this thesis. Beyond this contextual positioning, this examination has also revealed the relative narrowness of the current Doctoral education theorising in relation to knowing and mind. It has also revealed that there are viable and plausible alternatives that we could, and should, be examining. Let us bring these elements together.

Over the past four to five decades or so, three significant developments have occurred in the psychological study of mind research and theory. First, cognition has become a central concern in mainstream psychology research. Second, the disciplines of philosophy, psychology and biology have been increasingly drawn back together around the questions of mind, consciousness and agency. Thirdly, the establishment of cognitive science as a parallel research approach to the study of the mind. These developments can be seen as part of a larger expansion of cognitive research from psychology into engineering, mathematics, biology, and neuroscience. As Gazzaniga (1998) notes, "psychology, which for many was the study of mental life, gave way during the past century to other disciplines. Today the mind sciences are the province of evolutionary biologists, cognitive scientists, neuroscientists, psychophysicists, linguists, computer scientists – you name it" (p. xi).

As part of this shift, a more specific development can be noted, a growth in philosophical psychology. This is psychology understood from the perspective of philosophy. The founding figures of psychology would be most accurately described as engaging in a mix of experimental and philosophical psychology. The science of mentality has been caught, from its beginnings, between the poles of: objectivity – subjectivity; empiricism – rationalism; and realism – idealism (D. M. Armstrong & Malcolm, 1984; Hooker, 1991, 1995, 1996; 1998). Consequentially, psychological constructs such as consciousness, cognition, learning, behaviour, knowledge and mind are informed by fundamental philosophical principles, such as autonomy, agency, identity, rationality, intentionality, and volition (Bolton, 1979; P. M. Churchland, 1998; Cronbach, 1957; Damasio, 1996; Dennett, 1996; Donald, 1991; H. Gardner, 1993; Lakoff, 1990; Lakoff & Johnson, 1999; Shotter, 1975; Warren, 1998b).

Different psychological orthodoxies (e.g., functionalism, behaviourism, cognitivism, etc.) have been defined by their arrangement of conceptual structures and associated meta-philosophical underpinnings – a standard model if you will (Baldwin, 1960; Boring, 1942; H. Gardner, 1993; Haugeland, 1997, 1981b; Lakoff & Johnson, 1999; Shotter, 1975). Each period of orthodoxy contains assumptions about core concepts such as, learning, cognition, mind and intelligence (Baldwin, 1960; Gregory, 1981; Leahey, 1994; Valentine, 1982; Viney & King, 1998). Accordingly, what is vital in understanding the transitions between psychological perspectives or doctrines is not only coming to terms with their surface arguments but also engaging with changes in their underlying philosophical commitments (Dennett, 1984b). It is at this subterranean level that we are able to uncover the fundamental, or root, commitments that hold individual models, or constellations of concepts, together.

Complementing the intra-discipline effects of different meta-philosophical positions on psychology, are the inter-discipline influences on the status of Psychology as a discrete field of study[124]. Hooker (1996) argues that the dominance of idealism and dualism has served to create the view that Psychology is a discipline *sui generis*. The primary consequence of this view of the discipline, according to Hooker, is that psychological and philosophical analyses are treated as if they are unable to be integrated in principled and comprehensive ways. Philosophy and Psychology of the mind are thus construed as being concerned with separate domains and issues.

Hooker (1995) puts forward that the adoption of a naturalist perspective – viewing psychology as one of a collection of connected natural sciences - will allow for the necessary cooperation between Philosophy, Psychology and Science for the creation of a

[124] See Bourdieu (1981) for an analysis of the operation inter and intra discipline effects in "fields" of research. Boden (1981) describes this form of contestation as "though opposing armies were fighting battles in order to win the right to define the nature of the war" (p.71).

natural science of intelligent systems. More significantly, Hooker argues that a naturalistic framework (Christensen & Hooker, 1997a; Hooker, 1987, 1991, 1995, 1996; Hooker, Penfold, & Evans, 1992a) offers a means of incorporating one of the most substantial revolutions in scientific thinking (Prigogine & Stengers, 1984) – "The shift from linear reversible, and compositionally reducible mathematical models to non-linear, irreversible, and functionally irreducible complex dynamics system models" (Hooker, 1996, p. 186). This emergent paradigm challenges the western rationalist program[125] offering an alternative to a linear idealised logic centric view of agency, intentionality and reason (Hooker, 1982, 1991).

Just as the natural sciences have undergone transitions, under the auspices of complex systems thinking, so to has the science of the mental (P. M. Allen, 1989; Port & Gelder, 1995). As has been discussed in this chapter, new models of cognition that are driven by a commitment to concepts of complexity, organisation, dynamics, non-linearity, emergence and systems have progressively shaped psychology[126]. Connectionism, situated/embodied cognition, and autonomous agent research have contributed to the erosion of the cohesive function, or orthodoxy, of the language based logic-symbolic paradigm of intelligence (Christensen & Hooker, 2000a; A. Clark, 1997a; Hooker, 1996; Pfeifer & Bongard, 2007). The challenge presented by this transition is not simply a shift in the mechanism for describing cognition and intelligence, but rather it is a questioning of deeply rooted arguments about the nature of agency, intentionality and rationality. The requirement for an adequate replacement to the largely internalist[127] symbol-processing paradigm involves the development of not only a comprehensive theory of cognition but a general framework for describing agency, intentionality and rationality as well.

Understanding cognition as a philosophical problem allows us to bring together basic, applied and theoretical works from the mind sciences and the philosophy of the mind work concerning intentionality, rationality and agency. As Bateson (2000) advocated, we need to seek a model of the mind that expresses the dynamical coupling of cognition and context[128].

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125 The philosophic viewpoint offered by non-linear and dynamic system thinking should be placed into the larger tradition of anti or counter rationalist theorising. Existentialists, Phenomenologists and Anarchists have offered resonant critiques of the orthodox rationality based on a critical exposition of the complexities and dynamic interactions of the individuals, context and reason (e.g., Stirner, Nietzsche, Dostoevsky, Heidegger, Marcuse, Feyerabend, Lakatos, Sartre, and Merleau-Ponty).

126 Much of this research comes from outside of mainstream psychological and philosophical research into the mind, providing a counter perspective to the formalist, essentialist and idealist positions.

127 For further discussion of the internalist/externalist issue see (Fodor, 1981; Kornblith, 2001; T. Nagel, 1986; Putnam, 1982).

128 This form of coupling, similar to that described by Maturana and Varela, has been explored in the domain of phenomenology. In particular Merleau-Ponty's work has examined the interplay between context, thought and action. His ideas relating to skilled interaction will be taken up in more detail in the following chapter.

Such a model needs to encompass the interactive, iterative and constructive relationship that occurs between the environment, in all its dimensions, and an intelligent agent. But in grounding the mind in terms of time, context, and biology (while eschewing dualistic and idealistic accounts) we raise the problem of control. How do intelligent agents create new or smarter moves? What is the mechanism by which they are able to obtain the requisite flexibility and action management? Thus interaction, volition, regulation and purpose all turn about the issue of higher order control.

So, is this relevant to understanding the PhD and the nature of Doctorateness? We think so. For if the criteria of Doctorateness is to have a non trivial meaning, then it is to be found in the relationship between the experiences of doing Doctoral research and how this shapes the thinking and acting of the individual. By looking to the psychological domain - how we think, how we solve problems, and how we learn - we are able to reveal the latent complexity that underlies the phenomena of Doctoral education.

CHAPTER FOUR

REGULATION, CONTROL AND THE MIND

4.1 Orientation

As we observed in the previous Chapter, the science of the mind has come to increasingly look to the question of how mind, brain and body are meaningfully interrelated, interdependent, and interconnected. The next step in looking at Doctoral cognition, within this trajectory, requires us to understand the ways in which Doctorateness would be enacted by an integrated *mind-brain-body* system. As established in the Prolegomena, we need to move beyond a *Deus ex mechina* solution to this question. The most productive line of thinking for understanding knowing and Doctoral cognition, that is consistent with the naturalistic disposition of this work, lies in the direction of embodied cognition, self-regulation, control and the mind.

Traditionally the mind has been cast with three leading players – cognition, conation and affect[129]. Although James, Freud, and Wundt all grappled with complex interrelationship between thought, affect and will, their preliminary efforts were soon overshadowed by "the rise of positivism, mechanism, and reductionism, and by the general sense that the elimination of concepts like consciousness and volition enabled significantly more parsimonious but no less powerful explanations of psychological phenomena" (Karoly, 1993, p. 24). In the previous theoretical synopsis of the psychology of the mind, we traced a gradual accretion of a representational or information handling core in mainstream psychology's theory of the mind.

This core has been characterised by a very particular and narrow view of what should be counted as cognition (Bickhard & Terveen, 1995; H. Gardner, 1976; Hooker, 1996). In this view representations play an integral part, with cognition being construed as essentially a form of symbolic representation and manipulation or computation (Bickhard & Terveen, 1995; Pickering, 2011). Whilst this constricted view of cognition has manifestly been contested in the discipline of psychology, the conative and affective aspects of mind are nevertheless typically not accorded the same levels of consideration by orthodox models.

[129] This distinction is not without its critics. Kelly for example found this division as particularly problematic. He observed that the division between these elements indicates a "a natural cleavage between processes, a cleavage that confuses everything and clarifies nothing" (G. A. Kelly, 1979c, p. 91). Spinoza offered a positive and dynamic account of the mind that avoids this traditional distinction, while still acknowledging the aspected nature of mind.

Furthermore adaptive and regulatory processes or behaviours are not deeply contemplated by representational models (Pickering, 2011).

The interplay between goals, regulation, volition, affect, agency, intentionality, consciousness, sensitivity and skill has become obscured by the partition of cognition (construed as computation) from the other functions of the mind. The biological turn in the mind sciences has occasioned some movement towards a more integrated or unified view of mentation[130] but there still remains an appreciable indifference in cognition to the affective, volitional and environmental dimensions of thought (Barsalou, 2008; Christensen, 2008; Damasio, 1996, 2003; Dunbar, 2002; Geary, 2005b; Hunt, 2005; Panksepp, 2005; von Foerster, 2003). It is essential to the aims of this thesis that attention be given to how we can bring these neglected and overlooked aspects of the mind back into our frame of reference.

In this chapter we will pursue how self-regulation, as derived from the biological, psychological and cybernetic traditions[131], can provide us with unifying concepts for building a viable alternative to orthodox educational constructs of cognition. The account given here will also acquaint us with the contribution that can be made by the notions of regulation and learning to the construction of an embodied and embedded model of intelligence (which we propose is a critical aspect of individual knowing and particularly pertinent to present concerns).

We will begin firstly by characterising the relationship between the principal notions of regulation and volition. Then we will move on to discuss how cybernetics can provide us with a generic framework for characterising the types of regulatory control that is required for intelligent behaviour. Given that the cybernetic approach is somewhat unfamiliar outside of the engineering and cognitive sciences (Pickering, 2011) this section of the chapter will also provide an introduction to the core constructs of cybernetic theory.

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[130] The integration of these elements has been a significant aspect of personal construct psychology. Issues of identity and personality tend to lend themselves to combination of affective, volitional and cognitive components in both personal construct psychology and in general psychological theorising.

[131] Cybernetics is typically associated most prominently with Norbert Weiner. His role is a significant one, and is referred to in this chapter, but it is also critical to be mindful that there were two distinct but interrelated streams of cybernetic thinking and development underway. These can be loosely, but meaningfully, be distinguished as being British and American strands (Pickering, 2011). The American strand was concerned to significant degree with questions of control, where as the British strand was focused more intensively on adaption (and the mind). Both strands will be discussed here and they have equally important contributions to make to the present analysis.

In particular, consideration will be given to the obstacles that need to be successfully overcome, by a control system, for the attainment of effective skilled behaviour (noting that there is a significant difference between a minimal and sophisticated level of interactive behaviour). The examination of this issue is important to assessing the viability and value of this alternative narrative. Finally we will explore how to resolve these issues so that we can move from the basic notion of control to a model that is more like the finessed, nuanced and complex behaviour of *real world* intelligent agents.

Although this chapter may seem to move us away from the immediate issue of Doctoral education, it is in fact a vital part of setting out the foundations for an alternate view of cognition. Any account of cognition in the Doctoral domain must provide some explanation of the mechanisms or psychological processes that regulate behaviour and thought. As Dennett (1984b) notes "what are brains for? They are not, as Aristotle is reputed to have thought, just for cooling the blood; they are for controlling the bodies they are perched in … " (p. 38). What Dennett draws our attention to, with this pithy remark, is the purposeful and intentional nature of psychological processes. The question of control and regulation, framed in the context of the brain, are not immaterial or disinterested processes – they are embodied (quite literally) in the existential experience of the individual.

It seems plausible then to suppose that a model of embedded and embodied cognition must offer some account of how context sensitive behaviour is achieved through iterative engagement between the agent and their world. Furthermore, a crucial component in understanding how an agent achieves increasingly skilled and intentional behaviour is also being able to identify the basis of (regulatory) constraints that the agent uses to navigate the world. What criteria does an agent use to discern, judge and decide on their plans and actions? Where do these criteria come from? Can these criteria be derived naturalistically? Or is there an a priori basis to reason and thought? In this chapter we will begin to deal with how self-regulation can be shaped interactively; and we will return to the substantive issue of the role of norms, limits and constraints in later chapters. Here it is enough to note that the issue of control is inherently linked with the question of how we make sense of and experience our world.

4.2 Regulation and volition

As finite, fragile and 'ignorant'[132] creatures we are consistently challenged to improve our understanding of ourselves, our life world, and other creatures with the aim of maintaining and continuing our place in the world (Barkow, Cosmides, & Tooby, 1992; Donald, 2001; Hooker, 1994b; Lorenz, 1996, 1997; Piaget, 1980a; Sterelny, 2003). This drive is exemplified less by Bergson's *élan vital* (vital impetus) and the broader vitalist and idealist doctrines[133], and is instead more consistent with Schopenhauer *Wille zum Leben* (will to live) and Spinoza's *Conatus*[134], where striving, self-maintenance and (inter)action are an endemic response to the circumstances (both internal and external) of living[135].

> Humans are phenotypes with a large genetic investment in general adaptability rather than specific fixed adaptations. We are general problem solvers, born with few specific abilities and relying on an extended cognitive neonatey to acquire specific life skills; in order to survive we need to co-operate to co-ordinate individual learning, share knowledge and practices across the group and transform these as interests demand and transmit successful ideas and practice to the next generation (Hooker, 1991, p. 83).

At a species level humans trade-off preparation (adaptedness) for responsiveness (adaptiveness) (Christensen & Hooker, 1997a, 2000b; Hooker, 1996; Hooker & Christensen, 1998) in an attempt to find, in the coinage of Dennett[136], "smart moves". It is the process of finding smart moves that we commonly label problem solving[137] (we examine the importance of problem solving in Doctoral cognition in the upcoming chapters). In fact it is the ability to actively select, and implement, smart moves that is one of the hallmarks of an intelligent agent (Cavedon, Rao, & Wobcke, 1997; Maes, 1991b; Pfeifer & Scheier, 1999;

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132 In this case, ignorance refers to being in possession of a very limited or constrained amount of knowledge.

133 Deleuze recast Bergson's *élan vital* into more of an ontological distinction by using it for describing the immanence and emergent properties in the world. This would seem to be an attempt, on Deleuze's part, to retain the intuitive notion of a distinction between living and non-living matter that Bergson's concept explores. Nonetheless preference is given here to Schopenhauer's and Spinoza's constructs as they encompass *connotative* elements that are seen to be fundamental to intentional activity.

134 Spinoza uses the term "conatus" in propositions 6, 7, and 8 in Part III the *Ethics*. He ascribes to conatus the follow characterisations: "Each thing, as far as it can by its own power, strives to persevere in its being" (Proposition 6) and "The striving by which each thing strives to preserve in its being is nothing but the actual essence of the thing" (Proposition 7). Spinoza uses the term 'Conatus' or the more expansive phrasing 'conatus sese conservandi' (the striving for self-preservation) (Allison, 1975; Duff, 1903). See Damasio (2003) for a extensive examination of the relationship between Spinoza's work and neuroscience and the importance of conatus.

135 Goldstein (1995) drew the distinction between "functional significance or value – by which we mean essential to the nature of the organism – and survival importance by which we mean paramount to the preservation of life" (p. 47). Goldstein saw that these two components are in balance in the 'normal organism' and survival importance only comes to dominate in pathological cases. It is useful to bear in mind that 'greedy reductionism' can trap us into perhaps removing some essential components in our catalogue of what is essential to agency.

136 Dennett equates his notion of a 'smart move' with Gregory's (1981) kinetic intelligence. Gregory explains kinetic intelligence as the capacity to "jump the gaps (usually small) from what we know to we need to know, to solve a problem or perform a task" (p. 313).

137 Heylighen (1991) explains, "different perturbations will require different reactions or compensations. This means that the larger variety of potential perturbations, the larger the variety of compensations the system must be able to perform ... every adaptive system disposes of a repertoire or variety of possible actions, that potentially compensate perturbations. However, a repertoire alone is not very useful. The system must also be able to choose that actions from the repertoire which is most likely to compensate a particular perturbation" (p. 75).

Smithers, 1995a; Stojanov & Kulakov, 2003). Furthermore, it will be proposed that representational or logico-centric models cannot satisfactorily account for, nor duplicate, the process of finding smart moves.

> The creation and improvement of intelligence is one of evolution's most impressive products, but not all things engage in the battle of wits, of course, or at any rate not to the same degree of commitment. Roughly speaking, the "choice points" in evolution are between the Maginot Line ("digging in" and opting for the immobile, armoured, (relative) invulnerability of plants, clams and other living things of minimal behavioural virtuosity) and guerrilla warfare (hide-and-seek) against other players in the environment … Note that the merely behavioural (or "information-processing") capacity to "wonder" about the evidentiary pedigrees of one's "beliefs" and the soundness and coherence of one's "desires" (the capacity that Locke praises, minus the presumption of consciousness) is a major advance in that cognitive arms race. Even an imperfect capacity to "evaluate" some of one's own cognitive and conative states makes a big difference (Dennett, 1984b, p. 37).

Humans, as a paradigm example of intelligent agents, are construed here as "informavores" (G. A. Miller, 1983) with an epistemic hunger, actively engaged in their environment (B. Allen & Kim, 2001; Bickhard, 1992a; Savolainen, 1995).

Unsurprisingly, we both want and need to know about our world. In sating this need or hunger we seek the means to move from our current circumstances, in response to an opportunity, impediment, need or threat, to achieve either the maintenance or improvement of our circumstances (Ashby, 1958; Heylighen, 1991; Maturana & Varela, 1980, 1998; Simon, 1962; Sterelny, 2003; Sternberg, 1996a). Indeed, if we accept that to survive and adapt, as Lorenz (1997) proposed, an organism needs to extract both information and energy from the environment, then humans are quintessential omnivores with an epistemic hunger as potent as our physical one.

> Cognitive processes seem … to be one and the same the outcome of organic autoregulation, reflection its essential mechanisms, and the most highly differentiated organs of this regulation at the core of interactions with the environment, so much so that, in the case of man, these processes are being extended to the universe itself (Piaget, 1971, p. 26).

Sterelny (2003) remarks that while all creatures have complex sensing and control systems (which allow them to adapt their behaviour, to some degree, to the contingencies of the environment and their particular circumstances), humans present a somewhat unusual case of this basic premise. In particular, humans display a technical and social proficiency that has allowed for the physical and social modification of their habitat in innumerable ways (Gamble, 1999; Goodson, 2003; Luria, 1976; Mithen, 1990; Tattersall, 1998). Furthermore, culture plays a distinctive enabling role such that we "have been encultured for as long as we have been human" (Sterelny, 2003, p. 3).

Not only do humans possess subtle and complex systems of control and sensing, but they also demonstrate a biological and cultural precociousness for cognitive (and epistemic) organisation of their sensing and acting that allows them to both exploit and create environmental stabilities and perturbations. As a result, higher order cognition contains at its centre, the process of skilled self-regulation whereby the information generated from an autonomous intelligent agent's interactions with the environment is in turn used to construct a framework (or criteria) for future actions with the intention of maintaining the agent's viability (Carver & Scheier, 1998; Christensen, 2004a, 2007, 2008; Karoly, 1993).

Cognition, when viewed from this self-regulatory approach, becomes integrated with the agent's particular biological, psychological, developmental and social circumstances. Under this view, an attempt to separate cognition from 'the world' could diminish our model of knowing to such a degree that it would not only lack explanatory power, but it would also lose the integrated and interactive features that are being identified by researchers as central to thinking, knowing and learning. Equally an attempt to separate out cognition from affect and volition is also problematic (R. Ellis & Newton, 2000; G. A. Kelly, 1995; Spinoza, 1876; Warren, 1998b). In particular, the attractiveness of the information processing model has made some sections of cognitive science 'affect blind' in terms of their theories (R. Ellis & Newton, 2000).

Addressing this blind spot requires us to contemplate how we might alternatively comprehend the integration of the affective, conative and cognitive domains. As Toulmin (1969) remarks, when trying to understand the nature and complexity of cognition we must be prepared to "reanalyse our ideas and terminology in the light of new empirical discoveries, and also to restate our empirical questions in the light of better conceptual analysis" (p. 71). An example of Toulmin's principle can be found in the development of cybernetics and its attempts to characterise the 'guided', 'regulated' or 'adaptive' nature of behaviour (Pickering, 2011). Cybernetics offers us a means of expanding our view of cognition. What's more, by focusing on the more universal notions of control or regulation we can bring in both volitional and affective aspects of the mind to our construction. For these reasons then, we now will turn to an introduction to cybernetic theory.

4.3 Cybernetics and control

Within the nascent domain of cognitive science, Norbert Wiener[138] (1948) introduced a fundamental adjustment to how we view the cognitive domain (Pickering, 2011).[139] He placed the question of control at the centre of cognition and behaviour.[140] Wiener (Rosenblueth, Wiener, & Bigelow, 1943) articulated a concern with how behaviour was directed towards the achievement of goals.[141]

While cybernetics does share some common ground with Wundt's notion of the *will*, Wiener was much more directly interested in the processes and organisational arrangements that allowed intentional action to unfold. He wanted to see inside the behaviourist's black box[142] but without giving up the importance of action and feedback (Wiener, 1948). As such Wiener's cybernetics was more than simply an amalgam of behaviourism, cognitivism and artificial intelligence – it was an attempt to extract some basic principles from previous notions of the mind and shape these into a new model which was sensitive to both internal and external drivers (Pickering, 2011).

In simple terms, traditional cybernetics[143] allows the functional decomposition of activity into a plant (or controller), and controlling components (Ashby, 1956; Astrom & McAvoy, 1992; DiStefano, Stubbard, & Williams, 1976; Lerner, 1970; Sayre, 1976; Wiener, 1948). Linking these functional components together is a series of rules or standards that regulate the interaction between the current state of the system and its end state.[144]

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[138] As in the case with the emergence of any field of activity there were a number of instrumental figures who shaped, and assisted in establishing, the field of cybernetics. Nonetheless, the common origin story of cybernetics attributes to Weiner a lion's share of the kudos.

[139] Luria explains in his introduction to *The Co-ordination and Regulation of Movements*, Nikolai Bernstein (1967) was working on control theory and global feedback twelve years before Wiener published his first works on cybernetics. Luria goes on to observe that Bernstein "formulated some basic principles of self- regulatory systems and the role of feedback in the regulation of man's voluntary movement" (N. A. Bernstein, 1967, p. 9).

[140] In Psychology, and in particular cognitive science, the differentiation between control and automatic response is a key factor (Cohen, Aston-Jones, & Gilzenrant, 2004). Posner and Snyder (1975) and Shiffrin and Schneider (1997) provide a detailed discussion of the research and theory surrounding the distinction between these two. Traditionally Psychology understands controlled and automatic responses as complex phenomenon. But this doctrine does not allow for the fine-grained understanding required to capture the intentionality of intelligent behaviour, as a system property.

[141] There are a variety of terms often associated with this idea (e.g., teleonomic, teleomatic, teleologic, intentionality, purposiveness, or goal-directedness). See O'Grady and Brooks (1988) for a more detailed discussion of this terminology.

[142] Wiener contrasted the 'black box' of behaviourism with the 'white box' of cybernetics (Wiener, 1948). In simple terms, a *black box* is situation when an observer does not know (can not observe or is disinterested in) what is going on inside a process or device. By contrast a *white box* is when an observer considers that they do know (or can observe or is interested in) what is going on inside a process or device.

[143] The North American tradition of cybernetics adopts engineering or mechanical descriptions as its the *lingua franca* where the European tradition move to a more biological or brain based descriptions.

[144] Hooker, Penfold and Evans provide the following description of this process: "Engineering control problems begin with a system S whose output $O(S)$ is to be controlled as to approximate some desired reference output $O(R)$. Control is achieved through by adding to S another system C in such a way that the augmented system $S + C$ accurately models a given reference system R. Functionally, C samples the output $O(S)$ and uses the error signal $E = O(R) - O(S)$ in some way to modify the input $I(S)$ to S so as to reduce E, ideally to zero" (Hooker, Penfold, & Evans, 1992b, p. 72).

Wiener's helmsman or steersman metaphor is the prototype example of cybernetics in action – where skilled navigation is achieved by a combination of feedback and internal reference states. This arrangement allows for responsiveness and error correction (i.e., control) that are both necessary for skilled action.[145] For Wiener, control did not necessarily require computation (in the strictly formal sense[146]). Yet Wiener's cybernetics still relied on a prosaic form of abstraction or functionalism, comparable to that used in AI, in that it does not matter as to exactly how control is instantiated - the focus is on representing the universal process.

By advocating for the control-plant model, cybernetic theory also introduced a requirement for us to consider the system, or global, level interaction and goals – what is the required end state? And how does a system work towards them by interacting with the environment and its own actions? Thus cybernetics, with its concern with the functional control of interaction (D. T. Campbell, 1974, 1990), opened the way for systems thinking and more importantly provided a way to reconcile the division of human cognitive process from that of the rest of biology.[147]

> If there is more than one action possible, the organism will need some way to functionally select which action to engage in. Such selections will, in general, depend on the internal outcomes of previous interactions -- for example, if interaction A has just completed with internal outcome S, then begin interaction B. If a paramecium is swimming down a sugar gradient, then it will stop swimming and tumble for a bit, before resuming swimming -- eventually it will hit upon a direction that moves up the sugar gradient, and then it will continue swimming… (Bickhard, 2001).

Cybernetic theory offered a way to reintegrate the biological domain into the analytical equation via the issue of action selection, learning, complexity and self-organisation.[148] But the notion of a plant and a controller does seem to be vulnerable to the trap of dualism. Smithers (1995a, 1995d) contends that there is an important distinction between 'autonomous agents' and 'cybernetic systems'. In Smithers' view autonomous agents[149]

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[145] See Dennett (1996) for a useful introduction to cybernetics and the relationship between Weiner's ideas and the study of consciousness.

[146] 'Formal' is used in the sense of Block (1980a, 1980b), Field (1981) and Searle (1980). See Stich (1983) for an argument for the primacy of structures over content.

[147] Indeed, cybernetics spilled out into a wide array of disciplines and areas – being applied to economics, management, design and education.

[148] The domain of complex systems research has proved to be a valuable counterpoint to somewhat narrower interpretations, that have at times, characterised dynamic systems theory (see Dyke, 1988; R. Ellis, 2000; Morowitz & Singer, 1995; Tschacher & Scheier, 1996).

[149] Smithers demarcates *agents* in the following terms – "We simply appeal to the observational fact that there is a class of systems which can be picked out of the general observable goings on which engage their surroundings processes in a coherent and effective way. These systems, which we want to call agents, consist not just of a collection of arbitrary processes, but are formed from particular sets of processes whose dynamic combination leads them to interact with all the other processes that constitute their environment in ways that result in reproducible, reliable, and robust task achieving behaviour. For us the possibility of agenthood is not so much a folk psychological attribute as a biological fact" (Smithers, 1992, pp. 33-34). For further discussion of autonomous agents - (see Cavedon et al., 1997; Christensen & Hooker, 2000a; Christensen & Hooker, 2002; Ford & Hayes, 1991; Maes, 1991a, 1994, 1991b).

cannot be functionally decomposed into distinct plant and controlled components (and thus avoiding a dualistic path) – instead they are best described, in his view, as agent-environment interaction systems. "In AE systems, effective, adaptive, or intelligent behaviour is to be understood in terms of the dynamics of the interaction between agents and the environments" (Smithers, 1995c, p. 4/1).

As was the case for Maturana and Varela, this conceptualisation breaks with the traditional intentional assumptions and instead infers intentionality as a property of the system as a whole (rather than a conditional information relationship used in idealised process). For Smithers, it is in the space between agent processes and the environment that intelligent behaviour is deployed. As such understanding this interaction space is crucial for refining our models of intelligence. The agent-environment construct is a 'working' model for thinking about interaction and intelligent behaviour (Smithers, 1992).

Curiously, Smithers considers that behaviour in the interaction space, between the agent and environment is not a property of the agent (comparable to Gibson's view of active perception and Lewin's view of a life space), instead it is an emergent from the phenomenon of interaction. Smithers believes that not only does 'behaviour' emerge in the interaction space, but it is also the overall system, with its emergent properties, that defines an agent. Smithers readily concedes that his view fits well with Heidegger's Dasein, and that Maturana and Varela's structural coupling contributes to his working model.

To summarise then, an interaction space creates a frame, or window, through which an agent and environment are coupled (Smithers, 1995b). This 'interactive present' (Smithers, 1995b, 1995d) results from ongoing interaction, shaped by the structure of the agent and the environment. If an agent is limited in perceptual capabilities (i.e., proximal sensing only), as is often the case in robotics (R. A. Brooks, 2002b; Maes, 1991b), this produces a very different set of behaviours to that of an agent who has a wider view of the world (geographically, ecologically and temporally).

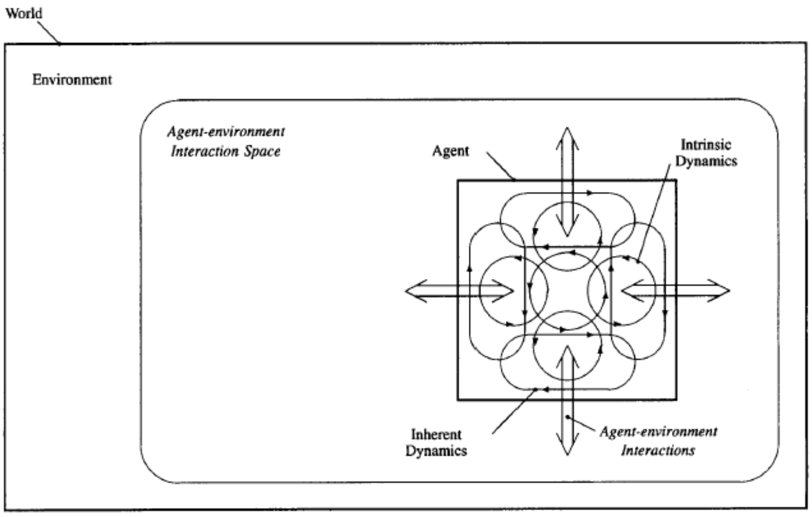

Figure 2. Smithers agent-environment interaction space (Smithers, 1995b)

Smithers additionally proposes that the capacity for self-governing is far more significant and complex than mere rule based regulation. Self-governing is an agent's capacity for self-creating its own rules for regulation.[150] The capacity to be self-organising in terms of reference conditions, along with the notion of infrastructure for flexibility, is one of the key contributions of Smithers' critique[151] of traditional cybernetics/control theory. Smithers pinpoints the dualistic challenge for cybernetics systems and invites the question: can traditional cybernetic organisation of a plant-controller provide the necessary dynamic context sensitivity that typifies intelligent agents behaviour?

Hooker and Penfold (1995) take up this very issue in their critique of AI and traditional control theory. They identified that AI needed to move away from static computational centric models of intelligence in the direction of a more dynamic and context sensitive approach. But to do so required addressing the issue broached by Smithers - 'how can we understand control in relation to bottom up, context dependent complex behaviour'? And by association 'is there a way to talk about control when we are ignorant of particular formulations involved in the conduct of an activity'?

Given the centrality of *control* to intelligent behaviour, in particular in instances when problems are best solved through "fitting" rather than computation, there was requirement

150 One possible means for achieving self-governing will be examined in the idea of local control – which allows for a system to generate context/system specific interactive reference conditions.

151 Although Smithers does provide substantive detail with regards to how DST can inform our description of autonomous agents he is unable to convincingly provide a consistent and viable characterisation of intelligent action by agents. The primary limits of his model are similar to those identified in van Gelder's work – DST is unable to provide an adequate unified representation of the intelligent behaviour of agents (in particular biological systems).

for an alternative notion of control and cognition (Hooker, 1996; Hooker & Christensen, 1998; Hooker et al., 1992a).

> It was always the a central ambition of the founding fathers of control theory, such as Ross Ashby and Norbert Wiener, to develop a fully adequate cybernetic theory of human functioning, to present us as homo cyberneticus. But over the past two decades that programme has been eclipsed by another, the development of a digital programming model of human intelligence, homo logico-programmus. Conventional control models themselves have had relatively little to do with current cognitive since and this, as we shall see, derives in significant part from the intrinsic nature of the standard control model, which is (perhaps ironically) in a similar programming tradition to that of homo logico-programmus (Hooker et al., 1992b, p. 71).

It is at this meeting point between the issues of *action, goals, cognition, control, intelligence* and *agency* we are offered the opportunity of seeking a new model for cybernetics that is free from both the previous psychological orthodoxies and the philosophical assumptions that underlay them[152].

Customarily, engineering has seen control as a process (or system) applied to a system to achieve reference dependent outputs (Hooker et al., 1992a). The aim of traditional control theory has been to provide a system level control process that is "relevant at all times and for all possible conditions of the system" (Hooker et al., 1992b, p. 72). In traditional cybernetics the control 'steers' the system to achieve a predefined end state (Carver & Scheier, 1998). Depending upon the nature of the 'problem' and associated end state there have been two standard control approaches – fixed (non-adaptive) and adaptive control.

Fixed control seeks to solve the control problem by pre-building controllers off line that are either fit for a stable system (i.e., the parameters of the system are known and not subject to perturbations) or robust enough to be able to tolerate a pre-specified range of variation in the system in/out puts (e.g., Zhou, Doyle, & Glover, 1996). This type of approach is particularly effective for very stable or predictable system interactions.

Adaptive control on the other hand seeks to up-date, or re-state, the systems reference parameters on-line. Both adaptive and fixed approaches make use of whole of system information (and parameters) to make determinations about the performance of the system (Kumar & Varaiya, 1986). This form of control has been achieved typically by the use of

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152 In the following decade Hooker, and his associates, would pursue several lines of attack on this problem. The initial steps were made in relation to control theory. Informing this approach was a concentrated analysis on the role of science, reason and dynamics. With these two aspects in place, control theory and a fresh analysis of regulation, Christensen would then further extend this analysis by drawing in the domains of biological sciences.

differential equations, for the representation of the reference conditions, and some degree of off-line pre-preparation.

The global control perspective offered by differential equations has been remarkably successful for many types of problems. This global strategy is less efficacious when total system level information (particularly in terms of the required end state) is either unavailable or very 'expensive' to obtain (Penfold & Evans, 1989; Penfold, Mareels, & Evans, 1992). In essence, the more complex and context sensitive the system, more dynamic control burden is generated. Bickhard typified this type of complexity in the following way:

> For more complicated organisms, the relationships among possible interaction outcomes and consequent further possible interactions will get quite complex. First, there can be multiple indications of interactive possibilities based on a single internal interaction outcome: interaction A with internal outcome S may indicate not only the possibility of interaction B, but also the possibilities of C, D, and E as well. Which, if any, of such multiple possibilities is selected to actually engage in will depend upon other states in the organism.
>
> Another form of complexity is the possibility of iterated conditional relationships among possible interactions and outcomes: if A reaches internal outcome S, then B is possible with a possible outcome T, and if B is in fact engaged in and T is in fact reached, then C becomes possible, and so on. Combinations of multiple indications and iterated conditional indications of interactive possibility can achieve enormous complexity, including interlocking webs of indications of possible interactions with closed loops and paths of indications.
>
> A third form of complexity is that of context dependency: outcome S may indicate one possibility if some other interaction K has reached internal state X, while S may indicate a different possibility if K has reached Y, or if some other interaction L has reached Z, and so on. Context dependencies of interaction complicate even more the webs of indications (Bickhard, 2001, emphasis added).

These types of complexity reduce the viability of a control system based on pre-determined system level linearisable end state parameters (Penfold & Evans, 1989; Penfold et al., 1992). The controller in traditional cybernetics needs to know everything about the system in order to function effectively.

In response to this issue Hooker, Penfold and Evans (1992a) advise that control needs to be redefined so that rather than being mathematical linearisable parameters (either pre-determined or estimated) it is instead a dynamic and adaptable capacity based on the two principles of control being a local problem and control beginning with behaviour modification. Control for intelligent agents is not about computation, it is about context and behaviour (Carver & Scheier, 1998; A. Clark, 1997a; Conant & Ashby, 1970).

An example of this precept can be seen in Dreyfus' (1992; 1986, 1999) recognition of contextual sensitivity and fine grain regulation as critical substrate to an agent's experience of the lived world. Dreyfus, drawing on the phenomenologist tradition, explains that Merleau-Ponty's (1962) concepts of the arc of intentionality and maximum grip offer us a richer picture of what should be counted in our science of the mental (Dreyfus, 2006).

> The body is our general medium for having a world. Sometimes it is restricted to the actions necessary for the conservation of life, and accordingly it posits around us a biological world; and other times, elaborating upon these prime reactions and moving from their literal to a figurative meaning, it manifests through them a core of new significance: this is true of motor habits such as dancing. Sometimes, finally, the meaning aimed at cannot be achieved by the body using natural means; it must then build itself an instrument, and it projects thereby around itself a cultural world (Merleau-Ponty, 1962, p.146).

The intention arc is an embodied characteristic of perception (very similar to that of the interactive present described by Smithers). It connects past present and future contexts through responses to the environment.

Intentionality, in these terms, is a relationship to the world, which an agent actively and purposefully discriminates for (to achieve maximum grip). As an agent moves along the intentional arc they shift from a context insensitive "rule" governed interaction to one where they are tuned to the environmental flows and consequently shape their behaviour in relation to their "feel" for the outcome (Merleau-Ponty, 1962). This form of intentionality also involves an affective investment in the outcome – agents are seeking to get a maximum grip on their situation (Dreyfus & Dreyfus, 1999).

For Merleau-Ponty, cognition is 'subtended' by intentionality and our interaction with the world is one of "skilful activity in response to one's sense of the situation" (Dreyfus & Dreyfus, 1999, p. 111). Christensen (1999) interprets this to be a process of congruent development of perception and action, where similarly to structural coupling, reciprocal feedback provides the resources for improved modulation. Thus the aspects of perception and action bootstrap each other, allowing for increased sophistications of interactions, which in turn generates new affordances, which then allows for more fine grained modulation of action, and so on (Hooker, 2009).

Hooker, Penfold and Evans' (1992a) explain that to accurately represent this kind of control requires a paradigm change regarding control. They observe that the standard control paradigm has three areas of weakness: epistemic (what is the knowledge required by the controller?), learning (when, how and why does a controller learn?) and methodology (what are the most appropriate problem solving strategies for determining efficient control?).

These control difficulties define the challenge put to conventional cybernetic theory – how can traditional control theory techniques that require a global model of the system (in terms of its behaviour and the desired reference condition), and that do not allow for learning and that represent problems in terms if logico-symbolic structures provide us with a plausible model for the complex behaviour demonstrated by even simple biological agents? For Hooker, Penfold and Evans the answer is – it cannot.

As with AI, the type of abstraction used in traditional control theory (and cybernetics) moves the solutions further and further away from the activities that are trying to be modelled. While there are many aspects of intelligence and control that can be captured in terms of logico-symbolic representation, it appears that this does not help us understand the much more common and mundane behaviour. In the words of Maes:

> A complex agent has complex goals. First of all, it has many goals, second the goals it has vary over time, third they have different priorities, and fourth their priorities vary according to their interrelationships. So it is definitely important that an autonomous agent can mediate among goals and handle their conflicts or even try to exploit their interrelationships to optimize their achievement over time (Maes, 1991a, p. 51).

Fundamentally the global system end state can not be specified in advance and more importantly, the system itself may be subject to change in its nature over time as it interacts with the environment (i.e., maturation, learning, damage, degradation, etc.). Unlike traditional control approaches the notion of local control is a graded property that can respond to current state and requirements of systems, which range along the evolutionary spectrum. Increased sophistication can be acquired with the capacity for memory. Memory allows for the capture of global reference conditions so that it can then be used to improve the local level predictions and associated behaviours.

The principle of local control adds to the global system trajectory or reference, of traditional control theory, a local behaviour reference. Local behaviour is referenced to the current context of the system and as such allows for dynamic behaviour (in terms of both the selection of action and learning). But this local activity is in turn constrained by the global reference conditions – behaviour is open but there are system level requirements[153] that need to be 'kept in mind'.

> The problem of guiding a system into a particular morphic end state is then less like specifying every construction sub step operating on an amorphic substrate, and a lot more like gently shoving a naturally dynamic system along particular developmental trajectories at critical bifurcation points (Christensen, 1996, p. 309).

Similarly to the notion of subsumption architecture or nnets, local control seeks to create the capacity of interdependent behaviour without necessarily demanding a single global controller and invariant pre-determined reference condition (A. Clark, 1997a). This perspective provides for the nesting of multiple levels constraints that seems to characterise biological processes[154] (J. Campbell, 1982; Houston & McNamara, 1999; O'Grady & Brooks, 1988).

The local control approach appears to offer a much more plausible model in regards to Weiner's metaphor of navigation. The capacity of local control to allow the system find its way, or to adjust, in relation to the 'current' situation while also maintaining an overall goal appears to create much more 'freedom' without the unusual computational or information 'explosion'. Furthermore, the system is thus able to learn about its current state and form a response rather than needing a complete understanding of its requirements before being able to determine a control solution.

This type of control is also a more probable fit with the finite, ignorant and fallible nature of creatures (Hooker, 1996). In the biological world we learn through living (C. Allen & Bekoff, 1999; Dennett, 1995, 1996; Engestrom, Miettinen, & Punamaki, 1999; Lorenz, 1997; Piaget, 1980b; Rayner, 1997). Although there is a certain level of pre-preparation in the biological world, by far and away the largest investment for intelligent agents is in context sensitive and adaptive control (Carver & Scheier, 1998; Houston & McNamara, 1999).

> This suggests that problem solving behaviour, language, expert knowledge and application, and reason, are all pretty simple once the essence of being and reacting are available. That essence is the ability to move around in a dynamic environment, sensing the surroundings to a degree sufficient to achieve the necessary maintenance of life and reproduction. This part of intelligence is where evolution has concentrated its time … (Brooks, 1991, 140).

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153 Autonomy is an example of one such property. This will be discussed further in Part B.

154 Bickhard's (1980b, 1992c; 1996; R. L. Campbell & Bickhard, 1986) framework for describing this type of nesting as it relates to knowledge and development will be discussed in Part B.

The link between the capacities for control and self-maintenance is crucial. Both self-maintenance and development require regulatory processes.

For intelligent agents the reference conditions form part of an externalised relation, conditioned by the nature of the system and its coupling to the environment. Christensen and Hooker (1997a) define interaction as a natural expression of controlled exchanges (external and internal) between an organism and the environment.

> The control reference model, such as it is, is embodied in a way which the system's outputs plus the environment is connected to the local activation thresholds of inhibiting and enhancing structures. There is no physically distinct controller as such, instead control is distributed (Christensen, 1996, p. 310).

Here control is organised is such a way as to meet the requirements of maintaining the continued existence of an organism in a context-dependent relationship with environment. Reference conditions are thus derived from internal states and interaction with the world.

Intelligent agents participate in an interactive and dynamic relationship with their environment (which involves explicit epistemic and ontological dimensions). As the regulatory control increased in complexity and subtlety so too does facility for context sensitive fitting or adaptability[155]. This interaction is intentional, referenced against the needs of the agent (as defined by its goals, circumstances, and capacities). There is a strong association between the capacity for self-regulated control of interaction and adaptability (Christensen, 2007). The question follows, what is the relationship between adaptive control and higher order cognition? The answer is, in a word, *learning*.

4.4 Learning - bringing regulation, intention and interaction together

The act of living is conducted in the present but projects forward to the future (Smithers, 1995a, 1995d). Learning is intrinsically part of this process, from simple conditioned responses that captivated behaviourists to the distributed multi-agent investigations of science (Christensen & Hooker, 1997a; Hooker, 1982, 1987, 1995). By drawing together the themes of control, adaptation, dynamics, systems thinking, autonomous robotics and neuroscience Christensen offers a generic model of adaptive learning in intelligent agents (Christensen, 2004a, 2004b).

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155 Volition is an example of this principle of directed interaction, rendered in psychological terms. Nietzsche (1968) also captures this in his notion of the *will to power*, Freud (1961) in his idea of *drives*, and Deleuze with the notion of *becoming*. Although these constructs may have an analogical rather than technical association with the mathematically orientated dynamic and cybernetic systems theories, the principle of directed growth is conserved.

> SDAL [self directed anticipative learning] is a model of fluid real-world learning in its natural interactive, task-oriented, context. In an SDAL process the system learns about the nature of the problem as it tries to solve it. The underlying theoretical strategy is to move away from an artificial intelligence conception of learning as algorithmic problem solving in a formally characterized domain dominated by fixing correct symbolic reference, towards a conception in terms of functional problems which must be interactively solved in a natural context while operating under, but also through manipulating, multiple constraints (Christensen & Hooker, 2000d, p. 3).

The features implicated in self directed adaptive learning (SDAL) – targeting, tracking, selecting, refinement, evaluation, credit allocation, context sensitivity, continuous skilled interaction, anticipation, and clarification – are not only recognisable in our folk understanding of cognition and intelligence, but they also allow for consistency with a growing body of neurological findings[156] (Blair, 2006; Christensen, 2004a; Christensen & Bickhard, 2002; Christensen & Hooker, 2000a, 2000c). According to Christensen (2004a) the two key features of SDAL are "integration of multiple overlapping sources of information" and "improved anticipation and error detection".

In a typical application of SDAL, the learner is seeking to integrate a wide source of information about the context and issue. The ill defined or open nature of the problem means that the learner has to apply finite resources to reduce their overall ignorance in regards to their problem. While some mechanistic strategies may be of use at this stage, they are crude heuristics (in comparison to latter actions) for gaining traction on the problem. Over time the information, both from the environment and the learners self-calibrating norms, allows the learner to "improve the recognition of relevant information, perform more focused activity, and evaluate performance more precisely" (Christensen, 2004a, p. 21). The multiplying effect of SDAL comes when an intelligent agent is able to improve their anticipations to the degree to which it allows them to run ahead of the game[157].

[156] Christensen (2004a) provides an extensive discussion of research in support of SDAL and for the overall IC approach to higher cognition. While there is clearly significant work yet to be done, these findings are encouraging in that there is empirical consistency between the SDAL concept and neuroscience.

[157] van Rooij, Bongers and Haselager (2002) offer a developing explanation of how action, and anticipation in general, could be instantiated without needing some form of representation. Their work is in response to Clark's (1997a) observation that DST has yet to crack the problems that seems to involve high representational loads – such as thought about the future of distal events. This research is a demonstration of how DST provide good methodological tools for tackling issues of representation but also does not necessarily provide a clear connection to a holistic picture of the identity/behaviour of an agent.

Paradigmatic examples of the application SDAL are: hunting, foraging, detecting, and researching – where the outcome is arrived at through the process of solving the problem.

> When successful, SDAL results in a pushme-pullyou effect as learning is pushed forward by the construction of new anticipations and pulled forward by the environmental feedback generated, creating an unfolding self-directing learning sequence. Because of its characteristic self-improvement SDAL can begin with poor quality information, vague hypotheses, tentative methods and without specific success criteria, and conjointly refine these as the process proceeds. This makes SDAL powerful because it allows successful learning to arise in both rich and sparse cognitive conditions (Christensen & Hooker, 2000d, pp. 3-5).

In adopting this perspective on learning certain consequences flow – the primary one being that we need to shift from a dualistic, representational and computational model (of the mind, cognition, intelligence and agency) to an embodied, interactive, regulatory and constructive model[158].

4.5 Concluding comments

In this Chapter we have continued to build up the elements we need to establish a credible and naturalistic view of Doctoral cognition. Much of the discussion has involved a considerable amount of technical and abstracted details; but this is typical of the analysis conducted within the field of control and cybernetic theory. However, this level of abstraction in and of itself does not preclude this style of theorising from making a contribution to the question at hand. For while we need to build up a picture of individual knowing, this representation or model needs to be able to adequately encompass the breadth and depth of the phenomenon we are examining. Concordantly, this does require at times, a degree of abstraction.

This chapter has offered a demonstration of how we can characterise the higher order features of cognition (which must include the regulation of skilled behaviour, affect and volition) without having to necessarily appeal to a dualistic or computationalist doctrine (outlined in Chapter 3). More importantly the capacities for development (and refinement) through interaction (learning), the self-generation of normative constraints, and meaningful goal directed control of interaction have also been realisable (Hooker, 2009).

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[158] Christensen sees this as requiring an integrative theory of agency and adaptive intelligence. While this view is supported in this thesis, there is limited need to go into a detailed description and analysis of his thesis on agency. For a more detailed analysis readers are invited to look to Christensen's references.

For the analysis being built up here, control mechanisms are functional pathways needed for the expression of the will. The capacity for persistence, both in terms of basic life processes and in pursuit of multiple goals, is included amongst the defining characteristics of autonomy and agency (Hooker, 2009). The ability to regulate thoughts, feelings, goals and behaviour are instrumental in the adaptability of the human mind. This is of particular significance to any naturalistic account of the mind, because the notion of localised control provides us with a means of understanding the self-regulatory, self-norming and adaptive behaviour of intelligent agents. These functions are central to our account of knowing in the Doctoral experience.

Dennett (1996), as noted in the introduction to this chapter, describes the evolution intelligent behaviour as the outcome of a cognitive arms race where creatures invest in their capacity to shape their behaviour and environment[159]. Cybernetics provides a theoretical language for describing the mechanisms and processes used in this arms race. It also fixes our attention on the importance of boundary or reference conditions. Understanding higher order control requires us to engage with the reference conditions, goals and behavioural (and conceptual) repertoire of an agent.

For cognition in the Doctoral education the capacity to *regulate knowing* (and the reference conditions used to steer or guide that knowing) is essential. The ability to determine the relevance, applicability and import of information to achieving the various nested goals of Doctoral research is as obvious as it is presupposed; yet, taken for granted and usually oblivious to the history and complexity in relation to the understanding of the concept of mastery.

This chapter has described the important difference between global reference conditions (in the case of Doctorate institutional standards and discipline based epistemic paradigms) and local reference conditions (the researcher's interpretation and management of these requirements) in understanding the adaptive and learning capacity of autonomy and agency. For if the Doctorate is intended to generate autonomous and efficacious researchers, then the capacity to manage local level constraints while also responding to global constraints is crucial.

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159 Refer to Introduction for the extended quote by Dennett on his notion of a cognitive arms race.

Furthermore this would go some way to questioning the value in prescribing specific cognitive and behavioural endstates for the Doctoral student. Adaptability (adaptive local control), rather than adaptedness (fixed control), offers the greater capacity for development across multiple cognitive domains and epistemic contexts. Concordantly, it would seem that the notion of general cognitive abilities is closer to the mark. Thus do we picture an ostensibly simple process of Doctoral research - the example par excellence of higher order intellectual effort – resting in a most complex array of issues and understandings from control theory, regulation, learning, intention, being, and the autonomy of the human mind.

> The roots of intelligence lie in the complex organisational requirements of autonomous systems. Autonomous systems are sensitive to, because they are vulnerable to, impinging stimuli (internal and environmental) and most actively control and regulate their interactions with their environment and their internal states so as to at least maintain their life processes (Hooker & Christensen, 1998, p. 105).

CHAPTER FIVE

INTELLIGENCE AND THE MIND

5.1 Orientation

This Chapter is about rounding out our introduction to the psychological foundations of Doctoral education. We will do this by linking the array of concepts and models we have been discussing to a central feature - intelligence. In the previous chapters we have examined how cognition and self-regulation (control) are discrete, but associated, processes. Given the intentional and directed nature of the candidate's response to the Doctoral experience, self-regulatory capacity is a critical component of our account of knowing and Doctoral cognition. Here we will explore how self regulated and goal directed cognition, action and affect, can be considered under the rubric of intelligence as organisational features of adaptability. As in the two previous chapters, this will require us to explore particular key concepts and background to build up an appropriate level of detail and fidelity.

We shall begin by establishing the historical and theoretical background of the concept of intelligence and examine the requirements – in line with the naturalistic systems position taken here in regards to cognition and self-regulation - for proposing an alternate model. Attention will be paid to distinguishing the standard or mainstream approach to intelligence, and the view developed in this work of intelligence as an emergent organisational property of autonomous agents. The themes of representation, interaction, dualism, consciousness and agency will be applied to the issue of how best to redraft the notion of intelligence in such a way as to allow for a richer understanding of *cognition in action, knowledge in practice, and mind in context.*

The purposeful, flexible and directive nature of cognitive (autonomous) agents raises the issue of whether it is possible to characterise these properties in a general way[160]. The conception of a general mental, or cognitive, ability has historically been associated with the idea of intelligence (Adey, Csapo, Demetriou, Hautamaki, & Shayer, 2007; Cianciolo & Sternberg, 2004; Sternberg, 1996a). The notion of intelligence, which is a point of connection for cognition, reasoning, perception, learning, problem solving, adaptation, and control, is central to any such characterisation of cognitive agency (Sternberg & Detterman, 1986; Sternberg & Salter, 1982). Furthermore, intelligence, for many, is the central mental notion of institutionalised education, and concordantly occupies a position of de facto influence in both folk and scholarly notions of learning.

We also need to be mindful that intelligence is arguably a property that is distributed across the biological world (Pfeifer & Scheier, 1999; Sternberg & Kaufman, 2002; Thorndike, 1998). As such, essential to any generalised model of intelligence is the need to accept the position that intelligence is most likely to be a graduated biological/evolutionary property of autonomous agents rather than simply a discrete human property (Geary, 2005b). Within the scope of this work the term intelligence will be used as a superordinate categorisation that brings together the disparate aspects of the mind sciences. This is a different stance to that taken by the widely recognised psychometric construct of intelligence (e.g., IQ) – instead, intelligence is taken in this work to be a type of organisation or structure in cognitive agents in the first instance; and the capabilities that this structure allows cognitive agents in relation to both open and closed interactions.

5.2 Redrafting intelligence

At this stage our understanding of intelligence (even in psychometric terms) lacks the necessary fidelity to provide for an extension beyond humans (Christensen & Hooker, 2000b; Sternberg & Kaufman, 2002). This complexity presents significant model building challenges both in terms of identifying generalisable attributes and dealing with the various paradigms of intelligence (Gregory, 1981; Lakoff, 1990; Sternberg, 1990). From its initial entry into the science of the mind as a "human faculty" (Galton, 1883) intelligence has proved to be notoriously difficult to define and operationalise (Boring, 1923; H. J. Eysenck, 1979; Sternberg, 2003; Sternberg & Kaufman, 2002).

Given these preliminary observations, how then do we explain the basis of intelligence? What differentiates this capacity from simple chance or reflex? And on an even more basic

160 See McNemar (1964) and (Gould, 1981) for a discussion about the concept of intelligence and its relationship to individual difference paradigms.

level, is intelligence a proper object for study? One response to these questions has been to equate intelligence with a capacity for reason, and its instantiation in 'mind' as *res cognitas*. This stance provides a dividing line between what are seen to be the clever but somewhat mechanistic behaviours of other creatures and humans (P. M. Churchland, 1999; Damasio, 1996; Dennett, 1996; Heylighen, 1991; Hooker, 1995; Leighton & Sternberg, 2004; Rychlak, 1991; Torey, 1999).

Donald (1991, 2001) proposes that to adopt this stance requires the acceptance of a cognitive discontinuity in our worldview between humans and other creatures in our world. As we have discussed, in this situation cognition is fundamentally disconnected, in essence causally separated, from the world we inhabit and our biological history. This discontinuity then sits alongside of the largely accepted physical continuity between humanity and its antecedent forms (Dennett, 1995; Goodson, 2003; Sterelny, 2003). While this contradiction may not necessarily prove to be fatal, particularly if you are of the view that accepts some form of dualism, it does create an obvious contradistinction to a large amount of the current activity within the science of the mind (D. M. Armstrong & Malcolm, 1984; Catalano, 2000; Chalmers, 1996; P. M. Churchland, 1998; Dennett, 1991; J. Jaynes, 1976; Pfeifer & Bongard, 2007; Shear, 2000).

An alternative response is to adopt some naturalist and/or materialist stance, which more strongly equates the mind and the brain. This is what Sterelny (2003) characterises as seeking the "connection between interpretive facts and the wiring connection facts"(30). As described in Chapter 2, within the domain of the mind sciences, there has emerged over time a broad spectrum of philosophies of the mind which can be usefully mapped along a continuum of naturalistic commitment to the connection between wiring and interpretation (Callebaut, 1993; A. Clark, 2001; Damasio, 1996; Godfrey-Smith, 1998; Hooker, 1996; Sterelny, 2003). From those who acknowledge a need for consistency between the current 'scientific world view' and our models of thought and action (e.g., Searle, 1992; 1999); through to a purely materialist position that sees mind and brain being the same, and that the solution to the 'puzzle' of consciousness will be most likely found within the physical sciences (e.g., P. M. Churchland, 1999). Although current attitudes towards mind and consciousness, in the mind sciences, have been most heavily influenced by the more 'materialist' end of this continuum, the field is not without those who question the dominance, and explanatory power, of design and "physical state" models (e.g., Chalmers, 1996). Nonetheless, the orthodox or standard picture of the mind – as "an abstract cogniser possessed of little bits of cognised content called 'ideas"(Warren, 1998b, p. 41) - has remained largely isolated from these definitional debates.

It is clear that the study of the brain is an established part of contemporary psychological research (which is further evidenced by the development of (sub) disciplines such as neuropsychology). What is not so clear is the degree to which the corollary of this position, the embodied nature of cognitive processes, has had a sustained impact on the theoretical modelling of agents, actions and learning. It will be argued that the orthodox or standard construction of cognition, which is still largely internalist[161] and computational in basis, separates out cognitive systems from the interactive, iterative and constructive relationships that occur between the environment, in all its dimensions, and an agent. Furthermore, the very notion of agency remains bound largely within an idealist tradition (Hooker, 1996).

The impact of this situation can be seen writ large in the attempt of *The Journal of Education*, in 1921, to distil from leading psychological researches a definition of intelligence. The product of this process (see Table 1. Definitions of Intelligence – Based on Journal of Educational Psychology 1921 Review) shows two clear results – firstly, that there had been a broadening from the anthropometric models of Galton and Spencer to a view that intelligence was more likely to be some form of generalised psychological ability[162]; and secondly, that although intelligence is a polysemous concept from which it was still possible to elicit some stable attributes. Environmental sensitivity, adaptation, and higher order processes (i.e. problem solving, judgement, decision making, inquiry)[163] appear to be consistently identified as components, or at least contributors to intelligent behaviour (Sternberg & Berg, 1986; Sternberg & Detterman, 1986).

[161] Godfrey-Smith (1998) characterises these terms in relation to explanations about properties of systems (usually organic). 'Externalist,' in Godfrey-Smith's terminology, is used for explanations of organic system in terms of properties of the environment. Whereas explanations that characterize the organic properties in terms of other internal or intrinsic properties he terms 'internalist'. In terms of epistemology these terms take on a similar function – they are used to describe the basis of knowledge – whether it is through a connection to the world (externalist) or develop from the inside and do not require a connection to the external world (internalist). For further discussion of the internalist/externalist issue see Kornblith (2001).

[162] Sternberg and Berg (1986) repeated this experiment and while there was a large degree of overlap between the two groups there was the inclusion of metacognitive elements in the 1986 data.

[163] Sternberg and Salter suggest that the most commonly agreed upon definition of intelligence is as "goal directed adaptive behaviour" (Sternberg & Salter, 1982, p. 3)

Table 1. Definitions of Intelligence – Based on Journal of Educational Psychology 1921 Review[164]

AUTHOR	CONCEPT
Terman	The ability to carry out abstract thinking
Pinter	The ability to adapt oneself adequately to relatively new situations in life
Peterson	Biological mechanism by which the effects of a complexity of stimuli are brought together and given a somewhat unified effect in behaviour
Woodrow	The capacity to acquire capacity
Freeman	Sensory capacity, capacity for perceptual recognition, quickness, range of flexibility of association, facility and imagination, span of attention, quickness or alertness in response
Colvin	Having learned or ability to learn to adjust oneself to the environment
Thorndike	The power of good responses from the point of view of truth or facts
Thurstone	The capacity to inhibit an instinctive adjustment, the capacity to redefine the inhibited or distinctive adjustment in light of imaginally experienced trial or error, and the capacity to realise the modified instinctive adjustment on overt behaviour to the advantage of the individual as a social animal
Dearborne	The capacity to learn or to profit from experience
Henmon	The capacity for knowledge and knowledge possessed
Haggerty	Sensation, perception, association, memory, imagination, discrimination, judgement, and reasoning

To come to grips with intelligence (even in behavioural terms) we need to recognise firstly, how as an idea it serves as a conceptual connector (or meta-concept) between the domains of knowledge, cognition, learning, behaviour and the mind[165]; and secondly, how each of these component domains (and by association intelligence) are in turn informed by particular philosophical commitments (or underground arguments). For example, there is a clear relationship between our orthodox understanding of intelligence as symbol manipulation (or computation) and a commitment to the principles of formalism, idealism, and essentialism (Bickhard, 1980a, 1993; Bickhard & Campbell, 1996; Bickhard & Terveen, 1995; Christensen & Hooker, 1997a, 2000c; Hooker, 1995, 1996; Hooker & Christensen, 1998; Hooker & Penfold, 1995).

As such, the tendency of the computationalist perspective has been to strip away the context (or environment) and to describe intelligence solely in terms of encoding and information or symbol processing (Pylyshyn, 1980, 1984). Embodied in the view that "a physical symbol has the necessary and sufficient means for general intelligent action"

[164] Text taken from Pfeifer and Scheier (1999, pp. 6-7) and Sternberg (2003).

[165] Putnam (1962) proposed a category of concepts termed law-cluster concepts. Bermudez (2005) states that by using the law-cluster concept as guide we can identify (pace Putnam) theory cluster concepts. Cluster concepts "cannot be properly understood unless one explores the full range of theories in which they feature – from the tacit and implicit theory of commonsense psychology that many theorists think that we all deploy to navigate the social world to the empirical studies of cognitive psychologists and the mathematic models developed by computational neuroscience. … A proper understanding of the concept will come only through integrating the different strands in the cluster" (p. 10).

(Newell and Simon, 1976, p. 87). This approach effectively separates intelligence from the biological world (A. Clark, 1997a; Hendriks-Jansen, 1996). A secondary consequence of this style of analysis has been to create the impression that formalism is the best way to achieve analytical clarity and scientific rigour in the study of the mind (Bickhard & Terveen, 1995; Hooker & Christensen, 1998; van Gelder, 1995; van Gelder & Port, 1995).

Important to the present work is the recognition that the implications of this orthodoxy are not simply metaphysical – they directly relate to the kinds of research questions (and methods) that are seen as appropriate, and necessary, to ask (Bourdieu, 1981, 1991). For example, as O'Loughlin (1997) comments, the standard construct of cognition leads us to an overemphasis on language and neglects notions of embodiment[166]. Which means that we "see the body as a handmaiden of consciousness, or we ignore the body's intelligent connections with the world at hand in order to draw attention to the linguistic constructions of social structures… and discourse" (O'Loughlin, 1997, pp. 24-25). Because of this narrowness in the mainstream view, there are a number of theoretical and empirical trajectories that remain underdeveloped. For example, Piaget's (1970, 1972, 1980a, 2001; Piaget, Grize, Szeminska, & Bang, 1977) genetic epistemology[167]; Lorenz's (1997) 'hypothetical realism'; Popper (1979, 1994) and Campbell's (Overman, 1998) separate versions of evolutionary epistemology[168]; and Toulmin's (1976) investigation of conceptual change and development; could provide educational researchers and theorists with a range of (existing but under explored) avenues for building an embodied/biological model of cognition and epistemology.

The implication of an embodied viewpoint is a shift to a system level appreciation of agency and intelligence (Hooker & Collier, 1999; Moreno, Fernandez, & Etxeberria, 1990; Rosen, 1985; Serra & Zanarini, 1990; von Bertalanffy, 1968). A systems stance retains an aspected differentiation of the functional repertoires of agents but, similarly to cybernetics, does not require a unique type of organisation. Instead the focus is on the system as a whole (cf. Rayner, 1997). Thus, use of systems analysis provides an approach that is sensitive to, but does not privilege, or depend upon, any particular instantiation[169].

166 The Phenomenologist doctrine provides a sustained critique of disembodied consciousness. Merleau-Ponty's (1962) work provides a good introduction to and clarification of the embodied viewpoint.

167 For a range of interpretations on Piaget's work see Mischel (1971); for a critical evaluation of genetic epistemology as it relates to cognition see Hooker (1995).

168 For other readings in the area of evolutionary epistemology see (Hahlweg & Hooker, 1989; Radnitzky & W.W. Bartley, 1987; Wuketits, 1984).

169 The ability to abstract away from the particular also drives formalist descriptions of the mind. Systems theorising remains more functionally aligned to context than logico-symbollic formalisms that have aimed to represent idealised and internalist models.

Additionally systems thinking is a means of understanding human cognition as but one particular type of cognitive system. Accordingly, we can divide the cognitive landscape up into discernable types of cognitive systems or agents. This identification of agents can be based on a cognitive systems' capacity for self-directed interaction rather than in relation to some imposed or 'external' metaphysical principles (Christensen & Hooker, 1997a).

It follows that the philosophical perspective offered in this thesis, which accommodates both existential and phenomenological traditions, is aimed at *gripping up* 'smart moves', solving problems, intelligence, learning, agency and self-maintenance and applying them to a particular exemplar – Doctoral research activity – to understand how cognitive agency provides us with an alternative perspective from which to illuminate cognition. In this work, the use of a system perspective is seen to be the most effective 'metaphor' for revealing the relationship between being, doing and meaning in doctoral learning.

To illustrate, Churchman's (1972) notion of inquiring systems[170] provides a demonstration of the efficacious nature of adopting a systems approach to describe the interconnection of the process for data solicitation, questioning, deciding, problem solving, knowing and information[171]. Churchman formulated five distinct modes, or systems, of inquiry. He expressed these modes through epistemic archetypes: Leibnizian, Lockean, Kantian, Hegelian, and Singerian. Each type of inquiry system operated through particular relationships between knowledge and the knower – formal, dialectical, experimental, synthetic. These different modes did not simply characterise different styles of interaction; they also delineated different forms of information that is sought. Mitroff and Sagasti (1973) explain that in Churchman's inquiry systems, information is understood as "a function of epistemology" (p. 119). That is, what an inquiry system (IS) knows about a particular problem it faces is a function of how that system has obtained its knowledge. This is a key insight and shapes much of the analysis undertaken in this work. The relationship between modes of interaction (inquiry), knowledge, organisation and control are central themes of this dissertation and we will regularly return to them, and the systems methodology, throughout this discussion.

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170 The use of a systems approach, methodology or thinking brings with it some particular challenges (P. M. Allen, 1983, 1989; Bateson, 2002; Laszlo, 1996; Morowitz & Singer, 1995; von Bertalanffy, 1968). For example, while encouraging a holistic approach it also demands a determination of where the system boundaries lie: What is internal to the system? What is external to the system? What are sub units, systems or components? How do these components interact with each other and with the environment? The determination of these parameters is more than merely a technical issue; this relates to the ontology of the system and the capacity of this method to assist in understanding the phenomena of interest.

171 There appear to be some potential links to be exploited between this philosophically grounded conceptualisation of inquiry systems and Sternberg's (1999a) discussion of thinking styles and abilities. At the very least there is sufficient resemblance between the two ideas to warrant consideration of how an inquiry system's behaviour could be described in further detail using Sternberg's research.

A critical first step in the process of building a truly genuine alternative to the orthodox conceptualisation of intelligence involves the breaking of the intelligence-computational bond (Bickhard, 1996; A. Clark, 1997a; Hooker, 1995; Pfeifer & Scheier, 1999; van Gelder, 1995). It is possible to come to terms with the concept of intelligent action without necessarily being forced into a formalist or anti-realist position to achieve our ends (cf, van Gelder, 1995; van Gelder & Port, 1995). To do this requires us to conceive of intelligence as part of the world, and most importantly as part of agency in the world[172]. The embodiment of intelligence demands that we consider the context, or environment, within which an agent operates (Dreyfus, 1992; Dreyfus & Dreyfus, 1986, 1999). If we begin with embodiment, interaction and construction, as our starting point then we travel in a profoundly different direction to the one that has lead to computational models of the mind (Christensen, 1999, 2004a, 2008; Christensen & Hooker, 1997a, 2000c; Steels, 2007).

For these reasons, let us briefly review the three main historical lines of activity within intelligence theory[173]; each of which can be distinguished by the object or unit of their analysis. Initially research on intelligence was concerned with issues of structure and attributes; researchers then moved away from pure psychometric approaches and this saw the emergence of a concern with development; and finally the emergence of cognitivism saw a commensurate interest in operations.

5.3 Defining intelligence as structure and abilities – a differential model

Driven by a concern with individual difference and psychometrics, as well as the influence of the nascent biopsychological theory, early research into intelligence sought to identify the constituent abilities, traits and structure of intelligence (Boring, 1923, 1942; Viney & King, 1998). This research program quickly transitioned from an anthropometric to psychometric methodology (while retaining a strong reliance on statistics) (Mitchell, 1999). The techniques of correlation and factor analysis were instrumental in 'revealing' the nature of intelligence. This analysis of function and structure fits well with O'Grady and Brooks' (1988) description of nonhistorical analysis which focuses on the current expression of phenomena without any consideration of origins, purpose or causes. Therefore, questions such as "what is it made of?' and "what does it do?" are typically the concerns of a nonhistorical approach. According to O'Grady and Brooks a nonhistorical approach does

172 Their position holds a sympathetic relation to concepts such as Heidegger's *Dasein* (being-in-the-world), van Uexhull's *Umwelt* (the surrounding world) and Merleau-Ponty's *intentional arc*.

173 See Sternberg's work (cf. Sternberg, 1990, 2003; Sternberg & Detterman, 1986; Sternberg & Grigorenko, 1997; Sternberg & Kaufman, 2002) for a detailed history and analysis of concept of intelligence. See Plucker (1997) for diagrammatic representation.

not necessarily preclude a teleological analysis, but it is very often the case that a mechanistic approach will be used instead. The strength of the nonhistorical approach is that there is no explicit requirement to examine how the phenomena came to be. In O'Grady and Brooks' view this strength is also a potential weakness because theorists can easily transition from mechanistic explanations of function to explanation of design based cause.

Although the initial scientific investigation of intelligence was influenced by early evolutionary theory there was little interest, beyond the notions of the differentiation or adaptive advantage, in the connection between intelligence and goals[174]. Binet and Simon (1916) would start to point theories of intelligence in a different direction with their model of intelligent behaviour/thinking. For Binet and Simon "intelligent thought comprises of three distinct elements: direction, adaptation, and control" (Sternberg, 2003, p. 14). This was a very different starting point to that of either Galton or Spearman. But this approach would remain largely unexplored until the emergence of developmental and cognitive theories.

By and large the initial description of intelligence was mechanistic in nature, and guided by the use of statistical techniques to identify aspects of importance. While this approach began with a rather simple model (e.g., Spearman's g) this was quickly replaced by multi-dimensional factors (as in Table 2. What is Intelligence? Abilities and Attributes).

[174] Evolutionary epistemology and psychology, along with the philosophy of science, would eventually see this issue being directly taken up.

Table 2. What is Intelligence? Abilities and Attributes

THEORIST MODEL	CONSTITUENT ELEMENTS
Spearman Two factor theory	• General cognitive factor (g) • Specific cognitive factors(s)
Cattell Triadic ability theory	• Fluid intelligence (Gf) • Crystallized Intelligence (Gc) • Capacities (g) • Provincial Powers (p) • Agencies (a) • Ability dimension analysis
Guilford Structure of intellect	• Abilities – operations, products, contents • Operations: cognition, memory, divergent production, convergent production and evaluation • Products: units, classes, relations, systems, transformations and implications • Contents: figural, symbolic, semantic, behavioural
Thurstone Prime mental ability theory	• Verbal comprehension • Verbal fluency • Number • Memory • Perceptual speed • Inductive reasoning • Spatial visualisation
Carroll Three Stratum theory	• Stratum III: General abilities • Stratum II: Broad abilities (fluid and crystalised intelligence, learning and memory, perception, etc) • Stratum I: Narrow abilities (69 Specific abilities)

We can see in these characterisations an attempt to represent what it means to be intelligent and the constituent properties, behaviours or levels that instantiate this attribute. But what was the basis of these elements? There was an underlying tension between psychological and psychophysical as the root cause of intelligence. This situation would lead very quickly to the division between those who studied cognition and those who studied intelligence. "[F]or the first seventy or so years of the twentieth century intelligence testing and cognitive psychology followed paths that, if not orthogonal, were not closer than 60 degrees to each other" (Hunt, 2005, p. 1). This external separation was matched by alternative approaches for analysing how intelligence arose and the differences in how it operated (Sternberg, 2003).

5.3.1 Intelligence as developmental

Piaget and Vygotsky were instrumental in recasting intelligence as something that emerged from cognitive structures and processes. The process of development, interaction, construction, regulation and adaptation are instrumental in their models. For Piaget's in particular, cognition was an extension of biological processes and best understood in those terms. There were multiple, and at times conflicting[175], dimensions to Piaget's theorising. As such it is hard to identify, from his vast body of work, a discrete and unified 'hard core' (Lakatos, 1978) to his theory – but there are particular aspects that clearly distinguish his model.

Piaget through his "life long focus on living organisms as dynamic, constructive, self regulating systems" (Hooker, 1994a, p. 199) pioneered the biological grounding of (human) cognition. His notion of genetic epistemology[176], with its consequent constructivism, was an attempt to encompass the whole of cognition within the biological world (Bickhard, 1980b, 1992c; Bickhard & Campbell, 1996; Hooker, 1994a). Intelligence was an expression of regulatory control, similar to Weiner's cybernetic idea of control in a system. The process of equilibration, combining assimilation, accommodation and interaction provided a positive developmental mechanism for adaptation. Piaget combined this mechanism with a stage-based sequence of maturation. Even here in this simplistic rendering of Piaget's model we can see both the quantitative and qualitative differences between his notion of intelligence and those of Spearman and Cattell. Adaptation and activity characterise Piagetian intelligence.

Vygotsky's primary concern was with environmental interaction rather than 'pure' biological maturation. His concept of internalisation, which has some parity with Piaget's schema model, involved the construction of internal states via external interactions. Additionally, Vygotsky's idea of the zone of proximal development identified a previously unexamined issue – firstly the fact that the development of abilities was not adequately understood in previous psychometric work; and secondly that there was a significant social contribution to cognitive processes (Bickhard, 1992c; Luria, 1976).

These developmental and constructivist accounts of intelligence grounded the question of intelligence in both the biological and the social worlds. They offered a more thorough

[175] In particular there was difficulty in reconciling the structuralist and developmental aspects of Piaget's thought. See Hooker (1994a) and Bickhard (Bickhard, 1992c; Bickhard & Campbell, 1996).

[176] The term *genetic epistemology* was originally coined by Baldwin (1968).

going understanding of the dynamic nature of intelligence and shifted the emphasis from simply performance to issues of competence and goals. This system-level perspective also challenged the underground argument of a dualistic and essentialist nature of previous models of intelligence. Given that we have previously discussed the basic ideas behind the cognitivist and biological aspects of intelligence, it is now obligatory to examine intelligence as understood in action.

5.3.2 Intelligence in operation

With the benefit of decades of established research and theorising, it has become possible for researchers to synthesise these various lines of activity. Gardner's (1985, 1993) theory of multiple intelligences, Ceci's (1996) bioecological model and Sternberg's (2003) successful intelligence provide effective examples of both the complexity with which intelligence is now modelled, and how these models (through synthesis) continue to develop earlier thinking.

Gardner's primary concern has been with performance, and in particular differential performance relative to different domains, rather than the fundamental nature of intelligence. Similar to Carroll and Cattell, Gardner (1985, 1993) has attempted to delineate types of intelligence. While there is a mixed response to Gardner's ideas (e.g., Kornhaber, 2001; White, 1988), the basic issue of different dispositions, abilities or preferences is an enduring one. Gardner's 'intelligences' were the product of a meta-analysis of literature that sought to extract, as Cattell did with personality, key components or characteristics. With this analysis as a foundation, Gardner (1985) offered a combinatorial view of intelligence within which human beings were understood as organisms who possess a *set* of intelligences.

Ceci's (1996) bioecological model is clearly influenced by Bronfenbrenner's (1979) ecological systems theory[177] (and by this association the work of Vygotsky and Lewin). Echoing Vygotsky, Ceci proposed as a response to the apparent contextual sensitive character of performance, that there is an interaction between cognitive potential (biology), context (ecology) and knowledge. This synthesis of a range of environmental and ecological concepts proves to be a useful touchstone between present psychological analysis and Vygotsky's earlier theory. For Ceci intelligence is a combination of biological informed contextually sensitive interactions. Sternberg (2003) observes that there is some

[177] Bronfenbrenner (1979) delineated five nested environmental systems: mircosystem, mesosystem, exosystem, marocsystem and chronosystem that impacted on psychological traits.

question as to whether this model is actually just a description of the interaction between biology and ecology or whether it presents a genuine theory.

Sternberg is one of the most prominent, and prolific, modern theorists of intelligence. His writing and research on the area has been prodigious. Within his work we are able to trace the development of what he calls a theory of "successful intelligence". Based on his initial Triarchic theory[178], Sternberg (1985, 1988) put forward the view that intelligent behaviour consists of three factors: *context*, *experience* and *cognitive processes*. These elements capture the essential aspects of task-related intelligent activity. For each of these factors Sternberg offered a further subtheory. The aim of this approach is to systematically account for the analytic, creative and practical aspects of intelligent behaviour. Sternberg has not only integrated previous research and theory into his work, but he has also retained a strong empirical commitment within his work (as noted above, the absence of this empirical aspect has been a particular criticism made of Gardner's theory).

The Triarchic theory has undergone further development and is now part of what Sternberg refers to as a theory of successful intelligence (Sternberg, 1996b). In this iteration of his theory of intelligence Sternberg links the triarchic components to adaptation and success. For Sternberg intelligence is the capacity and capability (creative, practical and abstract) of an agent to achieve context sensitive goals.

5.3.3 Intelligence as connection and control

Cognitivism, and 'good old fashioned AI', has contributed to the reinforcement of the views that intelligence is best captured by logico-symbolic computation, and that theorists are being distracted by somewhat superficial implementation issues (Hendriks-Jansen, 1996). As Cronbach (1957) noted the theory of intelligence has become factionialised into at least two disciplines.

The idealist and essentialist stance (central to cognitivism) has protected theorists from having to answer the hard questions of operationalisation. In fact it has taken a sustained effort, most recently by autonomous robotics, to raise serious questions about the efficacy of the logico-symbolic computation paradigm in capturing biological intelligence. So how have disciplines such as neurobiology, connectionism and cybernetics impacted on intelligence theory? Interestingly the answer to this question comes not from

[178] Not to be confused with Cattell's (1971) triadic theory of ability.

psychologists but from engineers and physicists. We will briefly examine two perspectives, Cunningham's dynamics and Powers' control systems, to get an understanding of this emerging paradigm in intelligence theory.

5.3.3.1 Cunningham – intelligence as organisation and development

Cunningham's model of intelligence has two main progenitors, Hebb and Piaget. Cunningham proposes an organisation structure of assemblages, much like nnets, as well as the principles for the development of this structure (which is founded on Piaget's equilibration) as the basis of intelligent agency. Essentially, the organisational structure of intelligence is built out of the concepts of schema and cell assemblies. Cunningham (1972) saw these as "two theoretical constructs, deriving from two widely different points of view, but with common characteristics which must be fundamental to a successful description of intelligence which is in the central nervous system" (p. 7).

These two approaches, Piaget's top-down and Hebb's bottom up, create for Cunningham a coherent view of intelligent behaviour as a property of organisational arrangements (assemblies) that undergo development as a regulatory response to their environment. Consistent with Piaget and Hebb, learning and activity are central to development. By using Hebb's approach Cunningham is able to create an organisational structure that is both dynamic and stable.

> The continuity and symmetry of the circular reaction between the internal and external world is easily overlooked when we theorise about the structure of their world independently of the other. Philosophically, we need to examine more closely the symmetry, continuity, and ultimate unity to understand how the structuring of one effects the other (Cunningham, 1972, pp. 160-161).

Given the similarity between nnets and Cunningham's organisational approach, we can begin to see how 'computation' of a wide kind may well be instantiated at the lower levels, and that this perhaps can be linked with the higher order processes that our folk psychology associates with intelligence (c.f. Cotterill, 1998). Cunningham's model is attractive in relation to its causal description of the dynamic and constructive elements of learning and cognition. It clearly offers, like nnets, a very brain-like system – but the explanation of how (self)regulatory control and goals fit into this organisation remains somewhat vague. The mechanism for emergence or development of control is clearly implied in Cunningham's discussion but his work would have benefited from further expansion on this point. Cunningham provides us with a description of how this type of control mechanism might work but its functional nature is undefined.

The addition of memory by Cunningham is also a significant augmentation to the connectionist approach, allowing interaction to occur across time[179]. As Smithers (1995c) argues the add-on of features like memory significantly increases the interactive options (or windows) available to an agent, and therefore the flexibility of an agent. It can be contended that the addition of memory (and by association the capacity to interact with "time" – past, present, future) to an agent's behavioural resources also explicitly requires a dynamic understanding of intelligence, as opposed to the somewhat static or passive views that tend to typify more metric based notions of intelligence.

So, on balance (and considering the time of writing) Cunningham's model is a positive example of how intelligence can be informed by connectionist and developmental perspectives, but as with WAIT this approach is more about the *how* than the *what*. Further support for this theoretical direction has been added by Quartz and Sejnowski's (1997) neural constructivism. Again by using Hebbian learning's general principles[180], and examining empirical and theoretical research, they have developed a model of constructivism based on activity dependent neural plasticity[181]. As with Cunningham, they begin with a relatively basic (i.e., small number of connections) network. In their view an intelligent system gains refinement and size iteratively to allow for more sophistication in terms of organisation. Quartz and Sejnowski see this as the underlying structure of development (and intelligence).

> [T]he human brain's development is a prolonged period in which environmental structure shapes the brain's activity that in turn builds the circuits underlying thought. In place of prewired modules, patterned activity builds up increasingly complex circuits, with areas staging their development. Cortical areas further away from the sensory periphery wait in anticipation of increasingly complex patterns of activity resulting from development in the lower areas. As this development proceeds, areas of the brain become increasingly specialised for particular functions, reflecting a cascade of environmental shaping. Some brain circuits close to the sensory periphery, such as early visual system, are in place by six months of age; but those in languages, further away from the sensory periphery, do not begin

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179 Torey (1999) goes further indicating the capacity to experience the world 'off-line' is the root element of consciousness.

180 Hebbian learning provides an explanation learning process by connecting learning with the adaptation of neurons in the brain. Hebb saw the learning process as involving the basic mechanism for synaptic plasticity – such that the theory is often summarised in Hebb's well know quote of of "Cells that fire together, wire together."

181 For background discussion to this approach and its application to the mind see Churchland and Sejnowski (1992).

> to complete their development until the eighth year of life (Quartz & Sejnowski, 1997, p. 13).

This observation agrees with Cunningham's ideas and his view of how intelligence, refined through learning-driven development, might be instantiated in the brain. Quartz and Sejnowski's approach links with the Piagetian and Hebbian aspects of Cunningham's model of intelligence, but there is little attention (not surprising given the empirical domain) given to the interactive (extra-neural) components. Christensen and Hooker (2000c) argue that the failure to consider the interactive and normative components of cognition and learning is a major limitation on standard neurocomputational models.

5.3.3.2 Powers - control and goals in intelligent behaviour

Powers (1973) on the other hand is far more concerned with the issue of what happens in terms of control. Powers' work is deeply concerned with the domain of cybernetics and has contributed a novel integration of psychological and engineering paradigms with regard to cognition. His ten level hierarchy of control distributes the regulation of behaviour and perception throughout the entire system; although in the final assessment, what Powers offers us is not so much a theory of intelligence, but a functional description of the kinds of things that have to be done as part of intelligent behaviour. In engineering terms – he provides us with a detailed requirements assessment for cognitive control.

Learning, goals, purpose, memory are all identified as properties of the overall system. Interestingly the relationship between the levels in Powers' hierarchy is one of exchange. Each level utilises the signals from the level below as input. This approach begins to present a practical description of how agents are able to pull themselves up by their bootstraps. Importantly, this also shares Piaget's view that complex logical and abstract processes can be built from what is available to an agent. As such, cognition and control do not necessarily require the provision of some transcendental power or dualistic commitment.

Powers has combined the basic thinking behind cybernetics and systems engineering to produce a functional representation of a control system of intelligent behaviour. While there is some capacity for development, this engineering approach leaves Powers with some difficulties in explaining the origins of these hierarchies. Setting aside the issue of predetermination of his hierarchies, Powers' model allows us to see how local reference conditions at different levels interact with the overall system goals. Powers' model is somewhat like Ceci's bioecological model – it is more of a methodological heuristic that we can use to consider what kinds of functions are required or necessary. The issue of how they are to be achieved is still an open question; but by linking Powers notion of control with Cunningham's idea of intelligence we may have some insight into what a naturalistic generalised account of intelligence may begin to look like.

5.4 Taking the next steps

Hooker (informed by the ideas of Hebb, Powers, Piaget and Cunningham) describes his generalised naturalized theory of intelligence as an aspirational theory capable of "encompassing any systematic theory of intelligence" (Hooker, 1996, p. 187). As this Chapter has shown, the achievement of this ambition requires not only the capacity to synthesise a diverse range of theory and research but it also requires the development of a suitably general theory of agency as a foundation of intelligence.

Hooker's idea of a generalised theory of intelligence has been strongly shaped by his reading of Piaget and in particular Piaget's conceptualisation of intelligence[182].

> Intelligence is an adaptation … to say that intelligence is a particular instance of biological adaptation is thus to suppose that it is essentially an organisation and that its function is to structure the universe just as the organisms structures its immediate environment (Piaget, 1963, pp. 3-4).

Hooker (both individually and in his work with Christensen) has undertaken to pursue a naturalist project that seeks to systematically construct a model of agency, cognition, intelligence and reason that is consistent with this vision of intelligence as *natural* process. Hooker and Christensen have identified three underlying or root properties of intelligence – autonomy, adaptability and anticipation. Hooker (2009) believes it is from these components that a unified theory of intelligence will be able to be built.

Much of the technical detail of the meta philosophical elements of Hooker's program does not warrant detailed reproduction here. We have sketched, for our purposes, a sufficient characterisation in the previous chapters to perceive its broad orientation and philosophical commitments. So let us begin, now that we have established the historical and theoretical background, with some preliminary definitions to illustrate the fundamental differences implied in this approach.

182 Hooker is concerned with notion of intelligent behavior as part of a larger project that looks to provide a naturalistic account of reasoning in particular and scientific activity in general.

Hooker defines cognition "in its broadest descriptive sense to refer to the thinking aspect or dimension of being intelligent, to the action and faculty of thinking, including perception and conception" (Hooker, 1995, p. 12). Thus intelligence is a master category that subsumes cognition, volition, and adaptation. In defining intelligence in these terms Hooker is able to include the affective, somatic and interactive domains that have been previously ignored under the computationalist view of mind.

This type of approach is necessary for Hooker's commitment to naturalistic explanation – too narrow a definition and he risks intelligence becoming a property *sui generis*. Added to this is the dynamically grounded character of Hooker's theory. This commitment demands that intelligence be active – for intelligence in living systems is functionally both action orientated and purposeful. To meet Hooker's criteria intelligence needs to be embodied and embedded in the environment; for in Hooker's program intelligence becomes conceptually vacuous outside of an agent.

> In this picture intelligence is characterised as a capacity for contextual sensitive action, and the emergence of intelligence as a distinctive adaptive strategy is associated with a form of adaptability focused on complex action in variable environments (Christensen & Hooker, 1999a, p. 135).

Intelligence, in these terms, is a graduated organisational arrangement that can be found in living systems. Life provides the initial conditions, and intelligence is one of the organisational responses to the problem of meeting these conditions. As living systems seek to increase their capacity for interaction in the world (most typically by going multicellular) they attract an associated 'coordination of effort' dilemma (Christensen & Bickhard, 2002).

Thus too, intelligence, as a general property of system organisation, emerges as we travel up the evolutionary gradient. The more sophisticated and context sensitive the action required, the more constraints that need to be managed, the more directed behaviour, and the more complex[183] the system. These are the initial parameters for intelligence under an I-C model – arrived at through a bottom up methodology starting with living systems and understanding intelligence as an elaboration and specialisation of the basic or root capacities of living. For Hooker and Christensen, human beings are the paradigm example of intelligent agents.

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[183] It is useful to bear in mind the key difference between the ideas of a *complex system* and a *complicated system*. A *complicated system* is one comprised of a great many interacting elements. A wide range or plausible organisational arrangements or configurations, on the other hand, constitute a *complex system*. Furthermore the behaviour of complex system while often displaying trends or patterns is also in response to context and time. These types of characteristics are often gripped up in the notion of self-organising systems.

Living systems are dynamically coupled, via their interactive capabilities, to the environment. These two processes of Interaction and Construction define the root biological condition called autonomy. For Christensen and Hooker – autonomy is the turnkey condition for agency (Hooker, 2009). The fundamental character of this relationship between the environment and a living system involves an asymmetry of organisation with the system constitutive (or constructive) processes being substantially endogenous to the system itself (Christensen & Hooker, 1999a). Thus autonomy provides the basis for the eventual congruent emergence of both agency and intelligent behaviour.

By using Interactivist-Constructivist principles to bridge the gap between the biological and cognitive science programs, Hooker and Christensen offer us a means of critically assessing the place of the internal computation/representation symbol process in cognition and intelligence. At the higher levels of organisation cognition is typically characterised as the capacity for strategic reason, concept formation and ill-defined problem solving. Christensen's approach, characterised by the notion of Self Directed Adaptive Learning (SDAL), directs us to instead construe higher order cognition as a situated process and as such requires a thorough going consideration of the attendant contextual complexities that exist beyond symbol processing abstractions (Christensen, 2007, 2008). Consequently learning, which has often been treated as the poor cousin to cognition, is immediately implicated as a system organisation strategy for ascending (horizontally) or expanding (vertically) cognitive capabilities for the modulation of action. Thus in characterising general intelligence we understand the need to be able to represent both breadth and depth when speaking about regulatory control in an intelligent agent.

5.5 Concluding comments

Newell (1980a, 1980b) proposed a set of criteria that needed to be met in the development of cognitive models if they were to offer a plausible description of intelligence. Newell's criteria reflect the changing nature of the 'science of mental' and help us identify the key modelling challenges that needed to be undertaken.

1. Flexible behaviour: behave as an (almost) arbitrary function of the environment;
2. Real time performance: operate in real time, respond as fast as human;
3. Adaptive behaviour: exhibit rational and effective adaptive behaviour;
4. Vast knowledge base: use vast amounts of knowledge about the environment to affect performance;
5. Dynamic behaviour: behave robustly when faced with error, the unexpected or the unknown
6. Knowledge integration: integrate diverse knowledge and make links;
7. Natural language: use natural language;

8. Consciousness: exhibit self-awareness and produce functional accounts of phenomena that re-reflect awareness;
9. Learning: learn from the environment;
10. Development: acquire capabilities through development;
11. Evolution: arise through evolutionary and comparative considerations; and
12. Brain realisation: be realized within the "brain" (the physical embodiment of cognition) (J. R. Anderson & Lebiere, 2003).

In the Newell criteria or "test" for cognitive models (summarised above by Anderson & Lebiere) we see an attempt to bridge the gap between first and second generation cognitive science – but Christensen and Hooker would argue that this approach avoids an examination of whether the current orthodox conceptual infrastructure (of narrow intelligence, agency and rationality) is the most appropriate basis for building these models. Instead they argue that we need to adopt a naturalistic approach – one that seeks its paradigms from within the biological and dynamic domains of the embodied agents. This conceptual trajectory travels through the concepts of: living systems, self-organisation, autonomy, and cognition to intelligence (Table 3. Intelligence Reconsidered - Abilities and Attributes).

Table 3. Intelligence Reconsidered - Abilities and Attributes

CONSTRAINTS	CHARACTERISTICS	CAPABILITIES	CONCEPTS
Finite	Interactive	Active	Autonomy
Dissipative	Constructive	Anticipative	Action
Fallible	Embodied	Adaptive	(Self) Regulation
Ignorant	Purposeful	Informing	Normative
Delicate	Persistent	Wilful	Anticipative
	Self enhancing	(Self)maintenent	Adaptive
	Self replicating	Goal-seeking	Teleological
	Self regulating		(self) Signifying
			Interactivist
			Constructivist
			Identity

Christensen and Hooker have begun with a set of basic constraints on living systems. These constraints have lead to a set of characteristics and expressed capabilities within living systems. This approach and associated concepts are the starting point for the Interactivist-Constructivist paradigm. From Table 3 we can identify an additional, if not alternative, set of criteria for that a plausible description of intelligence: Autonomy, Anticipation, Adaptation, Interaction, Construction, Normativity, and Regulation.

There are overlaps between these two sets of criteria (Newell and I-C), but they do not share the same conceptual infrastructure. It is reasonable it assume that both approaches could be necessary to developing a third generation of cognitive science. The goal of I-C is not to disavow cognitivism as having nothing to offer, but instead to recognise that cognitivism is not a pervasive answer to all the issues involved in understanding intelligence. In adopting this approach, we open rather than close the door on problem solving – and in doing so we are obligated to re-examine how we understand the infrastructure of problem solving: reason, epistemology, ontology and change.

PART A: SUMMARY

In Part A we have carefully examined the interplay between the western intellectual tradition (and in particular the western rational project)[184] and psychology of the mind. The most prominent conceptual vector in psychology of the mind has been the move away from subjective, context sensitive, and interactive agency towards an abstracted, essentialist and formalist position. This perspective has promoted a narrow doctrine of rationality, intentionality, and intelligence. The methodological frame for this doctrine is often idealist in outlook. Consequently cognition has been divided up between a range of disciplines each exploring a component, often with little reference to a systems view (integrating functions and environment into a holistic organisation).

The emergence of cognitive science is demonstrative of a desire to re-integrate cognitive disciplines. The initial stages of the re-integration were enabled by the information processing paradigm (Hendriks-Jansen, 1996). Models based on quantitative and algorithmic methods were easily transported across discipline lines, and allowed first generation cognitive science to condense around a set of basic assumptions (articulated most explicitly by Simon and Newell). This provided initial traction on problem of 'capturing' cognition, but it soon became apparent that cognition did not behave the same way in the 'wild' as it did in 'captivity'. Changing the parameters around cognition opened up a different set of concepts and techniques. But the idealist infrastructure surrounding rationality, agency and intelligence, largely remained in place. Overtime this frame of reference would increasingly become equated with the basic facts about how the mind operated.

To review, we adopted as our basic principle that the construction of concepts about cognition, regulation, and intelligence should be guided, to some degree, by naturalism[185] – that we should ground, or empirically constrain, our conceptualisations in the dynamics of the world (and in particular biology). Further, that a systems methodology (e.g., P. M. Allen, 1989; Funke, 2001; Laszlo, 1972; von Bertalanffy, 1968), with a cybernetic stance (Ashby,

184 Hooker (1991) characterises the western rational project in the following terms: the essential idea of Western intellectual culture is that man is a rational animal, i.e., reason is what distinguishes men from animals. The essential project of reason is transcendence, transcendence of the limitations of animal life: ignorance, prejudice, bias, egocentrism, anthropocentrism, projection (anthropomorphism). Beyond that there lies transcendence of this world, of finitude, decay and time itself" (41).

185 Botterill and Carruthers (1999) observe that "according to naturalism human beings are complex biological organisms and as such part of the natural order, being subject to the same laws of nature as everything else in the world. If we are going to stick to a naturalistic approach, then we cannot allow that there is anything to the mind which needs to be accounted for by invoking vital spirits, incorporeal souls, astral pales, or anything else which cannot be integrated with natural science" (pp. 1-2).

1956; Moreno et al., 1990; Pask, 1975b; Sayre, 1976; von Foerster, 2003; Wiener, 1948), provides the basis for a promising alternative to the orthodox models of intelligence that have been developed under the western rationalist project (Collier, 1996; Hooker, 1996). The key concepts in this emerging model of generalised intelligence are: construction, interaction, adaptation, autonomy, directedness, and regulation. This overall meta-philosophical approach, set out in the writings of Christensen, Hooker, Collier and Bickhard, is labelled Interactive-Constructivism (I-C).

Under the I-C line of inquiry intelligence is taken to be a graded property of sophisticated action selection and modulation, by an agent, in response to a normative matrix of global and local constraints. This modulation capability is central to the solving of ill-defined and open problems that are ubiquitous to our everyday world and interactions (Davidson & Sternberg, 2003; Ericsson & Smith, 1991; Klein, 1998; Klein, Orasanu, Calderwood, & Zsambok, 1995; Lave, 1988; Reitman, 1964; Schraw, Dunkle, & Dendixen, 1995; Simon, 1973). There has been in psychological and philosophic doctrine a tendency to separate out the processes (cognition) from that of implementation (inter-action)[186]. The result of this has been either a commitment to reductionism, which sees the contextual factors as largely formally irrelevant, through to relativism (Gould, 1981; Pinker, 2002; Shotter, 1975; Wimsatt, 1976). As argued in Part A, this has had a profound effect on our notion of the mind, intelligence and agency. Reason has long been seen as the necessary and sufficient characteristic for intelligence. But if we follow the formalist line of thinking that leads to artificial intelligence it is interesting that we have not felt the need to create neologisms for artificial reasoning, artificial epistemology or artificial problem solving. Why is it that we have felt the need to circumscribe a concept of synthetic intelligence[187] but these components, which seem to be implied in intelligence, do not require similar simulacra[188]? Perhaps this is because these characteristics of intelligence are seen to be, *ab abstracta* - removed from the world - and, distinct from biological intelligence[189]. The rational agent is pure mind, *res cogitans*, and able to expressed through formal (symbolic) statements.

Accordingly a commitment to the position of pure mind has taken the role of problem solving, in intelligence, and allocated it to a sub-class of operations that predominately is

186 This can be seen in standard types of problem solving test – for example the Tower of Hanoi where the experimental weight is on the computational description rather than the interactive behaviour of the agent trying to solve the problem.

187 Pask (1975b) notes "as an overall dogma I see no need to use the qualifier artificial. If a system is intelligent (more interestingly, if it evidences the exercise of intellect) it may be biological or not" (p. 14).

188 Representation

189 Fodor asks the question "how is rationality mechanically possible?" (Fodor, 1986, p. 20)

seen to require logico-symbol manipulations (Dawson, 1998; Dreyfus, 1997; Fodor & Pyslyshyn, 1988; Graben, 2004; Hooker, 1995). The dominant description of problem solving has been one of de-contextualisation, representation or encoding, and computation (e.g. Newell, 1980a; Newell & Simon, 1972)[190]. But Hooker, Penfold and Evans (1992a) argue that there are (at least) two paradigms for problem solving – computational and fitting. By definition a 'fitting' strategy implies an interaction with, rather than abstraction from, the problem.

In the next Section we shall, in principle, be guided by Hooker's (1995) decision-centric program which extends the basic I-C principle beyond the level of biological assemblages to that of societal level systems[191].

> I propose that we adopt a strategic or decision theoretic conception of cognitive agency whose basic component is the epistemic utility of increasing strategic decision in response to a problem posed in a particular decision context. This allows the explicit introduction of problem context to cognitive theory and so an explicit role for social structure, in particular a central role for the institutionalised social structure of science in scientific rationality. And it imports the decision theoretic framework of social context-dependent strategic interaction among rational agents as a basis for a dynamics for science. The complex interactions within these systems include both belief and goal formation and re-formation and structuring and re-structuring of role/processes. All these processes occur within and between all system levels from sub-individual to whole-society and now to whole-species, and they derive from interactions both within and between all system levels (emphasis added, p. 4).

With this as our point of reference we will aim in Section B to broaden the orthodox notion of *reasoning* and *problem solving* to a more generic "context sensitive learning capacity". The components in this account are the *agent*, the *environment*, and the *interactions* between the two[192]. In a sense all interaction is a kind of learning (Bannister & Fransella, 1971; Bickhard & Campbell, 1996; Bruner, 1990; Christensen & Bickhard, 2002; Dewey, 1930, 1997; G. A. Kelly, 1991b; Moreno et al., 1992; Piaget, 1970, 1971, 1972, 1980b, 2001; Piaget et al., 1977; Pribram & King, 1996; Quartz & Sejnowski, 1997; Rubinshtein, 1957; von Foerster, 2003; von Glasersfeld, 1995), but we want to know is "how learning, interaction and change are linked" in problem solving for ill-defined or open situations? Furthermore, of particular interest in our analysis will be the domain of conceptual change and its contribution to reasoning, decision-making and judgement.

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190 It is important to note that Simon was an advocate of the environmental aspects of decision making and problem solving, but this did remain largely underdeveloped within his models.

191 For a demonstration of this approach see Christensen and Hooker (1997a) discussion of the scientist in the natural/biological world.

192 Smithers (1995c), as discussed in Part A, terms this type of relation an Agent-Environment system.

As von Foerster (2003) described it, we want to understand understanding. By taking interaction and its correlate context sensitivity as our lens, we are able to give visibility to a host of issues, such as intentionality, volition, and self-efficacy, which have tended to disappear under the reductionist program[193]. As proposed in the previous examination of intelligence, exchanging our conceptualisations requires an examination of the philosophical infrastructures that supports them. Our next task is to elaborate the processes and broader frameworks that constitute intelligence in general and Doctoral cognition as part of research in particular.

Key Points

- Although there are competing models of agency, cognition and intelligence there is currently no comprehensive and unified alternative approach to that offered by cognitivism.
- A viable alternative model of intelligence requires not just new ways of thinking and operationalising intelligence, but it also requires a new model of agency to underpin it.
- From within a naturalistic framework agency needs to be grounded in the biological world.
- By using the systems and teleological thinking as integrative concepts it is possible to build-up a generalised naturalistic account of both agency and intelligence.
- In a naturalist account, agency is survival and self maintenance of autonomy systems. Autonomy is the work that needs to get done as part of the job of living.
- Cognition and intelligence are emergent priorities of the organisational arrangements that allow for directive control of systems interaction and constructing.
- Learning allows for adaptiveness – self directed adaptive learning allows for fine grained interaction.
- Intentionality (Coupling, reflex circuit, intentional arc, and goal seeking); Control (Regulation); Construction (Structure and organisation) and Constraints (Global and Local constraints) offer a different set of modelling properties and opportunities to current paradigms.

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193 At the same time that the rationalist doctrine was being shaped, with particular emphasis being taken from Descartes' heuristic for separating the mind and body, Spinoza was arguing, by employing the same kinds of 'rational' techniques, for an integrated and holistic view of agency and mind. For Spinoza (1876) the mind and body could not be meaningfully separated and more importantly that the cognitive and affective domains were in fact a part of a experiential whole rather the discrete entities. Refer to Damasio (2000, 2003) for a detailed discussion of Spinoza and his contribution to cognitive analysis.

PART B

ELABORATION OF PRACTICE

A philosophy is characterized more by the formulation of its problems than by its solutions to them. Its answers establish an edifice of facts; but its questions make the frame in which its picture of the facts is plotted (S. K. Langer, 1942, p. 4).

PART B: INTRODUCTION

Orientation

After an initial assessment of why we need to look to Doctoral cognition – the degree to which our existing frameworks can offer a coherent, comprehensive, and defensible account of real world thinking and learning in the context of higher education - we now need to consider what a elaboration of Doctoral cognition might entail. What precisely are the salient dimensions of Doctoral cognition, and how can we see them? Related questions include, but are not limited to: What provokes Doctoral cognition? What hinders or frustrates Doctoral cognition? What is happening cognitively during the Doctorate that distinguishes 'successful progress'? How does a student acquire Doctoralness? And, what does Doctoral cognition mean for higher education in general and Doctoral assessment in particular?

We have established in Part A that a suitable foundation or framework for a theory of Doctoral cognition would need to accommodate the concepts of *intelligence, self-regulation,* and *the embodied and embedded mind.* That in describing Doctoral cognition we are trying to understand the iterative refinement of self-regulatory processes that allows for the improvement, development or expansion of a student's skills and knowledge. But again the issue that comes to hand is - *what does this process look like*?

George Kelly's work on individual knowing and meaning making can assist us here. Kelly (1991a, 1991b) observed what he saw as the striking similarities between his clinical work with patients and his research supervision of students – he believed that the *same underlying process was playing itself out in these different scenarios.* In each case, the individual was trying to make sense and meaning of their world. Both the student and the 'patient' are making use of *constructs* and *construing* to determine a course of action and predict their likely outcomes. When construing, the individual notices the affordances that are within their world. This is a process whereby individuals are able to attribute and interpret their own and others' meanings through the act of anticipating future courses of action and their outcomes.

For Kelly the basic mechanism for making meaning and determining a course of action are the same in these two contexts – we use the same cognitive organisation in solving real life problems as we do in solving research problems. It was the generalizability of this principle of personal constructs that saw him adopt the image of "man as scientist" - or in the vernacular of this thesis, the person as researcher – as emblematic of his theory. A more nuanced understanding of how we engage with the world, make decisions, solve problems, and learn is critically relevant to advancing our understanding of knowing, learning and thinking at the Doctoral level. But we need to understand how this *process of construing* is a systemic process that implicates the aspected totality of an individual.

By drawing support from a large base of theory and research a case has been made for both the credibility and usefulness of adopting an embedded, embodied, interactive and constructive approach to Doctoral cognition. Concordantly, this work adopts (and advocates for) a holistic or systems view (Bateson, 2000; Churchman, 1972; Laszlo, 1972, 1996; Pask, 1970; Von Foerster, 1970) of agents (in our case Doctoral students) in which thinking, behaviour, emotion and acting are interrelated and interdependent.

Doctoral cognition is construed here as an instance of self-regulated and normatively constrained inquiry (and learning). Thus to further develop this notion, we are interested in exploring the circumstances and types of processes, in Doctoral education, that require a student to express self-regulated and adaptive knowing or inquiry (Christensen, 1999, 2004a, 2008; Christensen & Hooker, 1997a, 1998a, 2000c, 2000d). It is in these circumstances that Doctoralness should be able to be observed "in the wild".

Concordantly, in Part B we are now concerned with identifying and elaborating the components of cognition that are salient to ill-defined problem solving. Problem solving, in this work, is taken to be a cyclic process of actively applying constructs to problems for the purpose of generating anticipations – in Dewey's (1998; Dewey & Bentley, 1949) parlance, inquiring about the world - and then evaluating the outcomes of our interactions in relation to our anticipations (Davidson, 2003; Davidson & Sternberg, 2003; Dunbar, 1998; Duncker, 1945; G. A. Kelly, 1979c, 1991b; Laurillard, 1984; Novick & Bassok, 2005; Popper, 1999; Simon, 1973). But, why will examining ill-defined problem solving help us understand Doctoral cognition?

When we attempt to solve ill defined problems we use knowledge in a transactional, interactive, iterative and constructive way (cf. Duncker, 1945; G. A. Kelly, 1979a; G. A. Kelly, 1979c, 1991b, 1995; Leont'ev, 1978; Swann, 2009; Wertheimer, 1959). We act epistemically on both our internal knowledge structures (or constructs) and the external reality (Kirsh &

Magilo, 1994; Lorini & Castelfranchi, 2004; Medin, Lynch, Coley, & Atran, 1997; Piaget, 1972, 1980b; Piaget et al., 1977; Rychlak, 1994). We look "at the world through transparent patterns or templates" (G. A. Kelly, 1991b, p. 7) that we create. In solving problems we attempt to fit these templates "over the realities of which the world is composed" (G. A. Kelly, 1991b, p. 7) and construct a course of action, as well as anticipations about the outcomes of these actions. Kelly (1991b) explains that they way we construe the world enables people, "and lower animals too, to chart a course of behaviour, explicitly formulated or implicitly acted out, verbally expressed or utterly inarticulate, consistent with other course of behaviour or inconsistent with them, intellectually reasoned or vegetatively sensed " (p. 7).

Therefore, Doctoral research, learning, and knowing (in part, if not on the whole) can be reasonably construed as requiring self directed and adaptive responses to problems. Doctoral students come to know and understand their research project by actively solving problems (Dunbar, 1998, 2001; Swann, 1999, 2009). In doing so students apply their psychological processes and construction systems to help shape their actions and choices (Pope & Keen, 1981; Yorke, 1987). Kelly (1969) instructs us that by examining a person's "undertakings, the questions he asks, the lines of inquiry he initiates and the strategies he employs, rather than in analysing the logical pattern of the events with which he collides" (p. 16) we can begin to understand the psychological processes that channelize (or regulate) his, her or our behaviour. It is argued here that by investigating these processes, we can begin to establish a series of more fine grained constructs to assist in the characterisation of the perceptual, discriminative, organisational and anticipative capacities that contribute to self improving action modulation in general (or more simply – getting on with life in the world), and Doctoral cognition in particular[194].

Philosophical position – a reminder

Essentially, this work argues that Doctoral cognition involves the active, creative, intentional and pragmatic construction of systems of meaning and knowledge; that students (and supervisors) are not to be construed as passive receivers of knowledge or disembodied processors of information but instead they are active, anticipative, regulatory,

[194] Kelly (1979a) construes "learning" as such a fundamental psychological process that on closer examination it simply becomes part of the process of being and becoming. He explains that "[m]an lives best when he commits himself to getting on with his life. Since I see the concept of learning as nothing less than this, the term seems redundant when applied to a living creature. … However, if you prefer to call the whole thing "learning" then I have no objection to this use of the term – as long as its meaning is now narrowed down to something less than life's basic enterprise …" (p. 64). This work agrees with Kelly that the intentional interaction with the world, and the adaptive or learning component of it, is fundamental to being. It is also noted that it is difficult to narrow this basic process back to a more constrained position – this section of the work will strive to strike a balance between acknowledging the centrality of *learning* to Doctoral cognition and living.

intentional, autonomous and embodied agents. The emphasis here is on self regulated interaction, intention and construction as the sources for constantly developing systems of meaning and knowledge through inquiry, validation and invalidation [195].

This position has been predominantly derived from the concepts of constructive alternativism, interactive constructionism and complementarity (see Prolegomena). These concepts form the starting point for the development of a meta-theoretical[196] account of intelligent autonomous agents' (in less technical terms – individuals) capacity for inquiry, learning, adaptation, and knowing.

The elaboration of Doctoral cognition presented in this work fits within Mahoney's (1988) three basic epistemological and theoretical features of constructivist metatheory: proactive cognition (i.e., we are co-creators of our reality), morphogenic nuclear structure (i.e., a form of organisation where core processes dictate and constrain the forms expressed at peripheral levels) and self-organising development (i.e., that autonomous systems organise themselves so to protect and perpetuate their integrity). These components, in Mahoney's view, allow us to assert that *the proactive participation of the individual is entailed in human knowledge and experience*.

This elaboration is also broadly consistent with Bickhard's (2003) view of interactionism's commitment to "process and action as the proper framework for modelling mental phenomena". Bickhard explains that construction is a necessary feature of action systems – they cannot arise passively. Through the manipulation of objects (*pace* Piaget) an individual is able to extend and expand their knowledge structures (Bickhard, 1980b, 1992a, 1992c; Bickhard & Campbell, 1996). Knowledge is produced through interactive construction. Importantly knowledge and construction are key components in how an inquiring system is organised (*pace* Mahoney's morphogenic nuclear structure and Churchman's inquiring systems). This then is the philosophic foundation upon which our elaboration of Doctoral cognition will be built.

To summarise, some of the key philosophical assumptions for establishing this elaboration are: First, that there is a world independent of us, and that we come to know about this

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[195] This distinction should not be made too bluntly here – the point is to be mindful of the importance of content, relevance, application and meaning to our overall system of constructs.

[196] "Metatheories transcend theories in the sense that they define the context in which theoretical concepts are constructed, just as a foundation defines the context in which a house can be constructed. Further, metatheory functions not only to ground, constrain and sustain theoretical concepts but also functions to do the same thing with observational methods of investigation" (Overton, 2006, p. 41).

world through reciprocally interacting with it. Second, that these interactions are based on, and are the basis for, our understandings of the world. These understandings are expressed through the commitment to particular constructs. Third, that our understandings are used in composing (and constraining) our goals or anticipations of events. Fourth, that these constraints are fundamental to the regulation of our interactions. Fifth, that our understandings of the world (and ourselves) are dynamic, and therefore are subject to change. And finally, that these processes are continuous with the natural world (i.e., they do not *necessarily* require dualistic or idealistic postulates).

Part B outline

Chapter 6, informed by the philosophical assumptions described above, outlines a case for ill-defined problem solving being a window onto the psychological processes at play in Doctoral cognition and knowing. In this discussion, research is framed as an activity that requires productive thinking – thus drawing together, in a non-trivial association, research behaviour, self-regulation, intelligence, and cognition. An emphasis is placed in this chapter on the centrality of *knowing* and *acting* to the process of doing research.

Chapter 7 extends the discussion from the specific context of research activity into the domain of problem solving more generally. Here we identify the constituent and fundamental interactive and constructive processes of general ill-defined problem solving. Information will be established as providing a critical component for adaptive responses to ill-defined problems and situations.

Chapter 8 elaborates the substantive role that active perception plays in knowing and Doctoral cognition. It is argued that the act of knowing and perceiving is not free floating. As Delbruck (1986) contends perceiving is an integral part of both *being* and *agency*.

How we structure, organise and regulate our interactions in response to, or anticipation of, a problem is explored in Chapter 9. A critique of traditional rationality is offered that eschews disembodied reason and makes a broad case for construing rationality as a form of organisation for self-regulation. Under these conditions rationality becomes linked with agency and intelligent behaviour, not as an idealised or dualistic force, but instead as the interactive expression of increasing levels of regulatory control (Hooker, 1982, 1987, 1995, 2009).

Chapter 10 is devoted, at a broad level, to an analysis of the *art of knowing*, as well as the conceptions employed by reasoned or scientific thought in interpreting the world (G. A. Kelly, 1991b). This chapter completes our theoretically based conceptualisation of Doctoral cognition. In this we are looking to *close the loop* between the internal and external worlds of the Doctorate[197].

Concluding comments

To review, in Part B we will be using ill-defined problem solving (as an exemplar) to formulate how intelligent agents interact with knowledge and *learn to learn* (Swann, 1999, 2009)[198]. To borrow a Kellian term, ill-defined problem solving is the intended *focus of convenience* for our elaboration of Doctoral cognition. The projected *range of convenience* for this elaboration will encompass the psychological processes that are involved in Doctoral education and learning more generally - from question definition through supervision on to submission and assessment[199].

Before commencing our elaborative work it is useful to remind ourselves that the goals of this work (see introduction) do not demand that we arrive at a final answer to what Doctoral cognition is[200]. Instead this exploration of Doctoral education and learning requires us to examine what a credible alternative account of Doctoral education, based on interactive and constructive traditions, might look like. This type of speculative investigation is critical for advancing and refining our thinking about the Doctorate.

This notional stance allows us to bring new methodologies, techniques and constructs to bear on higher education as a domain of research. It demands of us a Vaihinger-like (Vaihinger, 1952) discipline of "what if" [201] – what if the Doctorate is best understood as an exercise in *meaning making* rather than *knowledge accumulation*? What if problem solving

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197 But not close off the inquiring systems from the world.

198 Ill-defined problems (or circumstances) by definition demand interactive and constructive processes.

199 Although the primary concern in this work is with Doctoral cognition from the perspective of the Doctoral student (broadly consistent with an idiographic position), this chapter also acknowledges the significant social processes that are involved in Doctoral research. While relevant to the question of Doctoral cognition, an in depth exploration of the 'total Doctoral experience' per se is beyond the scope of this work.

200 This work takes direction from Kelly's (1991b) observation that there are benefits to be found in making a "theoretical position provocative, and hence fertile, rather than legalistic" (p. 32). Kelly explains that good scientific theory should encourage the production of new ideas and approaches. As discussed in the introduction this work subscribes to this view and seeks to contribute to a generative program of research and theorising.

201 Vaihinger's construct of *fictions* – represented in the phrase "as if" - is recast here using the alternate phrase of "what if". The intention of this phrasing is to retain the essential spirit of Vaihinger's thinking, while adapting it to understanding the procedures and processes involved in institutionalised education. It is important to remember when applying Vaihinger's notion of "as if", is that this approach is intended to generate a *fiction* and not a hypothesis – fictions are intended to augment or extend our understanding of the world (Warren, 1998b).

is a better metaphor for Doctoral activity? What if Doctoral cognition is 'in and of the world'?

The benefits of seeking to elaborate the processes involved in Doctoral cognition are four fold: firstly, this can provide further detail for an alternative view of Doctoral education – one that is committed to prioritising the interactions and constructions of proactive and self directed agents (who are invested in making meaning through their research); secondly, this elaboration contributes to further revealing the ways in which an agent's constructs function as reference points for their learning; thirdly, this construes the supervisory relationship as something of cognitive, and not just administrative, significance; and fourthly, the question of motivation, ability and effort are drawn into the discussion of research processes. This will perhaps further reveal underground arguments about the nature of who is seen to have doctoralness and whether this is typically construed as a state, trait, disposition or *habitus*. This approach brings together the dimensions of conceptual change, learning and intentionality and in doing so opens up the possibility for new lines of theorising and practice in higher education (e.g., Denicolo & Pope, 2001; Pope & Keen, 1981; Pope & Scott, 1984; Zuber-Skeritt, 1987, 1992).

CHAPTER SIX

DOING RESEARCH AND THE MIND
THE COMBINATION OF PROBLEMS, ANTICIPATIONS AND INSTITUTIONS

6.1 Orientation

The starting point for this chapter is the deceptively simple proposition that if Doctoral education is about doing research (and *being* a researcher) then we need to understand the nature of *doing* research and *being* a researcher. As we have established in the earlier chapters, identifying a domain of inquiry can be reasonably straightforward; but the challenge really lies in how we circumscribe this domain and understand the inter- and intra- relationships and constructs that constitute this domain.

The first objective of this chapter is to disrupt the complacent relationship that we may have with the notion of 'research'. This will involve a deliberate and purposeful interruption to our automatic response of – "Everyone knows what research is"! We want to understand how research is part of a bigger picture of Doctoral cognition and knowing. Next we will look at how we can link the foundations outlined in Part A with the context of research activity and thinking.

Essentially it will be argued that the research process has something to say about how doctoral cognition, learning and education happens. By seeking to locate cognition, learning and knowing in the intersection between the natural and the social sciences, we are able to frame our constructs in terms of an aspected totality - an agent in context - and in doing so shed light on both Doctoral thought and behaviour (B. Davis & Sumara, 1997, 2002, 2006; B. Davis, Sumara, & Kieren, 1996; B. Davis, Sumara, & Luce-Kapler, 2008).

As Schoenfeld (1999b) argues, this type of investigation can serve to bridge the schism between fundamentally cognitive, fundamentally social, and fundamentally biological studies with the aim of offering "an integrated theoretical perspective that provides an adequate unified view of the ways we think and act" (p. 5). Thus we are brought to the question of - how can we, in a principled and systematic way, represent Doctoral activity (and thinking) so that we can develop a more thorough elaboration of what is 'happening' in doctoral knowing? Furthermore what is the relationship, if any, between our everyday knowledge and 'research' knowledge?

As we have previously established in Part A, answering these questions requires a thoroughgoing understanding of cognition, intelligence and self regulation (Auyang, 2000; Bransford, Brown, & Cocking, 2002; Christensen & Hooker, 1997a; A. Clark & Karmiloff-Smith, 1993; W. M. Davies, 2003; Donald, 1991; Gregory, 1981; Hofstadter & Dennett, 1981; Lakoff & Johnson, 1999; Pollock, 1995, 2006; Pribram, 1986; Ryle, 1949; Sternberg, 1990; Varela et al., 1993; Vygotsky, 1978; Wimsatt, 1976). A cogent response will also require some form of *rapprochement* between philosophical and psychological viewpoints in educational theorising (Schoenfeld, 1999b; Warren, 1990b, 1992); thus allowing for a more satisfactory, and progressive (Lakatos, 1970; Laudan, 1977), characterisation of knowledge and knowing in general, and of Doctoral cognition in particular.

6.2 So what is research?

A brief consideration of the etymology of the terms research and cognition can give us some initial purchase on how these processes could be involved in Doctoral research. This in turn can assist in identifying some of the salient candidate constructs and connections (cf. B. Davis et al., 2008) for our elaboration. Research derives from the old French *recercher*[202] meaning to seek out or search closely. This definition is suggestive of active seeking, and therefore is resonant with notions such as intentionality, volition and agency – i.e. that there is a seeker implied in the act of seeking[203]. Although in its modern usage we have come to draw a close affinity between the "scientific method" and research, it is useful to keep in mind this more general characterisation, which better preserves the relationship between action and agency. It would seem reasonable then to assume that "to search" implies that we must also have some means of recognising what we are seeking and/or the ability to construct recognition (perhaps from the act of seeking itself).

The roots of the term cognition lie in the Latin for knowledge (*cognitio*), recognition and knowing (*cognoscere*). As such, searching, knowing, and recognising form part of a more general ontological schema for constructs such as 'thinking' and 'reasoning' (B. Davis et al., 2008; Deleuze & Guattari, 1987; Dewey, 1930, 1997; Dewey & Bentley, 1949; Gibson, 1966; Gigerenzer, 2000; J. Habermas, 1987; Heidegger, 1968; Hofstadter & Dennett, 1981; Holyoak & Spellman, 1993; G. A. Kelly, 1980, 1995; Klahr, 2000; Lakoff & Johnson, 1999; Maturana & Varela, 1998; Neisser, 1967, 1987; Piaget, 1972). Based solely on these semantic attributes it

202 from re-, intensive prefix, + cercher "to seek for"

203 In the spirit of William James' observations that we tend to regard mentality as being a property, usually attributed, to active rather than inanimate objects, we can note that the fact that we do not commonly speak of a rock as 'researching' their environment. This fact reveals something about thinking as much as it does about rocks.

would be presumptuous to assert that there is a high degree of conjunction between research and cognition; but nonetheless there does appear to be, at the very least, a strong 'family resemblance' (Witgenstein, 1953) between research (focused searching) and cognition (knowing and recognition).

This resemblance provides some preliminary justification for continuing this line of inquiry. In doing so we commit to the proposition that research and cognition are linked at some essential level, and that this connection could provide the necessary leverage for understanding the role that research plays in provoking Doctoral cognition. More critically we also need to consider precisely what part knowledge occupies in doctoral research behaviour.

6.3 *Demarcating enquiring behaviour*

Research is construed as a type of (self)regulated knowing, which is within a class of activities that are deeply implicated in our understanding of what it means to be intelligent[204]. It is the complementarity of seeking, finding, knowing, thinking, acting with reason, intention and volition that directs us to a view of cognition and intelligence as being a nesting of iterative and recursive processes (Maturana & Varela, 1980, 1998; Varela, 1981; Varela et al., 1993). Thus we shall construe research as an intentional generative interaction with the world with the purpose of providing epistemic returns.

Furthermore, research activity is primarily 'self directed' - in the sense that an agent relies on the resources available to them rather than some *Deus ex machina* to achieve their goals (Carruthers, Stich, & Siegal, 2002). As such, we need to seek a "theory that fully integrates accounts of reason, cognition, ethics and policy into our best bio-physio-social and other scientific accounts" (Christensen & Hooker, 1997a, p. 275). This viewpoint does not, in principle, preclude the impact of social or collective influences on individuals (Bourdieu, 1981, 1990, 1991; Herfel & Hooker, 1998; Hooker, 2003; Latour, 1987). Instead it is an acknowledgement that the practice of research – as an exercise of reason, knowledge and

[204] Fromm characterised the difference between reason and intelligence, as "Reason is man's faculty for grasping the world by thought, in contradiction to intelligence, which is man's ability to manipulate the world with the help of thought. Reason is man's instrument for arriving at the truth, intelligence is man's instrument for manipulating the world more successfully; the former is essentially human, the latter belongs to the animal part of man" (The Sane Society Chapter 3 1956, p 64). Fromm points to reason, rather than intelligence, as the means for extracting and representing that meaning in our thoughts. Intelligence (has a far more mechanical role in Fromm's critique) takes on narrow meaning. A different stance is taken in this work - intelligence is broadened in it usage and is recombined with the elements contained in Fromm's notion of reason. Intelligence is construed as a unified construct that speaks to both the capacity to manipulate the world and making meaning through these manipulations.

intelligence – is fundamentally a property of the world, a natural phenomenon, and as such can be studied like any other natural phenomena (Hooker, 1991, 1995, 2003, 2009)[205].

As Lewin (1935) explains "the dynamics of a process are always to be derived from the relation of the concrete individual to the concrete situation, and in so far as internal forces are concerned, from the mutual relations of the various functional systems that make up the individual" (p. 41). Kelly (1963, 1980) perhaps best captured this *Weltanschauung* in his metaphor of 'man as scientist' in which he construes individuals as essentially self-directed agents[206] that are inherently oriented towards 'sense making' (cf. Carroll, 1974; Colapietro, 1990; Dervin, 1983; Frank, 1989; Neimeyer & Fexias, 1990; Novak, 1993; Warren, 2004 for a critical discussion of meaning making). This orientation is expressed through a creative capacity to anticipate and construct rather than merely react to the environment[207]. As Warren (1998b) remarks:

> As individual human beings we seek to understand our individual and social predicament. In this striving, we are always 'interested' in that our striving is always for a purpose, is always subjective, by definition; we as individuals are never 'disinterested', we cannot escape our passionate engagement in life. Yet, we do seek, and appear to need to seek, some degree of understanding that transcends ourselves, transcends our mere subjectivity (58-59).

Undeniably our day-to-day experience is replete with circumstances that require of us the capacity to construe meanings, make anticipations, and find/construct solutions (Auyang, 2000; Chaiklin & Lave, 1996; Klahr, 2000; Lave, 1988; Sternberg et al., 2000)[208].

The ubiquity of problem solving is such that Popper (1999) observed "all life is problem solving". This statement can be understood as more than simply a teleological axiom about the purposefulness and directedness of life[209]; instead it can be read as a characterisation of the necessary response to the complex and open nature of living (Hooker, 2009; G. A. Kelly,

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205 Maturana and Varela (1980) propose that "to live is to cognize".

206 The term 'agent' is widespread in the vernaculars of cognitive science, artificial intelligence, robotics and intentionality. This term is freighted with meaning and as such requires careful application to avoid equivocation.

207 Kelly (1962) describes this in the following terms: "… by assuming that the fundamental thing about life is that it goes on. It isn't that something makes it go on; the going on is the thing itself. It isn't that motives make man [sic] come alert to do things; his alertness is an aspect of his very being. Talking about activating motives is simply redundant talky-talk, for once you've got a human being on your hands, you already have alertness and movement, and sometimes a lot more of it that you know what to make of…" (p. 85).

208 Sterelny (2006) captures the spirit of this claim in his description of human life as "one long decision tree".

209 Hegel's and Fichte's notion of dialectics, as a teleological imperative, could be characterised as a form of directive problem solving at the levels of the individual and society.

1969, 1979a, 1979c; Swann, 2009). But we need to be mindful that all problems are not the same[210].

Finding solutions for well defined, simple (low complexity), closed problems may not necessarily be isomorphic with finding solutions to problems that are ill defined, open and complex (Bartlett, 1958; Duncker, 1945; Moss, Kotovsky, & Cagan, 2007; Newell, 1969; Polanyi, 1983; Reitman, 1964; Simon, 1973). If we want to be able to understand how researchers, construed as intelligent agents, perceive ill-defined problems and their solutions we need to understand how precepts, norms, standards, principles or constructs guide researchers towards 'truth' (Auyang, 2000; Carruthers et al., 2002; Christensen, 2004a; Cohen et al., 2004; Dunbar, 1995, 1997, 1999, 2002; Giere, 1988; Goertzel, 1997; Gregory, 1981; Hooker, 1987, 1995, 2003, 2009; Latour, 1987; Moreno & Umerez, 1993; B. Scott, 2000). In many ways, detection is a paradigm example of how an intelligent agent navigates a sea of information, guided by discriminatory skills (expressed in sophisticated and context sensitive detection and action selection) and epistemic norms, to construct understandings, actions and goals (Auyang, 2000; Bickhard & Richie, 1983; Godfrey-Smith, 1998; Pollock, 1995, 2004; Sterelny, 2003; Stich, 1990; Tolman, 1925)[211].

Discrimination of information, for living systems, is an important component of interaction (and learning) – and is possibly the fundamental element of control and adaptability (Sterelny, 2003, 2006; Swann, 1999). Higher order discriminatory skill is seen to be more than (simple) stimulus response; instead it is sensitivity and skilled interaction coupled to a 'theoretical domain', which is able to be refined through experience, instruction and maturation (Christensen, 2004a, 2008; Christensen & Hooker, 1997a, 2000d). Does this not sound like what we would see Doctoralness to be? More than mere expertise but a significant organizational change in the knowing and doing capacities of the individual researcher. Keep in mind that this transition would not necessarily be associated with the administrative timeline of submission, but instead it could be conceived in developmental and/or emergent timeframes.

> Consider the enormous increase in discriminatory skill (and theoretical insight) that spans the gap between an untrained child's auditory apprehension of Beethoven's Fifth symphony, and the same person's auditory apprehension of the same symphony forty years later, heard in his capacity as the conductor of the orchestra performing it.

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210 This issue will be the subject of more thoroughgoing analysis in the next chapter.

211 Johnson-Laird (Johnson-Laird, 1983) provides a exploration of this idea by critically comparing the process used by Sherlock Holmes with othe models of thinking and reasoning.

> What was before a single voice is now a mosaic of distinguishable elements. What was before a dimly appreciated tune is now a rationally structured sequence of distinguishable chords supporting an appropriately related melody line.
>
> The conductor hears far more than the child did, and probably far more than most of us do. [...] what is finally mastered is a conceptual framework [...] a framework that embodies far more wisdom about the relevant sensory domain than is immediately apparent to untutored discrimination.
>
> Such frameworks are usually a cultural heritage, pieced together over many generations, and their mastery supplies a richness and penetration to our sensory lives that would be impossible in their absence (P. M. Churchland, 1998, pp. 178-179).

For intelligent agents the process of discrimination (or intentionally guided perception) forms not just a feedback loop from the environment, but also a feed forward mechanism, that allows for predictions, suppositions or anticipations to be made about the context from which information is being drawn. Therefore, this viewpoint encompasses an alternative set of conceptual choices about the nature of mind, learning and action (e.g., Sterelny, 2003).

For example, if we consider research into the area of *novice versus expert* knowledge and skills we predominantly encounter investigations into differences in performance or what characteristically typifies expert skills (Bransford et al., 2002). But these analyses have tended to be based on static and idealized, rather than dynamic and situated, conceptualisations of cognition (A. Clark, 1997a; van Gelder & Port, 1995). Embodied cognition tries to reconnect thinking with environment, context, culture, time (evolutionary, historical, biological) and space (cultural and physical). It is important to note that an embodied approach need not be necessarily antagonistic to theorising conducted under a more static model (A. Clark, 1997b; Port & Gelder, 1995; Thelen & Smith, 1995; van Gelder, 1995) and perhaps can be complementary to but more 'true to life'.

Dynamically grounding cognition allows for the possibility of an iterative relationship between discriminations and norms (which includes skill-theory constructs) (cf., Barsalou, 2005, 2008; Barsalou, Breazeal, & Smith, 2007; Barsalou, Simmons, Barbey, & Wilson, 2003; Markman & Dietrich, 2000; Prinz & Barsalou, 2000; Sterelny, 2003). This stance aligns problem-solving (and problem capture) as a central aspect of both intelligent behaviour and agency (Christensen, 2004a, 2008).

> There is a close linkage between the psychology of human learning and philosophy of knowledge. Creating new knowledge is, on the part of the creator, a form of meaningful learning. It involves at times recognition of new regularities in events or objects; the invention of new concepts or extension of old concepts; recognition of new relationships (propositions) between concepts; and, in the more creative leaps, major restructuring of conceptual frameworks to see new higher order relationships (Novak, 1993, p. 183).

In this type of process, normatively constrained anticipations help shape predictions, which then inform action selection and performance; which in turn generates information from the environment, which then assists in the process of refining or changing our discriminatory skills; which then assists in shaping theoretical framework. Kelly (1991b) elaborated this process in his first postulate of personal construct psychology: "A person's processes are psychologically channelized by the way he anticipates events" (p. 32). Consequently epistemology is not seen as simply relating to a set of 'beliefs' or intellectual capacities, but instead (in)forms an horizon or boundary from within which we 'notice' and 'respond' to issues and problems. Kelly (1991b) explains that our construction systems "sets the limits beyond which it is impossible for" (p. 90) us to see. In his view, our constructs are controls on our outlook on the world.

Conceptualisation[212], taken from an embodied, situated and personal perspective, is a dimension within the normative matrix by which an agent navigates their world (Agnew & Brown, 1989; Diamond, 1975; Diamond & Zuber-Skeritt, 1986; Lyddon, 1991; Pope & Scott, 1984; Zuber-Skeritt, 1987). Conceptualisation or knowing, thus construed, becomes instrumental to our discriminatory capacity and is intimately tied to action selection. We can think of knowing as providing us with pathways for movements. Importantly these pathways are both enablers and inhibiters of psychological processes. To move beyond our established pathways requires of us the building of new "conceptual routes to follow" (G. A. Kelly, 1991b, p. 89). The application of a matrix or grid heuristic can offer us a starting point for thinking about how to capture changes to the epistemological dimension of the matrix (Fransella, Bell, & Bannister, 2004).

Epistemological changes in how we construe may be linked to an individuals success and failure criteria for interaction with the world and knowledge. This stance will allow us to construe epistemology as an agent-level property and in doing so provide a means for

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[212] Kelly (G. A. Kelly, 1991b) defined gnosiology as the "systematic analysis of the conceptions employed by ordinary and scientific thought in interpreting the world, including an investigation of the art of knowledge, or the nature of knowledge as such" (p. 16).

incorporating the notion of epistemic change within our broader reconceptualisation of epistemology (constructed at the level of both the individual and the institution)[213]. For if an agent (individual or group) makes changes to their normative matrix, they are by association bringing about changes in how "they see the world" and how they "solve problems" (cf. Martinez, 2001). This type of transition suggests that an epistemological shift could be fundamentally linked to an ontological shift or refinement. Given the complexities of the debates surrounding these dimensions we need to proceed with some caution in construing a non orthogonal relationship between the epistemology and ontology (Mahoney, 1988) of agents.

From a perception, sensing or discrimination-centric stance epistemological cognition (in this case deployed as a component of doctoral cognition) is thus construed as intentional (aimed at a relationship with the world), and serves as the basis for describing the brain/mind as an anticipative engine. This anticipative capacity (or Conatus) provides a mechanism for problem capture and in a sense may explain differences in problem capture. This view of personal or individual epistemology transformation resonates with the notion of praxis and phrenosis (which are also importantly connected to professional activity and mastery learning and change). Furthermore, this stance draws together a wide range of perspectives already circulating within educational theorising (interactionism, constructivism, developmentalism). As show in Part A, construing intelligence as a property of a (cognitive) system empowers us to combine the ontogeny of norms (from a naturalist and process metaphysics) and dynamic construction (e.g., Piaget, Vygotsky, Dewey, Pask and Kelly) to offer a model of intelligent behaviour, agency, identity and learning that is rendered at the system/agent level.

In following this path we can genuinely begin the process of housing cognition in the world; rather than having to either separate out human cognition from the rest of the natural world or having to tolerate an internal disconnect between consciousness and the brain. This view of agency and epistemology fits within the 'empirical constrains' currently provided by current psychological and physiological research. Concordantly, by working within empirical parameters, we are better able to guard against internal contradictions or discontinuity that have undermined the formalist and idealist approaches, in basic

[213] Epistemology, at a discipline level, has typically been concerned with describing the function or character of knowledge rather than considering the transformational pathways that lead to changes in epistemologies. Evolutionary Epistemology is one of the most explicit attempts to combine both functional and transformational perspectives on epistemology; although this approach has tended to trade off the individual, against the group as the unit of analysis.

assumptions about cognition and learning. For example this stance allows us to understand cognition, and reasoning, as a naturally occurring phenomenon. As such we do not have to necessarily introduce a dualistic model to enable us to get to the upper ends of the gradient of intelligence and agency.

But can we use this approach to talk about processes between individuals? Is it a viable way to construe collective or social activity? Given the institutional and social nature of Doctoral programs it is critical, when looking to develop new ways of construing the Doctorate (and cognition), that we look for models that allow us to talk about the supra individual processes that contribute to, and are perhaps fundamentally part of, Doctoral cognition. To demonstrate how to bring these components into contact with the individual processes, we shall now delineate the role of epistemic institutions and economies. As this work is not considered with an in depth examination of the social systems involve in the Doctorate (beyond the level of supervision) this discussion will be limited in its scope.

6.4 Epistemic institutions

Clark, Christensen, Hooker, Luria, and Sterelny each argue (with slightly different emphases) that a particular feature of the collaborative behaviour of humans is the use of institutional, cultural and linguistic structures to provide for nongenetic inheritance and regulation. In particular, we have developed what Hooker terms 'epistemic institutions', to provide social structures for the collaborative extension of individual cognitive capacities (Hooker, 1982, 1987, 1991, 1995). In Hooker's view, epistemic institutions act as a kind of external nervous system providing the necessary regulatory control for 'science' and 'research' in general, and 'objectivity' in particular. This social system provides the necessary generation of both inter and intra personal norms, dispositions and behaviours (Christensen & Hooker, 1997a; Hooker, 1991, 1994a; Lieberman, 1991; Luria, 1976; Rayner, 1997; R. C. Richardson & Boyd, 1999). As Sterelny contends, "we do not just live in groups, we are marinated in the material, behavioural, and informational products of our culture" (p. 3).

Doctoral research is an example of the kind of artefact that epistemic institutions create and exchange, but it is arguable that this as much a supra-individual product as that of the work of an individual. Both the artefact itself and the standards of cognitive legitimacy that are used to evaluate it are part of larger cognitive and epistemic institution. Just as the Doctorate provide an archetype of intentional problem solving; supervision provides an archetype of the social collaboration that lies at the core of epistemic institutions. In some sense the supervisor serves as an external regulator of the learner's activities (at least in principle) providing a proximal level sensor and effector for the larger epistemic institution of which the Doctoral project is part. Concordantly, Doctoral supervision allows for some degree of spreading epistemic risk and load, while at the same time providing for the general increase in knowledge (individual and institutional). Keep in mind that these epistemic conditions are instantiated in the behaviour and choices of the individual researchers. It is at this level the majority of analysis discussed in this work is focused.

Much of the theoretical work in trying to understand societal knowledge transformation has come from the domains of the sociology and philosophy of science where the literature is voluminous (R. J. Bernstein, 1983; Callebaut, 1993; D. T. Campbell, 1974, 1988, 1990; Carruthers et al., 2002; Christensen & Hooker, 2000d; P. M. Churchland & Hooker, 1985; Dunbar, 1995, 1997, 1999, 2002; Feyerabend, 1978; Giere, 1988; Hahlweg & Hooker, 1989; Hinde, 1987; Hooker, 1987, 1991, 1995; Hull, 1998; Klahr, 2000; Lakatos, 1970; Latour, 1987; Martinez, 2001; Maturana, 1978; Newton-Smith, 1981; Piaget, 1972; Poincare, 1952; Pollock, 1993; Radnitzky & W.W. Bartley, 1987; Rouse, 1996; Shimony, 1993; B. F. Skinner, 1953; Stokes, 1997; Wuketits, 1984; J. Z. Young, 1960). What can be extracted from this milieu, in Hooker's (Herfel & Hooker, 1998; 1982, 1987, 1991, 1995) analysis, is the view that theories themselves are construed as artefacts (created in accordance with specific norms) that embody the practice of epistemic institutions.

Moreover that by their very organisation, epistemic institution themselves are human artefacts that are the realisation of specific norms for reporting, training, regulation and criticism – forming an epistemic ecology within which these institutions function. "It is these interactions with, in combination with institutional roles, generate macro scale properties like research tradition, disciplinary grouping, cultures of criticalness and the like which are essential for science to proceed" (Herfel & Hooker, 1998, p. 5). By leveraging off the scalability offered in a system's stance, we are able to deploy particular notions of agency, norms, cognition and reasoning (derived from a Hookerian stance) that can accommodate both individual (students and supervisors) and collective (institutional) activity. Consequently, this stance offers us explanatory power at the level of the individual, the institution and society[214], without sacrificing a commitment to our broader meta-philosophical position.

To achieve this kind of integrated approach, Hooker employs an adaptation of Piaget's genetic epistemology. Hooker reads in Piaget's work a crucial differentiation between cognogensis (development and transformation in public or institutional knowledge) and psychogenesis (transformation and development in knowledge at the level of the agent). These processes identify crucial windows through which the knowledge development can be seem as a multi-layered and dynamic interaction between biological, environmental and regulatory effects.

By adopting this stance, Hooker is able to map transformations in knowledge (and regulation of knowing) at the level of individuals and collectives, as well as advocating the important role of that regulation and trans equilibration play in the knowledge growth[215]. Hooker encourages the "incorporation of environmental information into a regulatory structure" (Hooker, 1995, p. 242). By doing so Hooker is seeking to make environmental information central to the mechanism of regulation at both the level of individuals (ontogenesis/psychogenesis) and communities or institutions (phylogenesis/cognogenesis). The transequilibration is thus equally important in modelling changes generated by individual researchers and epistemic institutions. In Piaget's (1970) words "knowledge, then, is a system of transformations that becomes progressively adequate". Thus in principle it is possible to deploy naturalistic (and dynamic) theoretical constructs that are applicable at multiple levels, and scales of epistemic organisation, practice and transformation.

6.5 Epistemic economies and production

Similarly to the challenge faced by historical materialists in their move away from transcendentalism, the naturalisation of knowing and knowledge generation is faced with

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[214] Although Herfel and Hooker (1998) caution that if science is characterized in terms of a non-linear dynamic system then we may be faced with macroscopic irreversibility. They state "although science's dynamic is determined by local actions of individual scientists (micro-level), information about the exact nature of most of these actions is lost at the macro state (e.g., in journal papers) and is not recoverable by running a macroscopic model in reverse. Science is also irreversible because its epistemic character leads it to being both accumulative and revolutionary. Again, the details are typically sensitively dependent on activity changes in the individual scientists and lost at the public macro scale" (p. 7)

[215] Hooker (1995) offers the follow reading of Piaget's project:

> "Piaget's lifelong focus [was] on a conception of living organisms as dynamic, constructive, self-regulative systems. He conceived of the whole of life as a multilevel interacting complex of such systems bound together, both within each level and across levels, by positive and negative feedback and feedforward processes. … each system in this grand cybernetic device strives for the stability of its own viability conditions (homeostases) and its own processes (homeorheses), importantly through developing improved ones when the former fail. In this way, each system develops increasing endogenous functional completeness, thus further propelling its own development/evolution and autonomy. In the process, environmental information is incorporated into regulatory design" (p. 228).

the question of what best explains the purposefulness of the social production of knowledge? At the root or fundamental level at which Hooker and Piaget have engaged with this issue, adaptability and autonomy provide the fundamental turnkey conditions – but these conditions do not necessarily offer an explanation of how these drivers play themselves out on a macro scale. Hooker has challenged the traditional evolutionary epistemological view by setting aside the standard view of knowledge growth and change being driven by the mechanisms of variability and survival. Instead he has offered a dynamic and regulatory model that sees knowledge growth as a component of increasing levels of regulatory finesse.

An alternative approach, and perhaps a companion to Hooker's perspective, may be found in the interpretation of epistemic products as part of an economic field of production. Bourdieu in particular has applied this style of analysis to cultural activities. Bourdieu's concepts of symbolic and cultural capital allow us to discuss knowledge in the economic terms. There are two important benefits to this view – firstly it requires us to ask us what are the mechanisms and drivers of the production, distribution, exchange and consumption of knowledge? And secondly, how are the production, distribution, exchange and consumption of knowledge regulated?

In the previous discussion we have begun to pull apart these issues at the individual and institutional level. What is of particular interest is the specific epistemic economy of the Doctorate? The Doctoral process contains many terms freighted with economic significance – value, contribution, originality, significance, and relevance. These terms are all suggestive that there is an epistemic capital transmitted in the process and product of Doctoral education. Even the notion of assessment reflects a valuing of the thesis – a determination of its worth. In crude market terms, what role does demand[216] play in the valuing of the thesis? Is contribution conditional on need? Could a thesis make a contribution to knowledge if it is not 'needed'? In the context of the Doctorate, are notions such as truth-value affected by academic market driven orientations? Ultimately whatever the system principles used (evolutionary or economic) the issue of mechanisms of the system function (interaction, reaction, transformation) are important factors in extending our understanding of the particular experiences of the agent in context.

216 Perhaps timeliness would be a good proxy for *demand* in terms of research. practice.

6.6 *Concluding comments*

The purpose of this chapter has been to examine the promising connections between our basic interactive and constructive psychological processes and the process of doing research. By construing research as a discriminative activity, that involves searching for solutions to ill-defined and open problems[217], we have come to a fresh view of knowledge and knowing. We have observed that knowledge, and our constructs about knowledge and knowing, should play a significant role in this process[218]. This discussion directs us towards the issue of problem solving as a substantial element in building our understanding of the doctoral experience. To this end we will examine this further in the next chapter.

We have also discussed, in perfunctory detail, the role that individuals and institutions play in setting out epistemic pathways or channels along which our responses to problems tend to run. It is arguable that these channels become particularly evident when we are presented with circumstances that require us to anticipate a course of action and assess its outcomes. Under this view, knowing emerges when we have to fit our strategies and anticipations against the world. By examining knowing in this way we can expose the constructs that fundamentally shape our strategies and anticipations.

Thus anticipations, institutions, and problems become salient for understanding the process of doing a Doctorate. In this we have followed Kelly (1991a, 1991b), taking the position that anticipations are both the push and pull of learning, productive thinking and problem solving. Although the focus of our discussion will continue to be at the level of the individual, it is critical that we are mindful of the larger systems of which individuals are a part.

We now need to go beneath the surface of Doctoral cognition to elaborate deeper levels of meaning (Warren, 2009). To do this we will need to describe, in more detail problem solving and demonstrate how it illuminates an alternative view of Doctoral cognition and learning.

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[217] By problems – we do not simply mean the research question – we mean a whole suite of issues academic, procedural, interpersonal and cognition that make up the act and activity of doing research.

[218] This point raises important questions about the exact nature and scope of the relationship between knowing, knowledge and doing.

CHAPTER SEVEN

PROBLEM SOLVING AND THE MIND

7.1 Orientation

As was observed in the previous chapter, Popper (1999) once quipped that "all life is problem solving. All organisms are inventors and technicians, good or not so good, successful or not so successful, in solving technical problems" (p. 100). The ubiquity of problem solving, as expressed in Popper's observation, is such that there is a general affinity with the notion. But this situation disguises the fact that, as a psychological process, problem solving remains somewhat intractable. In fact it is difficult to distinguish, at one level between the concepts of knowing, problem solving, inquiring, reflecting, questioning, reasoning, deciding, judging, learning, and thinking.

In this chapter, we will again be delving below the surface of familiar and comfortable concepts, to reveal the latent complexities that are in play when we are engaged with the world through *knowing*. We will be setting out a case for why and how the type of problem solving that takes place during Doctoral education is particularly revealing of Doctoral cognition. Keep in mind also that this chapter contributes to the broad objective of formulating the question of how Doctoral cognition functions and what are the kinds of things we need to be attending to as part of this analysis.

Given the proposed interconnection, research on intelligence, problem solving and reasoning have tended to travel along distinct but nonetheless conjoined pathways. It will be put here that an examination of problem solving or research (thinking) can offer us new perspectives for understanding cognition (both at higher and more basic levels). As Dunbar (2001) contends "rather than being an offshoot of mainstream cognitive theories … scientific thinking is a paradigm example of cognition that reveals the key features of many basic cognitive processes" (p. 115).

An analysis of problem solving offers us a point of leverage on the process of Doctoral cognition. It also serves as a point of integration for process metaphysics and the naturalist and the realist traditions with Doctoral cognition. Concordantly, the discussion in the following chapters will encompass an examination of the practical elements of problem solving and how they can expose the underlying constructive processing[219] that occurs in (human) understanding; as well as an exploration of the philosophical implications of these processes. To make effective use of the notion of problem solving to assist in understanding Doctoral cognition we need to commence by assigning a broader meaning to the term *problem* than is usual.

7.2 The problem with problems

So what exactly is a problem? And how do we solve them? When we pause to consider the notion of a problem carefully, we discover that it has a somewhat troublesome semantic (if not metaphysical) status (Novick & Bassok, 2005). The tacit familiarity and certainty of the notion of problem solving quickly gives way under closer scrutiny. For instance, what may be a problem to one individual may well not be so for another person (i.e., a problem can exist as real and present for one person, and be non-existent or trivial for another). Furthermore a problem may exist in the first instance but not recur for that individual again. In some circumstances a problem may demand ready action (i.e., fire, illness, threat or injury), while others may be ignored without any significant or discernible consequences. Heidegger (1996) made a distinction between *puzzles* - trivial or everyday situations or questions that although difficult, and perhaps without a clear immediate resolution, such as how to find a job, can be largely resolved by the application of procedural or technical responses; and *problems* - more non-trivial or bigger issues that are by their nature opened ended and ill defined situations or questions, such as, the nature of existence or *being*. He allocated the notion of problems to the domain of philosophical work. Thus problems can encompass a spectrum that ranges from profundity to triviality.

Of additional complication can be the fact that certain classes of problems may be said to be 'free floating' - to exist independently of a specific knower or discrete circumstance. For example, we can speak meaningfully of the problems of philosophy or the climate change problem. Complex, dynamic and collective problems such as these can have concrete instantiations and consequences for individuals, while simultaneously not being experienced by any particular individual (or owned exclusively by any individual or group). In summary, problems can be created, found, given, shared, ignored, individual or

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[219] Kelly observed that the testing of anticipations (or solutions to problems) was central to his notion of personal constructs. He saw this theory as connecting with the pragmatism of Dewey and his work on thinking and learning. Kelly explained that "Dewey emphases the anticipatory nature of behavior and the person's use of hypotheses in thinking. The psychology of personal constructs follows Dewey in this respect" (Kelly, 1991, p. 90). Joining with this tradition, this work in turn follows Kelly in this respect.

collective. Moreover they can be small, large, enduring, ephemeral, historic, immediate, expected, insignificant or overpowering.

The solution to complex and dynamic problems also appears to benefit from the capacity to build solutions rather than relying completely on "pre-wired" responses. Of course pre-determined responses can give rise to very sophisticated action patterns and at times behaviour so complicated that it is difficult to imagine it as not being the result of intelligence (in the common vernacular). But as researchers have discovered there are costs to using hardwire responses. There are distinct benefits and costs associated with being either adapted or adaptable (Hooker, 1982, 1994b, 2009; Hooker et al., 1992a). We have examined this issue under the discussion of regulation and control (see Chapter 4), so at this point we will merely note this as an issue of relevance when examining problem solving.

In review, it would seem, based on these observed characteristics that the Jabberwocky would be easier to identify and classify than the genus of problems. Added to this conundrum is the relationship between solutions and problems. Not all problems have solutions or alternatively there may be more than a single solution to a problem[220]. In further considering the issue of what can be meaningfully categorised as a problem we are faced with the possibility that problems do not cause problems, people do! Through this levity we reveal an important psychological postulate – problem solving for autonomous agents is a function of adaptability, agency and intelligence in the world.

Attempts to identify the exact ontic nature, essence or function of a specific problem also result in disruptions to our intuitive categories of knowledge, inquiry and thinking. Problems exist more like spandrels in the connection between things; but even this boundary condition is elastic, if not permeable. At once emergent, episodic, static and dynamic a problem - as a thing in itself - appears to primarily exist as the property of a transaction between an agent and their life world. Pask (1975a) describes a problem as a circumstance that requires an interaction, of some kind, to bring about or satisfy a relation. A relation is typically an association or a condition that allows the agent to achieve a 'steady state'. These relations can be abstract, concrete, internal or external in form. Perhaps the one thing we can say with a degree of certainty about problems is that they are fundamentally an 'indeterminate situation' (Dewey, 1998). So how can we best characterise

[220] This includes the notion of both optimal and sub optimal solutions.

our thinking when we are confronted by an indeterminate situation[221] (Davidson & Sternberg, 2003; Newell & Simon, 1972; Pretz et al., 2003; Simon, 1975)?

7.3 Productive thinking – the Gestalt tradition and beyond

Duncker (1945), was one of the first researchers[222] to explicitly address the domain of problem solving in psychology, linked the ideas of problem solving with goal directed behaviour. In particular he saw that a problem was constituted in the circumstances when an organism has a goal but does not know how to reach the required end state. "Whenever one cannot go from the given situation to the desired situation simply by action [i.e., the performance of obvious operations], then there has to be a recourse to thinking" (p. 1). We can see here that Duncker linked the process of problem solving with the act of thinking[223]. In his view problems were best understood as a catalyst for thinking – where thinking is to occur when an individual perceives, interprets, understands and organises information. The perspective of the problem solver and their capacity to represent and re-represent the affordances offered in particular circumstances is critical to the gestalt tradition (Novick & Bassok, 2005). Thus the notion of problem solving (as both a process and product) offers us a critical segue between activity, thought, and goal directedness.

In contrast to behaviourist accounts of problem solving that gave primacy to the use of 'trial and error' as a means of resolving problems[224], Gestalt theory wanted to place thinking at the centre. The two most prominent contributions of the Gestalt approach to problem solving were: firstly, a diverse range of experiments for exploring real time problem solving and thinking (the radiation problem for example); and, secondly the identification of insight and structural flexibility[225] as critical factors in productive thought (Davidson, 2003; Dunbar, 1998; Novick & Bassok, 2005). In proposing that problem solvers moved through

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221 Heidegger (1996) explained this type of experience as part of 'being-in-the-world' using the term *Gewortenheit* (thrownness) where we must interpret, understand and act in the world in which we found ourselves.

222 Kulpe , Buhler and Selz are the intellectual forebears of the Gestalt engagement with problem solving. There is a significant intellectual debt owed to these early theorists of problem solving by following generations of researchers and theorists of mind. Vygotsky, Lorenz, Popper, Tolman, Wertheimer as some of the most prominent examples of thinkers influenced by their work.

223 In Duncker's approach we can see that he is beginning to consider the higher order or metacognitive and regulative elements of problems solving. Although these are terms that were not in usage at the time – these concepts are consistent with his theorising..

224 As noted previously this is an oversimplification of behaviourism but it does go to the heart of the role of stimulus and response in explaining how creatures are able to develop 'smart moves'. The capacity to use trial and error is a complicated system in that the individual has to have the capacity to detect both success and error conditions. For some problem types this would require quite complicated action selection and information processing capacities. Trial and error can be enhanced with the addition of the capacity for memory, learning and the manipulation of 'hypothetical' or 'off line' solutions. But these capacities also tend to sit to one side of the behaviourist approach that seeks to look more explicitly at enactment and avoid investigations of internal or 'mentalist' like theorising.

225 Issues such as the generalisability of knowledge or knowledge transfer flow from Gestalt exploration of functional fixedness.

four stages – preparation, incubation, insight and verification – Gestalt theorists were attempting to tie learning about the problem and solving the problem together[226].

> When one grasps a problem situation, its structural features and the requirements set certain strains, stresses, tensions in the thinker. What happens in real thinking is that these strains and stresses are followed, yield vectors in the direction of improvement of the situation, and change it accordingly … (the solution) is a state of affairs that is held together by inner forces as a good structure in which there is harmony in the mutual requirements and in which the parts are determined by the structure of the whole, as the whole is by the parts (Wertheimer, 1959, p. 239).

Bartlett provides a counterpoint to this characterisation of problem solving[227] in general and to the model of productive thinking (and intuitive jumps) identified by Duncker and Wertheimer (Dunbar, 1998). From Bartlett's perspective problem solving and thinking involved a process of building on or extending 'evidence' drawn from the problem context through the use of individual schemas. Like the Gestalt tradition Bartlett was concerned with understanding how individuals made sense of perceptual input, and the ways this interpretive mechanism or skill was fundamental to understanding thought in general. Moreover, Bartlett argued for a broader or 'ecological' view of thinking that encompassed not only the individual's interpretation of the problem situation, but also the contribution made by context (social and physical). Bartlett was concerned with the need for naturalistic research. He advocated for research of not only real world problems but also problem solving in real world contexts. Bartlett, and his student Craik (1943), foreshadowed both first and second-generation cognitive science paradigms for cognition. Bartlett's work on thinking offers us a different perspective on how perception, memory and skill influence problem solving. Nonetheless there is also a shared awareness with Gestalt thinking of the role that comprehension of the situation has as a key component of thinking.

It was not until the rise of interest in the idea of artificial intelligence and the work on human problem solving through the lens of engineering and computation sciences that we see an explosion in experimental and theoretical integration in the science of problem solving. Much of what we would commonly recognise as research into problem solving is based on the operationalisations of Newell[228], Shaw, and Simon (Dunbar, 1998).

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226 Dunbar (1998) calls attention to the fact that exactly what was meant by the term 'insight' was largely unopened during the early period in the Gestalt school of thought and would not be significantly worked through until more explicit and fine grained accounts of problem solving were obtained.

227 Notably Kenneth Craik (Bartlett's student) made a major contribution on the development of the cognitivist response to behaviourism through his work on explanation and knowledge. This is discussed briefly in this section.

228 It is instructive to consider that while the work of cognitive science and artificial intelligence offered a very different characterisation of problem solving to the models offered by the Gestalt school, this does not mean that there was no connection between this two traditions. Newell (1985) has

By far the largest part of the theoretical investigation of problem solving and cognition has been undertaken under the auspices of the philosophy of science[229]. Both analytical and anecdotal observations have been used as the basis for explaining both how and why we solve problems (e.g., Darwin, 2002; Dewey, 1997; Duncker, 1945; Feyerabend, 1987; Hadamard, 1996; Hardy, 2005; James, 2002; Poincare, 1952; Polya, 1957; Rescher, 1977; von Neumann, 2000; Wiener, 1956, 1979). For example, Popper directly equated problem solving with science[230]. As such his theory of science was essentially an explanation of how the process of solving problems was a means for generating, or expanding, knowledge[231].

> From the amoeba to Einstein, the growth of knowledge is always the same: we try to solve our problems, and to obtain, by a process of elimination, something approaching adequacy in our tentative solutions (Popper, 1979, p. 261 emphasis added).

In Popper's theory a problem is a condition that results from the failure of an expectation (Popper, 1999). The action taken in response to this is to propose, test and select solutions[232]. Yet the underlying psychological mechanisms implicated in these steps are largely of a secondary concern for Popper, who was much more focused on the type of knowledge that this strategy allows for.

Indeed, for some philosophers of science, problem-solving behaviour is merely an exemplar of how 'objective' knowledge can be obtained. Thus we can broadly distinguish between two centres of gravity for problem solving theory: firstly, are those theories concerned with the process of solving problems; and secondly are those theories concerned with the outcomes or ends of problem solving. These approaches address two key questions of epistemology: "how can we know (process)?" and "what can we know (product)?"

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conducted an evaluation of Duncker's contribution to problem solving research in which he has attempted to incorporate the kinds of phenomena Duncker was working with into his own framework for problems solving.

229 Evolutionary epistemology is a particular sub component of this activity concerned with understanding how knowledge is generated at the macro level (cf., D. T. Campbell, 1974; Christensen & Hooker, 1999b; Hahlweg & Hooker, 1989; Hull, 1998, 2001; Plotkin, 1994; Radnitzky & W.W. Bartley, 1987; Wuketits, 1984).

230 Popper shares with many of philosophers of science the desire to reverse-engineer science as a fundamental process of human behaviour. While there is merit in this approach, Popper may well be 'begging the question'.

231 A question that arises in light of Poppers' quote is whether a PhD is seen to *grow* knowledge or *contribute* to knowledge – and what the difference may be between these two ideas. This issue was discussed in general terms in the Introduction but further analysis of this line of thinking is beyond the scope of this work; but it will warrant attention in the future.

232 Dennett (1996) uses this basic principle as a heuristic to explain the differences between kinds of minds and cognitive strategies. Dennett explains the process of engaging with the world (both inner and external) that allows for generation of different types of minds, through his notion of the 'tower of generate and test'. "As a new floor of the Tower gets constructed, it empowers the organisms at that level to find better and better moves, and find them more efficiently […] the various floors of the Tower of Generate-and-Test mark important advances in cognitive power …" (pp. 109-110). At a crude level the combination of evolutionary selection, epistemology, and scientific paradigms form, for Dennett, a basis for analysing the differences and transitions in cognitive structures and functions.

It would be inappropriate to see these theoretical groupings as independent (Mahoney, 1988). Instead we need to understand that problem solving theory and research has a philosophical infrastructure that contains elements of epistemology and ontology and that any functional explanations of problem solving will imply particular commitments about knowledge, reason, belief and truth. The focal issue will be the degree to which these commitments are explicit or serve more as underground argument.

The next issue we need to discuss is how we might be able to group types of problem together based on common characteristics. By using a grouping approach, we can then in turn select the type of problem that is most appropriate descriptor for the experiences of Doctoral education, and by association likely to require (or engage, at the least) Doctoral cognition in responding to the problem.

7.4 Problem types

Pretz, Naples and Sternberg (2003) propose that there are two basic problem types – ill defined (open) and well defined (closed). We have used these terms previously in this work, but it is now necessary for advancing our analysis to speak more explicitly about their definitions. For closed problems, the types of interactions and relations are such that there is a non-arbitrary procedural path that needs to be followed. The closure conditions of a well-defined problem require a discrete, decomposable, and molecular response. The required relationship for a closed problem constrains and defines the type of interaction necessary.

For open problems, the required interactions are unconstrained beyond the achievement of the closure condition. Essentially there is no single path, universal plan or algorithm that can be prepared for comprehending and obtaining the closure of an open problem. This is the existentialist dilemma – agents are free to choose, but not all choices are equal nor are they necessarily guaranteed to provide the required outcome.

Furthermore solving open problems, as defined here, involves self-referent norms. The nature of open problems is such that they lack constraints. In this situation an agent must try and fit, rather than compute[233] a solution. The interactions of the agent become both the means and the ends for generating the solution.

[233] 'Compute' is used in the vernacular rather than technical sense here.

> Problem solving by fitting can use whatever fitting process works best; it isn't confined to logical inference and formal algorithms … ultimately all that matters is whether the process provides its system with appropriate responses to input stimuli. The current explosion of non-linear, self organising dynamic systems act as prospective models for intelligent systems (Hooker & Penfold, 1995, p. 283).

This distinction contrasts starkly with the classical or conventional view of problem solving where the solution is determined through rational processes (we will have more to say on the notion of rationality in Chapter 9). In a fitting solution an agent causally fits itself to the problem by constraint. This is not blind trial and error but the application of an iterative self directed refinement whereby the individual comes to terms with the nature of the problem[234].

> The unsettled or indeterminate situation might have been called a problematic situation. This name would have been, however, prole
> ptic and anticipatory. The indeterminate situation becomes problematic in the very process of being subject to inquiry. The indeterminate situation comes into existence from existential causes, just as does, say the organic imbalance of hunger. There is nothing intellectual or cognitive in the existence of such situation, although they are the necessary condition of cognitive operations or inquiry. In themselves they are precognitive. The first result of evocation of inquiry is that the situation is taken, adjudged, to be problematic. To see that a situation requires inquiry is the initial step in inquiry (Dewey, 1938).

The nature of ill defined or open problems is such that it is unclear as to what is required or even the specific end state that needs to be reached. In essence it is a perturbation in the state of the system that reaches such a level[235] as to require attention. The source of this disturbance can be internal, external, proximal or distal. These disturbances range along of gradient of impact from trivial to critical, and their duration can be acute or chronic.

There are also multiple degrees of freedom in relation to an individual's activity and the outcomes of this activity (cf. N. A. Bernstein, 1967) – essentially the freedom to choose any response so long as it responds to the activation situation. This is more than simple S-R because the agent, nor the environment or the sensory register, is the locus of control. Of course, there are some situations where a prepared response will be initiated, but these triggers are typically related to subset of often self protective time sensitive circumstances. To crudely parody Pavlov's work, 'hunting' not salivation resolves the issue of hunger.

> Animals are not just herbivores or carnivores. They are in the nice coinage of the psychologist George Miller, informavores. And they get their epistemic hunger

[234] This may involve: seeking out support from others, gathering information, making tools, looking for similar situations and solutions, etc.

[235] In the context of this observation, the term 'level' should not be only directly equated with the idea of *severity* but rather with a crossing or activation of a threshold condition.

> from the combination, in exquisite organization, of the specific epistemic hungers of millions of micro agents, organized into dozens or hundreds or thousands of subsystems …. Without epistemic hunger, there is no perception, no uptake (Dennett, 2001, 108).

Information has been at the heart of cognitive and behavioural models of cognition in general, and problem solving in particular, since the emergence of the 'science of the mind'. Information is a theoretical construct that describes both the means and the ends of connecting the external world and the internal world of the agent (Dawson, 1998; Roszak, 1994). The primary difference is how information has been understood[236], and operationalised, in terms of defining its impact, nature and form (e.g., C. H. Bennett, 1985; D. R. Brooks, Collier, Maurer, Smith, & Wiley, 1989; Dretske, 1981; Fodor, 1998; Fogel, 1967; Hunt, 2005; Millikan, 1984; Oyama, 1985; Putnam, 1981; Solvic, Fischhoff, & Lichtenstein, 1988; Zurek, 1990). Information has properties that are similar to 'forces' or energy in physics and can be said to be equally as important in understanding the behaviour of systems or assemblages.

> … the behaviour of an organised system, the action of an organism, or human activity cannot be explained in terms of causal energy transmission alone … information rather then causality describes processes in, or between organised systems. The most general model of a natural process on which scientific explanation may be based is no longer the movement of a particle under the action of a force, but the storage (or organization) and the transmission of information within a system. This is the genetic model (Hutten quoted in J. Campbell, 1982, p. 255).

7.5 Problem solving and information

As Hutten advises us, information is the key. This cannot be taken too literally, with information[237] providing the basis for both unlocking problems and assessing progress in regards to solving a problem. Moreover information, as Miller and Dennett have suggested, is something for which we have a cognitive need or hunger for. As we will come to see the question of information (and knowledge) will be of particular significance in our elaboration of Doctoral cognition.

In a non-trivial sense all interactions can be said to involve some informational aspect or component (Auyang, 2000; Avery, 2003; Bateson, 2002; Dourish, 2001; Heidegger, 1996; Hendriks-Jansen, 1996; Husserl, 1973; Merleau-Ponty, 1962; Schutz, 1932, 1962). Furthermore information can occupy either the role of the prime mover in cognitive

[236] For example, Debons (1988) identified six main conceptualisations of information - commodity, energy, communication, facts, data, and knowledge. Whereas Buckland (1991) saw information being realised in three main ways – as process, as knowledge and as a thing (objects).

[237] At this point in the discussion 'information' is used in an inclusive way that embraces both technical and more folk or everyday usages.

activity, or it can simply be the raw materials for cognition. Thus we can credibly talk about a spectrum of information theories ranging from information transmission to information processing to information seeking (B. Allen, 1996; Case, 2002; Dervin & Nilan, 1986; R. E. Rubin, 1998; T. D. Wilson, 1994).

The act of sense making occurs where an agent's context, capabilities and resources interact with a perceived ambiguity or gap in knowledge[238]. Dervin interprets sense making as a process of seeking knowledge and meaning in an attempt to close the gap[239].

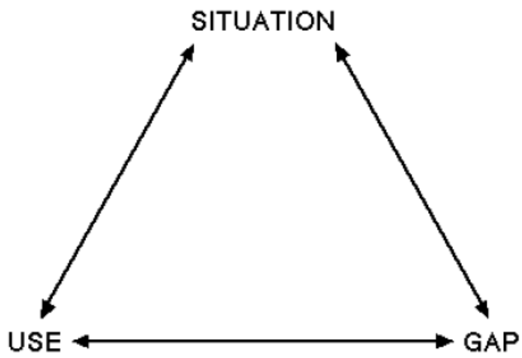

Figure 3 **The sense-making triangle: situation-gap-use** (Dervin, 1992)

This vision of information is substantially different to that of Shannon. Dervin is concerned with the intentional resolution of ignorance or confusion by interaction with the knowledge environment. This marks not only a broadening of the definition of information[240] but a transition from "communication" as data exchange to regulated behaviour and epistemic manipulation of the environment (Kirsh & Magilo, 1994; Lorini & Castelfranchi, 2004; Metzinger & Gallese, 2003; Peter Pirolli & Card, 1999; Solvic et al., 1988; Suchman, 1987; Withagen & Michaels, 2005).

Ellis (1989) identified a list of distinctive activities within information seeking behaviour: *starting*; *monitoring*; *differentiating*; *extracting*; *verifying* and *ending*. Wilson (1981) observed that while useful for describing the actions that occur in information seeking, this

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238 Sense making and meaning making are not conceptually synonymous, although they may be of the same family. As a rule of thumb we would describe sense making as having tendencies towards the epistemic domain and the determination of action; whereas meaning making tends towards the ontic domain and is connected with more expressed motivations and justifications. Obviously there is a connection here but the degree of overlap is a theoretical distinction and open to contestation at this time. For the sake of this work we will make use of Dervin's concepts as the most effective for the purpose of this work. But we are aware that there remains further definitional activity that needs to be done in sharpening both the language and the theory around *sense making*.

239 Although Dervin (2003) explains that this model has undergone transformation, much of this basic paradigm remains within her current view of sense making.

240 Brookes (1980) redefines the concept of information as something that impacts upon the knowledge structure of an agent receiving it. He represented this process in a 'fundamental equation'.

type of perspective neglects the sense making and contextual elements of the experience. Olsson (2005) explains that, "rather than conceiving of information behaviour as being driven by the desire to satisfy discrete information needs, any information interaction or encounter should be seen as one chapter in an individual's ongoing engagement with and construction of, their life-world" (p. 15).

To understand the significance of Olsson's explanation, and the degree to which it marks a shift in how information has been conventionally construed, we will undertake an epigrammatic overview of information theory's impact on psychology of the mind. Attention will be given during this overview to connecting with the previous chapter on cognitive science and cybernetics[241]. This knowledge base of information theorising is necessary for demonstrating how information serves as the currency of exchange between the life world and the agent.

> Life is an eminently active enterprise aimed at acquiring both a fund of energy and a stock of knowledge, the possession of one being instrumental to the acquisition of the other. The immense effectiveness of these two feedback cycles, coupled in multiplying interaction, is the precondition, indeed the explanation, for the fact that life has the power to assert itself against the superior strength of the pitiless inorganic world, and also for the fact that it tends at times to an excessive expansion (Lorenz, 1997, 27).

It was the fundamental or essential nature of the information exchange process in living that made the original work on theorising information as a functional movement between sender to receiver, appealing to the discipline of psychology[242] (Broadhurst & Darnell, 1965; Brookes, 1980; Debons, 1988; Fogel, 1967; Hunt, 2005; Krippendorf, 1975; Lindsay & Norman, 1972; Pierce, 1980; T. D. Wilson, 2000).

Inspired by work like Shannon-Weaver's information model, psychological researchers began to more closely examine the function of downstream (receiver) information processing as part of cognition (Broadbent, 1984; Dawson, 1998; Harnish, 2002; G. A. Miller, 1953, 1956; G. A. Miller et al., 1960; Neisser, 1967; Sternberg, 1990)[243]. Information processing analysis was initially concerned with the structural limitations (in terms of

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241 It is also worth drawing attention to the fact that while the information processing theory of the mind is part of most standard educational psychology texts, there is typically very little explanation of the technical definition of information that underlies this theory. This gap will be addressed to a small degree in the proceeding paragraphs.

242 In addition to this work on communication, there was a rich tradition in philosophy looking at the nature of representation, meaning, symbolism, truth and language.

243 Pierce (1980) observers that this communication theory has been originally misapplied in psychological research, where the very discrete concepts were taken up in a more metaphorical manner.

capacities and resources) of cognition (Bruner, Goodnow, & Austin, 1956; G. A. Miller, 1953, 1956; Roberts, 1982).

As researchers began to expose the constraints on information uptake, there emerged a more general curiosity about the kinds of mechanisms or structures that were required for information manipulation (Case, 2002; Dervin & Nilan, 1986; Leahey, 1994). Issues such as the following gained prominence: 'How do we manage incoming information?' and 'How do we perform advanced operations, given some of the apparent limitations of our senses and memory?' 'How do we store information and retrieve it in a timely and accurate manner'? The enduring value of this original empirical work can be seen, for example, in the continued reference in educational and psychological teaching to Miller's postulate of 7+/-2 items as a key parameter for short-term or working memory[244].

Miller, Galanter and Pribram (1960), as discussed in Chapter 3, identified the failure of behaviourism to adequately account for sophisticated behaviour with a serial process[245]. They contended that an overarching information processing architecture (top-down) model was necessary (Dawson, 1998) to effectively represent serial processing. The foundational or basic element of Miller et al.'s top-down information processing model was the TOTE (Test-Operate-Test-Exit) mechanism.

Ironically, the TOTE mechanism demonstrated the utility of Tolman's (1948) behavioural distinction between molar and molecular elements or units. By breaking behaviour into components, Miller et al. identified the molecular elements (in this case, the Test-Operate-Test-Exit heuristic) that could then be built into hierarchies that formed molar units of behaviour. This nesting of mechanisms provided for an impressive level of flexibility in behaviour, without necessarily creating unmanageable computational loads that had bedevilled behaviourist approaches. TOTE shares much in common with Simon and Newell's GPS (General Problem Solver) approach – both were committed to the development of concepts that could be examined through the use of logico-symbolic models (Duncker, 1945)[246]. Neisser describes the thinking and motivation behind this commitment to symbol processing in the following terms:

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[244] Unfortunately this has become somewhat of a *trope* in education and is usually disconnected from any significant engagement with Miller's work.

[245] This issue was examined earlier in this work by looking at the debate around language development and critique of Skinner's explanations of language behaviour (see Chapter 3).

[246] Boole (1951) developed extensive techniques for representing and solving problems. Boole's logical framework lent itself, much as Hobbes's (Hobbes, 1839) proposed, to conceptualising cognition as a form of machine implemental computation.

> The task of the psychologist trying to understand human cognition is analogous to that of a man trying to discover how a computer has been programmed. In particular, if the program seems to store and reuse information, he would like to know by what "routines" or "procedures" this is done. Given this purpose, he will not care much [how] his particular computer stores information … he wants to understand the program, not the "hardware." … we must be careful not to confuse the program with the computer that it controls … A program is not a machine, it is a series of instructions for dealing with symbols: "If the input has certain characteristics … combine the results in certain procedures … otherwise other procedures … combine the results in various ways … store and retrieve various items … etc". The cognitive psychologist would like to give a similar account of the way information is processed by people (Neisser, 1967, pp. 6-7).

Researchers' attempts to describe the 'program' of cognition encouraged further exploration of *memory* (e.g., Broadbent, 1957, 1958; Broadbent, 1984; Raaijmakers & Shiffrin, 1981), *perception* (e.g., Gibson, 1986; Gregory, 1998; Marr, 1982), *encoding* (e.g., Asch, 1969; Neisser, 1967; Rosenblatt, 1958; Sperling, 1960), *templates* (e.g., Hofstadter, 1979), *schemas* (e.g., Abla & Hasher, 1983; J. R. Anderson, Kline, & Beasley, 1979; Bartlett, 1932; Mandler, 1984; Rumelhart, 1980), *scripts* (e.g., Schank, 1975; Schank & Abelson, 1977), *pattern recognition* (e.g., Uhr, 1966), *types of mental models* (e.g., G. A. Kelly, 1963, 1991b, 1995) and *language* (e.g., Chomsky, 1968, 1980, 1993, 2000; Fodor, 1975; Millikan, 1984; Pinker, 1994). In turn these 'elements' of information processing were used to refine the overarching model of information transmission leading eventually to the notion of information processing itself (H. W. Eysenck & Keane, 2005; Leahey, 1994; Lindsay & Norman, 1972). For example, Broadbent's (1984) Maltese cross model of memory provided a very different relationship between storage and processing, than he first envisioned in his initial information transmission and capacity models (Broadbent, 1958).

Mainstream information processing research in education has stayed largely true to its aim of providing an adequate representation of the processes of cognition. But in doing so, it has never been required to articulate in a deep way how these processes or functions are related to the *mind*[247]. The 'discovery of information' (and the links to the idea of how minds worked or processed information) has been a powerful catalyst for the development of a wide range of investigations and research techniques. However, as we saw in our earlier examination of intelligence (see Chapter 5), a model of information processing that focuses overtly on symbol manipulation (as the best description of information processing) has some significant, and as some would argue fatal, limitations.

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[247] Fodor (1983, 1998, 2000; Fodor & Pyslyshyn, 1988) has expounded modular view of the mind, arguing that these components can be directly mapped to physical architecture of the brain.

Neisser (1976, 1988) himself was eventually to acknowledge that his image of the computer program had become a false friend, and that a break was needed to be made from the linear encoding and symbol manipulation model. This was done in two ways – firstly, agents needed to be more actively construed in their connection with information (and knowledge)[248]; and secondly perception needed to be transitioned from merely being an aspect of the sensory register to being integral to the process of information seeking and production.

Miller et al.'s concept of TOTE had contributed an interactive capacity to the somewhat passive model of information transfer (that had been articulated by Shannon-Weaver)[249]. Schramm and Berlo sought to further increase the fidelity of communication modelling by augmenting the original formalism of transmission – adding the notions of a *message* and *feedback*. Much of the debate surrounding meaning and interpretation would be undertaken, not by information theorists, but instead by linguistics and philosophers (in particular within the Anglo analytic tradition).

Information theory would come to occupy a dominant position, under the auspices of cognitivism, in mainstream psychology (H. W. Eysenck & Keane, 2005; Leahey, 1994; Lindsay & Norman, 1972). When combined with the increasingly multifaceted contributions of cognitive experimentation, information processing theory provided an attractive and viable alternative to the S-R (Stimulus-Response) postulate. Information theorist became persistent in challenging the linear assumptions of one-way communication (e.g., Barnlund, 1968; S. Becker, 1969, 1971; W. R. Brown, 2004; Dance, 1967; Dance & Larson, 1976; Ruesch & Bateson, 1951; Watzlawick, Bevin, & Jackson, 1967; T. D. Wilson, 1994).

Information behaviour and *Information seeking* theories took the next step by adopting an agent-centric and context sensitive approach (B. Allen & Kim, 2001; Savolainen, 1995; Solomon, 1997a, 1997b, 1997c; Talja, Keso, & Pietilainen, 1999), that eschewed Neisser's original position that had dismissed 'hardware' and context (J. D. Johnson, 2003; Schamber, Eisenberg, & Nilan, 1990; T. D. Wilson, 2000).

> Information behaviour is the totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking and

[248] See Chapter 5 for a more through going examination of this issue in relation to the notion of the mind in general and intelligence in particular.

[249] It should be noted here that given the purpose for which the Shannon-Weaver model was originally developed, and the ground breaking nature of this work, the fact that it did not address these elements is more of a limitation than a flaw or oversight.

> information use. Thus it includes face-to-face communications with others, as well as the passive reception of information as in, for example, watching TV advertisements, without any intention to act on the information given (T. D. Wilson, 2000, p. 49).

Researchers turned their attention to behavioural models of information searching strategies (D. Ellis, 1989), the information search process (Kuhlthau, 1991) and problem-solving (T. D. Wilson, 1996). Information need was interpreted to emerge in relation to the context or environment. Krikelas (1983) stated that “information seeking begins when someone perceives that the current state of knowledge is less than that needed to deal with some issue (or problem). The process ends when that perception no longer exists” (p. 7). The question now is how do we determine when the problem is solved, the information sufficient or the task unable to be resolved independently?

Given the complexity of solving the problem of living (which is ubiquitously ill defined and contextually dependent in character) there is limited efficacy in excessive pre-specification of solutions[250]. Instead the capacity to generate capacities (and by association information) seems to be a much more robust and effective strategy.

> Intelligent systems, and living systems generally, are not passively independent, in the way a rock’s crystalline structure is undisturbed by all but the most violent signals from its environment. Rather they are vulnerable to disruption by impinging signals – storms, predation, cold … – and constantly need to replenish their dissipating energy and order … This explains why those systems of this kind we do see are adaptable, for unless they can adapt to mitigate or compensate for disturbing signals, they will be disrupted and losing their cohesion, lose their identity as that sort of system (Hooker & Christensen, 1998, p. 106).

A functional[251] description of a *problem space,* for intelligent agents (in our case Doctoral students) interacting with the world consists, of at least five components:

- Sensors, Transducers and Effectors
- Action repertoire
- Control or action selection (passive or active)
- Information
- Constraints

These functions are instantiated by an agent, in a particular situation, and in terms of their goals or needs (as a result of the particular circumstances).

250 Phrased differently – would it be possible to teach a student by rote to achieve a Doctorate? Is the *Doctorate* something that could be achieved through the memorisation of a set of responses?

251 The term “function” has been freighted with a wide variety of meanings. In particular there is on going debate in the field of philosophical biology around the notion of teleology, function, intentionality and (self) regulation. For further discussion of the debate surrounding function see Bickhard (2000), Cummins (1984), Christensen (1996; Christensen & Bickhard, 2002), O’Grady and Brooks (1988), Millikan (1989), Mayr (1974, 1976, 1992), and Lorenz (1965).

An autonomous agent (*pace* Hooker and Christensen) has the means of acting upon a *problem* situation and a means of determining the success or failure of those actions. As we travel up the gradient of behavioural sophistication (in terms of action modulation) not only do the interactive virtuosities of agents become broader and richer, so do the interactive windows through which they are able to act on the world.

Increased capacity for fitting a wider range of behaviours, responses and information to indeterminate situation in turn expands the menu of situations in which agents can find themselves. In summary, increased diversification of circumstances in turn requires a productive and adaptive mode of interaction.

With greater capacity, choice and control comes an expansion in the types and forms of *problems* an agent can respond to[252]. It is this adaptive development that allows for learning as a result of problem solving. But the learning is not limited to simply the outcome or solution – the learning, as we construe it here, is also the result of the interactions and exchanges between the agent and their *life world*.

This process of coupling between the agent and the environment (ontic, epistemic, interpersonal and intrapersonal) is the next piece of our elaboration. We must proceed to an examination of perception as part of coupling – where the agent is not merely a passive recipient of data but interprets and acts to generate opportunities from the environment.

> Every interaction with an environment will change some thing about that environment and will depend upon on other characteristics of that environment in order for the interaction to reach a particular final state. Every interaction will change some things and detect others (R. L. Campbell & Bickhard, 1986, p. 47).

7.6 Concluding comments

This chapter commenced with the identification of *problems* and *problem solving* as a generative context, in which we should be able to perceive the action of an individual engaged in Doctoral cognition. In particular, the class or family of problems described as *open* or *ill defined* were of specific significance in that they require an adaptive response. We also proposed that the Doctoral context was best portrayed as a nested set of open problems (both in terms of the production of the final research artefact and the research process itself).

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[252] As discussed previously – the increase in behavioral responses also brings with it a cost. Greater behavioral options requires a more complex organization – a more complex organization requires higher levels of energy and more complicated self maintaining pressures. Whether we see this in terms of biological or epistemic systems the principles remains valid.

We have discussed (in Part A) the benefits, and the significant constraints, of pre-wired responses. The degree to which an intelligent agent can increase their adaptive capacity – specifically by being able to generate customised (and customisable) responses. But what is required to drive this process? What is the source of *energy* for them and what provides the *direction*? To achieve a more rounded understanding of the doctoral process we need to continue to unpack these questions.

As was discussed during our review of how to define the notion of a problem, the *problem* is in itself a significant contributor to the process. In particular we referenced Pask's definition that a *problem is a circumstance that requires an interaction*, of some kind, to bring about or satisfy a relation. But what else is needed? We have directed our attention to the contribution made to cognitive theorising made by information theory. Although the role of knowledge, perceptions and action has a long tradition within philosophy, there remain gaps within educational theorising. We will set aside this larger issue for later in our analysis. Instead we shall proceed with our more focused consideration of information and problem solving, by examining perception and knowing as part of our more comprehensive elaboration of Doctoral cognition.

> In speaking if "perception" and "cognition" we are not referring to concepts extraneous to the physical world, implying the mind of a mysterious "inner man". Rather, we realise that the beginnings of perception are already manifest in microorganisms, as represented by such phenomena as phototaxis in bacteria and phototropism in fungi. Even at this primitive level, the organism receives signals from the outside world, evaluates their significance, and responds appropriately (Delbruck, 1986, p. 273).

CHAPTER EIGHT

AGENCY, PERCEPTION, INTERACTION AND THE MIND

8.1 Orientation

By the conclusion of the previous Chapter we had arrived at the understanding that the informational (and epistemic) *coupling* between an individual and their life world is fundamental and critical to our unpacking problem solving and knowing. In this Chapter we will be construing this coupling as perception. We will be elaborating on the substantive role that active perception plays in knowing and Doctoral cognition. We will also argue that the act of knowing and perceiving is not free floating. As Delbruck (1986) expresses in the quote above – perceiving is an integral part of both *being* and *agency*.

The connectivity between *mind* and the *world*[253], as an essential property of development and learning has been a core, and long standing, aspect of Educational Psychology. In particular, Piaget understood this informational coupling or exchange as a basic condition of intelligent behaviour. Unfortunately, Piaget's tacit appreciation of intelligence as part of living can become obscured by his terminology and the tendency, in some circles, to reduce the scope of his work to an historical influence on Educational Psychology. What is missed in this obfuscation is Piaget's attempt to encourage us to understand cognition as an embodied and naturalistic process. Significantly, Piaget saw this process as being continuous with the biological world and living entities (Bickhard, 1992b; Chapman, 1988; Hooker, 1994a; McKinney, 1998; Piaget, 1972; Silverman, 1980)[254].

[253] We note here that this connection between mind and the world, has traditionally taken the form of an idealist interpretation of the mind and a narrow interpretation of the contribution made by the context. Alternatively this particular philosophical issue of agency and interaction has been subsumed by a more generalist discussion of issues such as *Nature versus Nurture*. In some ways the *nature versus nurture* debate is a paradigm example of how an educational debate that should drive us towards the questions of agency and being, instead become side tracked into much narrower discussions of cause (in the everyday sense of word) of behavior.

[254] In this Piaget remain true to his original training and personal interest in the biological world.

Piaget's exploration of *genetic epistemology* and *cognitive development* highlighted that continual adaptation to an environment impacts on the underlying intellectual organisation of individuals (Kitchener, 1981). It is not always a matter of coping with a situation and then returning to the *status quo*. In fact, he looked at how the adaptive process shapes and moulds the frameworks upon which our thoughts and perceptions are constructed (Bickhard, 1992a). This stance aligns with the case being built up in Part B, and offers a credible approach that links knowing and being as part of a general principle of development and action. Moreover Piaget gives as a way of characterising knowledge growth and change that is coherent, albeit at a theoretical level, with the general experiences and functioning of higher order cognitive frameworks (Bickhard & Campbell, 1996; J. Biggs, 2003; Chaing, 2003; Entwistle & Ramsden, 1983; Hofer & Pintrich, 1997; Laurillard, 1984, 1999; Marton et al., 1984; PMSEIC Expert Working Group, 2009; Pribram & King, 1996; Prosser & Trigwell, 1999; A. Taylor, 2007; Wood, 2006).

A cognitive (including both epistemic and ontological dimensions) framework can loosen and constrict (G. A. Kelly, 1991a, 1991b) to accommodate discrete circumstances, as well the *flex* and the *slop* of the world (B. C. Smith, 1996), but it also can be reassembled into a new organisational arrangement. These new circumstances provide alternatives for how we *know* the world, how we *perceive* the world[255] and how we *act* upon the world. It is this capacity for generating alternative constructs and frameworks of meaning that allowed Kelly to see the parallels between his clinical work and his supervision of research candidates. Both groups were trying to make sense of the world through the formulation and testing of different hypotheses. Both groups were also using the same fundamental or foundational mechanics to enact these investigations.

What is thought provoking about this circumstance is that we could say that even if information always remains the same (which is debatable), what we can make of it can be changed[256]. In a non-trivial way this resonates with the whole idea of Doctorateness. Furthermore, originality is suggestive of more than merely the avoidance of duplication. It is reasonable to argue that originality requires some degree of change or enhancement in

[255] This was demonstrated in the example of the different appreciation of music between a child and conductor.

[256] Here the analysis by Lewin (1999) of Charlotte Biihler's work instructive. Lewin takes from Biihler a simple but elegant example. "As is well known, the individual whose eye is met by a beam of light can turn this eye toward or away from the stimulus. This does not at all depend on the ray of light but on the individual's condition or will" (Biihler, 1928, p232 cited in Lewin 1999).

thinking from that of the undergraduate student to that of the Doctoral candidate[257] (R. Cantwell, J. Scevak, S. Bourke, & A. Holbrook, 2012b).

To review the case so far, what is likely to initiate or provoke doctoral cognition is a set of circumstances that require a controlled (or skilled) response that makes use of our ability to manipulate knowledge and information to generate adaptive alternatives. Importantly, at the same time the very process of responding to *problems* (and their contexts) provides an opportunity for change – either in terms of greater solidification of, or dispersion of, existing organisational and regulatory arrangements (i.e., confirmation or disconfirmation). Underneath this image of Doctoral cognition is a developmental paradigm. As an aside this means that Doctoral cognition may emerge as a new cognitive state but it nonetheless is part of a developmental endeavour[258]. As such it would be reasonable to suppose that this would require recurring exposure to the appropriate context/experiences to encourage development (Bickhard, 1992a, 2003; Bickhard & Campbell, 1996; R. L. Campbell & Bickhard, 1986)[259]. If this line of thinking can be substantiated, it raises important questions with regards to the necessary breadth, depth and duration of Doctoral study. It also asks of us "what is the extent of the immersion in Doctoral education that is required so that this experience registers on our cognitive structures and encourages development or at least the examination of alternatives"? Moreover, this line of thinking requires of us an increased awareness of the *habitus* of Doctoral education, and the ways in which this *habitus* can impact on the frameworks through which we perceive and act upon the world.

8.2 Perceiving the world differently

The legacy of essentialist and idealist doctrines has been to place thinking outside of the body – both causally and operationally. As previously discussed in this work, the assumption inherent in these doctrines, that cognition is fundamentally abstract logico-symbol processing have been under sustained pressure. But if cognition is not an abstracted activity of symbol processing, if it is not a closed internal process, if it is not a

[257] This point simplifies, for the moment, the whole question of variable performance by Doctoral candidates.

[258] This line of thinking would seem to be able to accommodate students who at a relatively young age (biological) are able to obtain higher degrees (Bargar & Mayo-Chamberlain, 1983; Brody, 2005). As noted in the Introduction, a new theory of Doctoral learning/cognition is needed that builds on existing models of learning and provides a deeper account of Doctoral behavior that allows us to understand other adult learning related phenomena. Such a theory (or theories) would not only advance our scientific knowledge about the Doctoral process, but also assist in enriching the supervisory process and examination. It would also be of help to students in coming to better understand their own experiences. To achieve these ends the theory would need to be inclusive of both the breadth and depth of Doctoral experiences..

[259] This may also suggest that there are optimal and sub optimal experiences for the encouragement of Doctoral cognition and change. Hypothetically this may also mean that there are maladaptive responses to Doctoral study. if this is the case then the examination of these may reveal important points for intervention in support of Doctoralness.

separate type of *thing,* then how can we understand its place in the world? Would this fact change our approach to understanding knowing?

The most extreme response has been eliminative materialism - to make 'the mental' equal nothing but the physical. Yet this response may simply be exchanging 'numbers' for 'neurons' – does this bring us any closer to capturing the interactive aspects of our experience of the world? More critically, eliminative materialism can neglect the more fundamental issue of a relationship with the world – intentionality – that has been central to phenomenology and existentialism.

Intentionality, as we have discussed it here, has come to represent the class of philosophical questions concerned with mind and its relationship to ideas, actions, and directedness (Hendriks-Jansen, 1996). While Searle (1983) is most often credited with initiating this issue of intentionality into cognitive science, his work is more accurately understood as a successor of Brentano's (1960) and Frege's (1984) essentialist/associationist views. Although Searle has been vocally committed to naturalising intentionality by seeking a biological frame for it, the actual means of being 'intentional' remain somewhat unclear. This seems to suggest an internalist commitment on Searle's part, at least in principle if not always in practice. Consequently, from Searle's perspective intentionality could simply be taken as a more specific type of relationship necessary for symbol manipulation, rather than the more holistic view that the phenomenalists, like Merleau-Ponty, have pursued (Hendriks-Jansen, 1996).

Metaphorically, for cognitivism intentionality is concerned with issues at the level of genotypes (the type of code or software needed), whereas phenomenologists are concerned with phenotypes (how an organism is put together and behaves in its environment). As such, a general theory of intentionality should be able to encompass the different types (narrow and wide) of intentionality[260] currently identified. Let us look at the types of connection, outside of the narrow representationalist view of intentionality, that are available to us (Bickhard, 1980a, 2003, 2007b; Christensen & Bickhard, 2002; Panksepp, 2005). In doing this we are looking for something that can capture *the why* of information exchange to match *the how* of information theory. We are proposing here that intentionality underlies and perhaps even drives the active aspects of perception, and

[260] We shall consider intentionality ,as it is specified by Brentano, as a narrow intentionality and intentionality as described By Merleau- Ponty as wide intentionality.

provides a bridge between the seeking and knowing aspects of being connected to the world. We will examine three models for how this could occur.

8.2.1 Dewey's reflex circuit

Alongside William James, Dewey stands as one of the towering figures of the pragmatist tradition. His contribution to the science of the mind was to retain an open dialogue between all the natural sciences in an attempt to generate a holistic framework (e.g., Dewey, 1910, 1930, 1997; Dewey, Hook, & Nagel, 1945). Amongst Dewey's concerns was the role and nature of knowledge. Emerging at this time in experimental psychology (as discussed in Part A) was a passive view of the relationship to the world (heavily influenced by Locke's associationist principles). Dewey felt this was the incorrect hypothesis with which to work.

> The older dualism between sensation and idea is repeated in the current dualism of peripheral and central structures and functions; the older dualism of body and soul finds a distinct echo in the current dualism of stimulus and response. Instead of interpreting the character of sensation, idea and action from their place and function in the sensory-motor circuit, we still incline to interpret the latter from our preconceived and preformulated ideas of rigid distinctions between sensations, thoughts and acts. [...] What is needed is that the principle underlying the idea of the reflex arc as the fundamental psychical unity shall react into and determine the values of its constitutive factors. More specifically, what is wanted is that sensory stimulus, central connections and motor responses shall be viewed, not as separate and complete entities in themselves, but as divisions of labor, function factors, within the single concrete whole, now designated the reflex arc (Dewey, 1896).

Dewey challenged the accepted view of the reflex arc, by arguing that organisms interact with the world through self directed activity that 'makes sense of the world' through interaction. The world was not something to be passively received but rather something *directly discovered* through interaction and experiment. These ideas would come to strongly influence Dewey's notion of education and pedagogy.

Dewey proposed rather than an 'arc', or uni-directional relationship, we need to have a circuit, or loop, that *connected thought, action and environment*. Interestingly this argument predicts the serial processing problems identified by Lashley in the behaviourist stimulus-response model. Dewey saw 'activity' as the site where *interaction and construction* came together in the form of a circuit of "continual reconstitution" (Dewey, 1896). The holistic analysis that the 'reflex circuit' argues for has been explored in a range of psychological models and theories - activity theory (Lektorsky, 1990; Leont'ev, 1978; Luria, 1976; Vygotsky, 1978), ecological psychology (Barker, 1968; Ceci, 1996; Gibson, 1966; Neisser, 1987), purposeful behaviour (Tolman, 1925), life space (Kurt Lewin, 1935) and constructivism (G. A. Kelly, 1963).

For Dewey, and those who would later draw inspiration from his ideas, the reflex circuit was a channel through which information circulated. This circulation contributed to the process of continual reconstitution. The constructive role for information in this model is a significant transformation of the standard behaviourists and information theory paradigms. It is informative to recall that the behaviourists were not the only group who wanted to set behaviour at the centre of their model. What differentiated these different views on the role of behaviour was the extent of the contribution that was made by the context.

To grasp how context plays a role in shaping information we need to briefly examine how context is *perceived*. Keeping in mind that we are again identifying the types of processes that we need to consider in our construing of Doctoral cognition. We are trying to identify the general generative mechanisms, at a metatheoretical level, that are most likely to be deployed as part of, and therefore implicated in, Doctoral cognition.

8.2.2 Perception, ecology and affordances

Perception, not surprisingly, is one of the main areas of theoretical and empirical contestation, in connecting the internal and external worlds. Behaviourist and information processing models originally incorporated a narrow view of perception in the notion of a sensory array upon which stimulus impacts (Hunt, 2005). This approach left both the environment and the biological domain as largely passive factors that while mechanically interesting are separate to the nuts and bolts of 'thinking' (see Marr, 1982 example of this kind of approach). Heidegger's philosophy (1996) would significantly contest this passivity with his concept of *Dasein*[261]. In psychology, Gibson's ecological model (Gibson, 1966, 1977, 1986) proposed that the environment, rather than simply being a passive domain, contained, what he terms, *affordances* (Gibson, 1977) which provided a crucial structure for perception as an active process of uptake[262].

[261] *Dasein* is a German word that translated literally means *being there* (German: *da* - there; *sein* - being). Heidegger brought his own meanings to this term – attaching the notions of existence, being, temporality and the human subject. Heidegger (1996) explains: "Dasein exists. Furthermore, Dasein is an entity, which in each case I myself am. Mineness belongs to any existent Dasein, and belongs to it as the condition which makes authenticity and inauthenticity possible" (p. 1). This idea shares some relation to Husserl's *Lebenswelt*, but contains the ideas of *being* as fixed, embedded, and immersed in the world.

[262] Consistent with concepts we have examined already – perception has been interpreted in narrow and wide ways. It has also been typified as either active or passive.

> The perceiving of an affordance is not a process of perceiving a value-free object to which meaning is somehow added in a way that no one has yet been able to agree upon; it is a process of perceiving a value-rich ecological object (Gibson, 1977, p. 140).

As such, in Gibson's view, *perception is an active engagement between the organisms and the environment that exposes affordances*[263]. Affordances recast traditional views of *noumenon* and *phenomenon* in an attempt to link awareness and environment in terms of information rather than mere sensation. Information from the environment is thus not 'reprocessed' by the organism, but rather an organism extracts affordances from the world - *modos et entia rationis cum fundamento in re*[264] (Descartes, 1998).

Gibson's notion of affordances was unique at the time. This concept shifted thinking about vision from the interaction between light, surfaces and the retina to an interpretation that proposes that perception translates what the external world affords the perceiver (Gibson, 1986; Hoffman, 1998; Marr, 1982; Sperling, 1960). Accordingly, extended planes are perceived to offer support for walking on, but only if the surface is of an appropriate size relative to the perceiver and substantial enough to hold the perceiver's weight, and the perceiver is actually capable of locomotion. In this example we can see the interdependence of '*what is perceived*' and the perceiver and context. More simply we see things from our point of view and this viewpoint influences what we see.

However, and this is a key point, affordances are not *necessarily always perceived* (Gorniak, 2005). Although an affordance is held in t*he relationships between an actor and the environment*, Gibson proposed an affordance was also independent of the agent perceiving them. In this sense an affordance is both a property of a relationship and a property of the thing in itself. For our purposes here an affordance is a *prediction about the possibilities offered by an object*. These predictions can remain fixed in place unless tested. So an affordance may be in error or may be missed or even may not be currently available to the circumstances of the individual agent. Consider for a moment what is offered by this approach as we expand our definition of objects to be inclusive of include abstract things such as ideas and concepts.

Gibson's view was that affordances were primitive aspects of the physical structure of the world. In this he saw them as neither objective nor subjective. Here an oft-cited example of

263 Bickhard and Richie (1983)note that Gibson's theory provides a clue as to how representation can be accounted for naturalistically, but it is unable to adequately explain the emergence of affordances in relation to mental processes (see Bickhard, 1980a more detail mental processing model).

264 Modes and beings of thought with foundation in the thing

a chair will serve us to explain this. Gibson proposed that there was no sense in which a chair affords sitting on, unless we enter the subjective mode and assume someone who is doing the sitting relative to the chair: the sitter must be of the right size and weight to get onto the chair and be supported by it (Gorniak, 2005). Thus, a human sized chair affords sitting for an adult human, but not for an elephant, a fish or a giraffe. A chair might also afford picking up and throwing for adult humans, but not if it is affixed to the floor. It may afford standing on to reach an object, but only if the object is within reach of the combined height of the agent and the chair, and so on.

Thus, the set of all affordances for an agent *in* an environment contains all possible interactions of that agent with that environment. But as we noted above, this set of affordances does not equal the set of perceived affordances of the agent (Gorniak, 2005). Furthermore, neither is the set of perceived affordances a subset of the set of all affordances, because the individual may be wrong about what the environment affords it. If an agent attempts (and fails) to sit on an object that resembles a chair but is actually made out of balsa, then the individual perceived an affordance that was not available – *to it*. The agent's prediction has been falsified, and if this is a significant enough event may impact of future predictions of affordances. As such, affordances have the interesting property of being subject to review and adaption, they can be in error and they are also a factor of the agent's experiences and predictions.

Much like Dewey's shift from an arc to a circuit, Gibson's affordance marks a significant recasting of the theoretical landscape. The possibilities that this offers us to aid in new understandings of interaction and knowing are considerable. Moreover it is a demonstration, in micro, of how shift in our understanding can open up new interactive possibilities. It is also an example of how we test our understanding and we can construe alternative constructions of the world.

Berthoz (2000) has extended the idea of affordances and predictions further by using neuroscience research to offer a fine grained understanding of the links between brain and environment in regards to movement. He explains how we build up an action space based on our understanding of what we can do – both in regards to our capabilities and the environmental affordances. The concept of affordances has been adapted by Bickhard (1980a) to an interactive constructive approach called '*apperception*'. In this model both the organisms and environment exist in a dynamic relationship – which is the basis of *learning*. Neisser (1976, 1987) agreed with the ideas contained in Gibson's work but, like Bickhard, developed his own perception-action cycle. Both Bickhard and Neisser make substantial use of Piaget's concepts to build an intellectual role for perception. This work is in turn contained with a broader ecological psychology (Bronfenbrenner, 1979; Neisser, 1987). Dewey made the link with the environment a necessary condition for understanding inquiry and mind. Neisser enhanced this by looking to enrich the environment (both in terms of its organisation and role). Here we can see a balancing out of theoretical space, shifting the centre of analysis from an idealised mentalist model of symbol processing, to a rich environmental interaction that shapes thinking. To move to the next phase in developing this conceptualisation, and to maintain faith with the underling naturalising agenda of this work, we need to look to the biological, or agent based, component of this perceptual exchange.

8.2.3 Dynamic coupling

Maturana and Varela's concept of *autopoiesis* is essentially a description of the relationships between a (biological) system and the environment. Within this model there is a consideration of the ubiquity with which systems and environments interrelate. They distinguish between interactions that are ephemeral and those that trigger changes in the system/environment. Maturana and Varela provide a functional description of the kind of interactions implied in Dewey's notion of a reflex circuit.

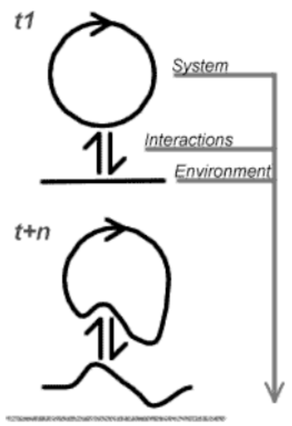
The following technical description of *autopoiesis* also shows how ideas like Piaget's *accommodation* and *assimilation* can be generalised to the broader biological world. We will need this technical detail to help us tie together the elements we have been highlighting as part of problem solving behaviour. Importantly the role of time (and development) is now drawn into this discussion. This enhances the notion of a reflex circuit making it be more than just iterative information uptake and exchange in the moment. Instead it is something that allows some agents to be adaptive and others to be adapted.

Let us begin with how we need to describe the connection between the system and the world. *Structural coupling* describes the *interdependent* nature of the relationships between system(s) and environments. Unlike other models of connection, structural coupling introduces a *sense of history* into these relationships (See Figure 4. System and environment interactions (Quick, 2007)). This coupling occurs at the level of structure (i.e., the instantiation of organisation) and as such relates to the causal characteristics of these relationships. Structural coupling is best understood as having a determining, rather than deterministic, nature.

> In the history of interactions of a composite entity in its medium, both unity and medium operate in each interaction as independent systems that, by triggering in each other a structural change, select in each other structural change (Maturana & Varela, 1980, p. xx).

Structural coupling creates congruent interactions between the linked systems. Put another way this concept represents the path of perturbation, and triggered responses, linking the environment and the system (i.e., the repertoire of experiences and responses available to a system). More simply, we are shaped by our experiences and the changes in our world (both internal and external). The more significant that change the more likely it is to impact on the organisation of an individual. But, and this is key; these changes are not always merely reflex or uni-directional (*pace* Dewey). We direct our attention towards the substantive events and set aside at this time the more transitory or ephemeral experiences.

Figure 4. System and environment interactions (Quick, 2007)



The greater the shared history of triggers and interactions, the greater the potential is for congruence between the systems (i.e., the greater the level of *adaptation*). The more plastic the structure of the system is, the more *potentially adaptable* this system will be over time. This process may explain how regularities (i.e., patterns of behaviour, preferences or dispositions) begin to emerge in particular types of systems (i.e, ways of being in the world).

> If one of the plastic systems is an organism and the other its medium, the result is ontogenic adaptation of the organism to the medium: the changes of state of the organism correspond to the changes in the state of the medium (Maturana, 1975, p. 326).

Cognition, under this framework, is then "a history of structural couplings that brings forth a world" (Varela et al., 1993, p. 206). While structural coupling is not necessarily a process of learning or fitting to the environment, it does provide the basic functional relationships that would be necessary for the enactment of learning. The type of responsiveness in structural coupling is a weak form of intentionality. Nonetheless it does offer a promising, biologically grounded, alternative to traditional intentionality.

In other words, the system-agent relationship is one of interaction and change. The more complex the environment, and the more changeable the system, the more options the system has in responding to the world and getting its needs met. The more the system can choose and regulate its behaviour the more responsive it can be to the environment. The greater degree of responsiveness, the greater the degree of *autonomy* as system will potentially display.

This is the point that Dennett was getting at in his notion of the cognitive arms race. He describes the options of "digging in" – adapting to the environment and maximising this but having to pay the price of reduced flexibility; and "guerrilla warfare" - where the fit to the environment is less robust but there are more options to move between and in environments. On basic level the more mobile or autonomous a system the more degrees of freedom it has, but it also has greater costs in terms of managing the complexity of its choices. As Dennett (2003) has observed on numerous occasions – complexity matters. It matters significantly for complex environment and complex individual interdependencies.

To bring together the pieces so far – information is an important resource that agents need to make use of, particularly when responding to ill-defined problems. Information comes from an interactive relationship with the world. Because this relationship is two ways, there is an opportunity for the agent to both push and pull information. Thus creating the opportunity for changes in itself, or in the environment, or both. The agent must choose what actions it wishes to take. The choices it has available to it relate to: how flexible its structure is, how richly it perceives its environment, its previous experience and capacity for change, and the resilience or stability of the agent. In essence how *intelligent* its behaviour is (given the constraints of the system and the environment). In this constellation of requirements there are key interdependencies between self-regulation, change, perception and action.

Apropos of Warren's observation about the essential interestedness of individuals in the world – for living things, particularly multi-celled complex structures like humans; they have to be interested and invested in the world[265]. Panksepp (1998) explains this interest through what he calls a SEEKING system.

> This emotional system is a coherently operating neuronal network that promotes a certain class of survival abilities. This system makes animals intensely interested in exploring their world and leads them to become excited when they are about to get what they desire. It eventually allows animals to find and eagerly anticipate the things they need for survival, including, of course, food, water, warmth, and their ultimate evolutionary survival need, sex. In other words, when fully aroused, it helps fill the mind with interest and motivates organisms to move their bodies effortlessly in search of the things they need, crave, and desire. In humans, this may be one of the main brain systems that generate and sustain curiosity, even for intellectual pursuits. This system is obviously quite efficient at facilitating learning, especially mastering information about where material resources are situated and the best way to obtain them. It also helps assure that our bodies will work in smoothly patterned and effective ways in such quests (p. 138).

Concordantly, without an interest and investment in the world, agents (or systems) reduce their capacity to survive in the world. Similarly, we can see the usefulness of Lorenz's idea that information is as fundamental to living as energy. Although Kelly eschewed the notion of drives and motivation, we can see in a non-trivial way this idea of a seeking system is consistent with Kelly's personal construct psychology, and the intent behind one's anticipations. We now have established the necessary basic descriptions of perception, agency and information; and we are now in a position to assemble an exemplar of how these elements can be drawn together.

8.3 Retelling the story of perception and knowing – a functional example

We will now review one attempt to re-tell the story of *problem solving, behaviour, information, perception, and knowing* from a system and interactive standpoint. Hooker and Christensen offer us a thorough going account of living systems engaged in interactive knowing. Again, this discussion will need to contain a high degree of specialist and technical terminology, but these are again necessary for a valid representation of this particular theoretical stance. Do not be too distracted by this language, nor by the

[265] Panksepp's (2005) research and theorising in the affective domain is especially instructive in here also. He explains that "Affect is the subjective experiential-feeling component that is very hard to describe verbally, but there are a variety of distinct affects, some linked more critically to bodily events (homeostatic drives like hunger and thirst), others to external stimuli (taste, touch, etc). Emotional affects are closely linked to internal brain action states, triggered typically by environmental events. All are complex intrinsic functions of the brain, which are triggered by perceptions and become experientially refined."

examination of biological processes that at first glance appear to be a discussion far removed from the actuality of Doctoral education. Just as Piaget looked to the behaviour of young children to understand something deep about cognition across the lifespan, so is the following discussion of biological organisation a *shibboleth* for doctoral thinking[266]. During the discussion examples will be provided where appropriate to keep the discussion relevant to the specific and general objectives of this work.

Hooker and Christensen propose that when we examine the basic problem of life, and the particular organisational arrangements that have developed in response to it, we are able to delineate living systems from other dynamical processes in general and non living material in particular. Using this approach, they believe it is possible to identify some basic, or root, conditions that characterise living systems[267]. They term this group of requirements *autonomy* (Hooker, 2009).

What is important to the work we undertake here is how Hooker and Christensen extend this basic *autonomy* requirement to demonstrate how higher order cognition could emerge out of these basic conditions. Their *oeuvre* can give us a robust account that supports the view that experience, interaction and an individual's response (to problems) are important to our understanding of activities like Doctoral Education.

Unsurprisingly this approach shares considerable common ground with Maturana and Varela (1980, 1998) who identified *unity, organisation, structure, structural coupling and epistemology* as the defining elements of the biology of cognition. To aid use, we will quickly explain each of these terms. The first element, unity is a boundary condition (or operation distinction). *Unity* is the condition that distinguishes an entity from its background. Integral to Maturana and Varela's concept of unity is the notion of organisation. *Organisation* is the relationship between functional components. The concrete realisation of organisation is instantiated in the actual 'physical' components and their relationship. Maturana and Varela labelled this *structure*.

Maturana and Varela have argued that these elements, combined with structural *coupling* and *epistemology*, provide the necessary and sufficient elements of characterising life and

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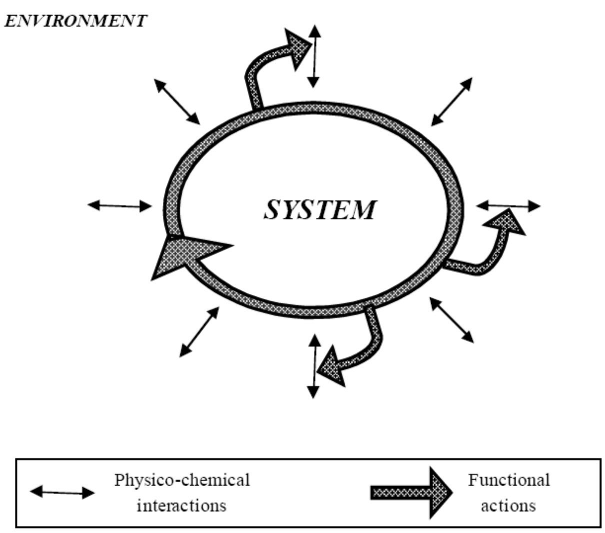
[266] Of course this is a crude comparison – obviously Piaget's work involved a degree of sophistication beyond what can be achieved in this work.

[267] In the broader disciplined debates that Hooker and Christensen contribute to, there is significant effort devoted to the demonstration of how living systems are differentiated from similarly complex non-linear dynamic processes. Bickhard, a collaborator and contemporary of Hooker and Christen, has offered a similar account in regard to autonomy. At this stage we will not be examining his work too closely but his contribution to how learning fits into the biological world will be part of a later discussion.

cognition. Importantly this overall process, termed *autopoiesis*, is seen to be self-organising and sustaining (Maturana, 1975; Maturana & Varela, 1980; Rosen, 1985, 1991; Varela, 1979). But there are many dynamic dissipative phenomena that display these kinds of self-organising and sustaining behaviours (e.g., Bernard cells, viruses, and candle flames) – so how are living systems different?

Fundamentally the difference is explained *by the development, as a function of more robust organisation, of adaptive capacities and capabilities* (Moran, Moreno, Minch, & Montero, 1997). The initiating state in this process is the creation and maintenance of a boundary (Moran et al., 1997; Moreno et al., 1990; Moreno & Umerez, 2000; Ruiz & Moreno, 1998, 2000; Ruiz-Mirazo, Moreno, & Moran, 1998; Umerez & Moreno, 1995). This boundary is an expression of internal, rather than external processes and as such created by, rather than imposed on, living systems[268]. Thus the system as a whole is maintained, via its structure and associated endergonic-exergonic couplings that produce cycles of repair, sustainment and adaptation (Fernandez, Moreno, & Etxeberria, 1991; Moreno & Umerez, 1993, 2000; Ruiz-Mirazo et al., 1998; Umerez & Moreno, 1995) (see Figure 5. Living system interactions (Ruiz & Moreno, 2000)). The complexities, and emergent properties, of this type of system mean that "[t]heir functionality is not reducible to a collection of functionalities of each property taken in isolation but is a global feature of the whole collection of functionalities to which each contributes and is in varying degrees essential" (Hooker & Christensen, 1998, p. 107).

Figure 5. Living system interactions (Ruiz & Moreno, 2000)



268 There is a large consensus for defining life in terms of hierarchical, temporally recursive, organisation. Thus, one can define living organisation as the result of a process of temporally recursive networks of component production, self-closed by a physical border generating by the system itself, whose viability is based on informational mechanisms of self-reproduction (Moran et al., 1997, p. 259).

Living systems can increase their interactive capacity beyond simple reflex and pre wiring, by adopting different organisation and structure – most commonly this involves becoming multi cellular (Maturana & Varela, 1998; Moreno, Umerez, & Ibanez, 1997; Ruiz, Etxeberria, Moreno, & Ibanez, 2000; Ruiz & Moreno, 1998; Umerez & Moreno, 1995). This strategy involves trading off an increased thermodynamic burden against greater capacity to extract resources from the environment (Ruiz-Mirazo et al., 1998). As size increases the pressure for different forms of unity, organisation and structures (i.e., internal skeleton, nervous system, increased metabolism, mechanical-muscular system, etc.) occurs (Moreno et al., 1990). There is also the need to handle the degrees of freedom problem (Rayner, 1997) to grade up from specialised pre programmed behaviours to increasingly generalised and adaptable interactions, which in turn requires greater coordination and more *fine grained environmental sensitivity* (Carver & Scheier, 1998; Houston & McNamara, 1999; Moreno et al., 1990; Moreno et al., 1992; Moreno & Umerez, 2000; Moreno et al., 1997; Powers, 1973; Thelen & Smith, 1995).

> Viewed cybernetically, evolution presents a multi-layered development of regulatory systems, from chemical auto-regulation, through various orders and levels of cellular and multicellular regulation to ecological regulation (local, regional, and planetary). Regulatory complexity may increase "horizontally", by increasing refinement within an existing regulatory structure, or it may increase "vertically" by adding new regulatory orders (regulatory ascent). From this point of view the highly organized human cognition known as science presents an extension of both horizontal and vertical regulatory complexity across orders and levels: Individuals carry much more complex cognitive regulatory maps, and the science-technology complex has driven both the planetary transformation of ecologies and the creation of planetary institutions of many kinds (Hooker, 1995, p. 42).

Single cells are the first autonomous agents and organisms. Species and colonies are examples of the degree of complexity that meta-organisation can realise in response to the autonomy condition (Christensen & Bickhard, 2002; Herfel & Hooker, 1998; Moreno et al., 1990; Moreno & Umerez, 1993; Rayner, 1997; Ruiz et al., 2000; Ruiz & Moreno, 1998, 2000). Our higher order cognitive functions are yet again another example (Christensen, 2004a, 2007).

From Hooker and Christensen's perspective autonomous systems are "cohesively self-maintenant" (Hooker & Christensen, 1998, p. 106) – or in other words (*pace* Warren) *interested* and *invested* in the world as part of living. As we have said, this approach is sympathetic with Maturana and Varela's thinking; the major difference being, where as *autopoiesis* describes a process of system closure, Hooker and Christensen conceive the process of living, as being open ended interactive. Levins captures the nature of *open* processes in the following observation:

> Organisms (a) select their environment actively, (b) modify their environment by their own activity, (c) define their environment in terms of relevant variables, (d) create new environments for other organisms, (e) transform the physical nature of an environment input as the effects of their activity percolate through the developmental network, (f) determine by their pattern of environment, and (g) adapt to the environmental pattern that is partly of their own creation. Further each part of the organism is an "environment" to other parts (Levins 1979, 766).

The *push and pull* of the requirements for self generation[269], and the holistic organisational interaction with the environment that this creates, constitutes in Christensen and Hooker's view, the "fundamental basis of biological norms … because it marks the emergence of a *perspective* (the continued persistence of the system) against which the outcomes of system processes are measured for success or failure" (Christensen & Hooker, 2000b, p. 139)[270]. This holistic perspective is globally orientated and provides a normative boundary or set of constraints from within which the system organises itself. Furthermore, local system constraints are derived from these global constraints thus distinguishing this model of norms from that used in information processing theory (Christensen & Hooker, 1997b, 1998a, 2000b; Collier, 1998).

> Organisms typically possess an array of norm signals, many of which can be simultaneously relevant in a given content. We shall refer to the full array of performance norm signals a system possesses as its *norm matrix*. These norms may often conflict, as when thirst or pain motivates the cessation of hunting while hunger motivates the continuance. The norm matrix thus establishes a web of tensions which the system must continually balance by modifying its interaction processes so as to 'steer' itself along a path that provides sufficient satisfaction of all relevant performance norms. If the system is adaptively successful this dynamic modulation of activity will shape interaction in ways that satisfy the fundamental conditions of viability for the system. A large part of understanding adaptiveness in this picture involves modeling the way the system manages, by modulating its actions, the interaction patterns that are generated. Characterising intelligence as a form of adaptiveness then becomes framed as characterising a particular type of management strategy. A management strategy is an organisational recipe for generating the interactional outcomes the system requires. It involves the interaction of the system's norm matrix, action generation processes, and interaction dynamics. In order to characterise intelligence we shall be principally concerned with distinguishing low order and high order management strategies (Christensen & Hooker, 2000c, pp. 13-14) .

269 This only bears of passing resemblance to Millikan (Millikan, 2002) pullme-pullyou concept of representation.

270 The capacity for perspective taking, so obvious, is something that information processing did not significantly grasp until more recent theorizing. The idea that the sender and receiver in a communicative interaction took perspectives, while present within philosophical discourse, was novel to information sciences.

To exemplify, normative constraints on an organism[271], such as hunger or pain are the result of a global requirement for self maintenance (Hooker, 2009). As such, hunger is referenced against this whole of system requirement (e.g., survival). Thus optimisation of a response to a local norm, by catching and incorporating a large amount of resources (by increasing the input of resources), does not necessarily resolve the larger constraint of self maintenance (the timely prevision of specific inputs relative to the context dependent and temporal requirements across the system). Concordantly, the self signifying nature of autonomous systems, at a holistic level, is central to their directive (cybernetic) capacity (Christensen, 2004b; Christensen & Hooker, 2002; Panksepp, 2005).

In other words, individuals *reference their needs against a sense of self* and a desire to maintain that self. To maintain their identity, individuals develop (and deploy) a set of skills and knowledge that allow them to meet their global needs as well as more specific (or individual) needs. For intelligent agents – one of their global needs is for information. This information helps navigate their environment. It also helps determine the opportunities and constraints on action. Goals, actions, needs and norms form a matrix[272] in which behaviour is deployed. This matrix limits the goal directed behaviour rather than determines it (E. S. Russell, 1946).

To review, autonomy is a property of living systems (Christensen & Bickhard, 2002; Hooker, 2009). But not all living systems engage in the same type of (intelligent) behaviour (which is a multidimensional capability) (Christensen & Hooker, 2000c). Different organisations, and associated global constraints, produce different varieties of intelligent behaviour. As we progress along the gradient of self directness (from low to high order control) increased levels of intelligent behaviour emerge and cognition and learning becomes possible (Christensen & Hooker, 2000c).

In turn, increased internal coordination leads to the ability to utilise the environment, and internal states, anticipatively (Christensen, 1996, 1999; Christensen & Bickhard, 2002; Christensen & Hooker, 1997a, 1998a, 1999a, 2000a, 2000b, 2000c, 2000d; Donald, 1991; Dyke, 1988; Hendriks-Jansen, 1996; Hookway, 1984; Hull, 1998; Jantsch, 1981; Roth & Dicke, 2005; Torey, 1999). Through memory, distal perception[273], feedforward action, dynamical

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271 For a comprehensive discussion of global and local normative constraints consider Christensen's and Hooker's work (e.g., Christensen, 1999; Christensen & Hooker, 2000a, 2000c, 2002).

272 Christensen describes normative processes as involving at least two key conditions: (1) a capacity to act in such a way as produce the required behaviour and (2) a normative perspective which differentiates outcomes that result from action against the need that generated the action.

273 Smithers (1995a) provides a more detailed analysis of how interaction is effected by expanding the 'interactive present".

emulation and imagination, intelligent agents[274] are able to move from being adapted to particular environments, or niches, to being adaptable (Christensen & Bickhard, 2002; Christensen & Hooker, 1999a).

Consider the degree to which these capabilities are at the forefront of how we think about cognition. Moreover consider how much the refinement of these types of skills encompasses the capacities we imagine emerging as part of Doctoral Education. But according to this model these kinds of skills do not simply spontaneously occur, nor are they fixed. Instead they are enhanced through use, learning and the degree to which an individual's perspective requires them to maintain a sense of self. All of which is part of how the individual is organised (Christensen, 2007; Christensen & Hooker, 1997a, 2002; Hooker & Christensen, 1998).

To represent how different modalities of activity control occur Hooker and Christensen have drawn on the notion of *organisation*. Living systems are focused, or organised, around *survival and self maintenance* (Norman, 1980; Rayner, 1997; Sterelny, 2003). Christensen and Hooker (1997a) argue that it is in organisation that we can perceive the emergence of life from other dynamical processes[275]. Let us call this the *organisational conjecture*[276].

The organisational conjecture shares an affinity with, but *is not identical to*, Maturana and Vaerela's notion of *structural coupling*. In both these ideas agents are organised in particular ways. Hooker importantly distinguishes between the use of organisation (a term he feels has been much abused or misunderstood) and order. Hooker draws on examples of order (roughly how predictable or regular things are) and organisation (which is concerned with relationships and constraints). Setting aside as peripheral to this current discussion the debates about how far we have come in resolving formal characterisations of organisation, let us simply say that the notion of organisation gives us a way of delineating

274 Hooker and Christensen differentiate between agents and intelligent agents in the following terms - "Agents are entities which engage in normatively constrained, goal-directed, interaction with their environment. Intelligent agents have goals appropriate to their situation and interact with the environment in ways which adaptively achieve these goals" (Christensen & Hooker, 1999a, p. 133).

275 Christensen, Hooker, Bickhard and Collier repeatedly exemplify these differences through a comparison between the organisation of a cell, a rock and gas. In this exemplar, cells are show to have a particular type of cohesiveness occurs at the global level but is functionally interact with local level processes. Christensen and Hooker (Christensen & Hooker, 2000b) identify this particular type of organisation found in cells provide an insight into the root characteristics of autonomy. Autonomy in this sense is underscored by five cohesive conditions – relatively shallow energy wells; nonstationary in response to dynamic conditions; reliant on self-generating dynamics conditions; and use internal organisation to perform work to extract the necessary environmental inputs for self-generation.

276 This position could also been seen as a corollary of Godfrey-Smith's (1998) complexity thesis – that *the function of cognition is to enable the agent to deal with environmental complexity*.

the set of potential actions and needs of an agent as factor of interactive history and constraints on the individual agent (global and local).

In a naturalist account of living-systems processes, interactions, construction and organisation are all central to capturing the differences between living and non-living. As we acknowledged earlier in this chapter, these are also key elements in our account of Doctoral cognition. The nature of living things is such that *the way they are organised places particular global constraints on them* - to maintain their integrity across time, - requires organisms meeting global conditions (Collier, 1988, 1998; Hooker & Christensen, 1998; Hooker & Collier, 1999; Rosen, 1985; E. S. Russell, 1946).

> Life is an eminently active enterprise aimed at acquiring both a fund of energy and a stock of knowledge, the possession of one being instrumental to the acquisition of the other. The immense effectiveness of these two feedback cycles, coupled in multiplying interaction, is the precondition, indeed the explanation, for the fact that life has the power to assert itself against the superior strength of the pitiless inorganic world, and also for the fact that it tends at times to an excessive expansion. The process whereby a large modern industrial company, such as a chemical firm, invests a considerable part of its profits into laboratories in order to promote new discoveries and thus new sources of profit is not so much a model as a specific case of the process going on in all living systems (Lorenz, 1997, 27).

Maintenance, while globally determined, occurs through a combination of local and high level interactions and state changes. As such, both positive and negative feedback, in combination with internal organisation, create the conditions for directive organisation (Christensen & Hooker, 2000b).

> Living systems must always be “doing” something. They cannot passively exist, as nonliving entities do. Any physical object has structure, and thus some degree of order. A living system must have its structure organized in a manner that performs particular functions that attain the end-state of continuing the organism’s existence. Functional properties are therefore nested within structural properties (O'Grady & Brooks, 1988, p. 287).

As previously identified, the science of complex dynamic systems avoids the traps of vitalism and essentialism by allowing creatures to be not only purposeful and self sustaining but also self-signifying.

> Fundamentally, a norm is an evaluative standard or principle. That is, it must be possible that there be departures from the norm, and whether there is departure or not must have value from some perspective. The etiological explanation of norms identifies selection history as an evaluative standard: a trait conforms, or fails to conform, to its selection norm according as it does or does not do what the ancestor trait did that led to it being selected. This has been considered a notable achievement because it identifies a norm with a causally based condition, in the context of a widespread

> philosophical presumption that norms cannot be explained causally. Lurking in the background of the normative function theory literature are longstanding philosophical attitudes concerning the non-causal nature of norms shaped in part by debates concerning the fact/value distinction and the problems of psychologism (Christensen & Bickhard, 2002, p. 9).

Similarly, while suggestive (and used to inform our construing in this thesis) there is not yet conclusive evidence for the proposed theory beyond the studies shown here, so its *psychological* actuality should be considered in this light. Even bearing in mind this caveat this account of the *interactive* and *constructive* nature of *being in the world*, places intentional knowing at the core of intelligent action. It also demonstrates the mechanism we deploy for meeting our most basic survival needs are also fundamental to addressing some of our psychological or mental demands. Consequently, when we look to complex behaviours, like research, we need to be aware that there is a mutually constraining and enabling tension underwriting our knowing. In the case of Doctoral research this means that we have a *normative framework* that we deploy to assist us in our decision making process and this framework sets the horizons of our action. Critically this framework develops out of our interactive history with our life-world. We argue that we can dove-tail this research into the fundamental or foundational processes that constitute a biological account of cognition, with other emergent fields of theorising and research in the domains of personal epistemology, metacognition, higher order cognition, conceptual change and learning. This work as a whole is itself an experiment into how we would begin the process of reintegrating these various elements into a cogent and coherent narrative of Doctoral education and individual knowing.

8.4 Concluding Comments

Accepting the position that information, perceiving, self-regulation, and agency are key elements in research thinking and acting (Chapter 7), there are two overarching requirements for elaboration of doctoral cognition. It must detail the structure of problem solving (Chapter 6) including its organisation (discussed further in Chapter 9), and it must tell a story about how this mental structure attaches to the world through an individual's perceptions, thinking and actions (Chapter 8). We have been building up a picture of doctoral cognition so far that is continuous with the biological world. We have drawn out the key mechanisms and channels by which internal and external worlds are connected; we have looked at the importance of need, experience, and choice in shaping future behaviour; and we have also identified that what we 'anticipate' shapes the options we perceive as open to us.

Although the setting out of our argument has progressed in a stepwise fashion, with each part and chapter seeking to either add a further layer to our picture, or to flesh out a previous sketch, there are still gaps in our picture. We have been considering both foreground and background elements, but we also need to remain mindful of the overall perspective being taken here. A commitment to naturalising Doctoral cognition needs to guard against becoming a case for solipsism; we must keep the social and the cultural aspects in play, as well as the importance of interactions with others.

This chapter has set out *how* knowing is focussed by the individual's interactive and iterative perceptions; that in fact we are active knowers rather than passive receivers or reactors to information. By examining interactive models of perception we have revealed the ways in which what we perceive is related to what we know of ourselves, the world and other salient conventions or expectations (internal and external). Essentially knowing occurs through our encounters with the world, not through are isolation from it. The next chapter will explore if there is a particular type of organisation, or normative framework, that we have developed to structure our research in the world, and in Doctoral education. We will also continue to argue that whatever organisational arrangement we might use to explain knowing and the mind, it needs to be arrived at through non-magical, spiritual or supernatural causes. In this we continue the line of educational thinking put forward by Piaget, that our notion of increased cognitive complexity sits within a developmental context, rather than existing *a priori*.

CHAPTER 9

REASON AND THE MIND

9.1 Orientation

Up to this point we have been primarily concerned with setting out the requirements for an adequate alternative account of Doctoral cognition (to that of an idealised and transcendental process) (Berthoz, 2000; Bickhard, 1996; R. A. Brooks, 1991; A. Clark, 1997a; Dreyfus, 1992; Dreyfus & Dreyfus, 1986; Lakoff & Johnson, 1999). Much of the discussion so far has been invested in providing an alternative story of how thinking, action and being could be told. We have argued that this alternate story has practical and theoretical relevance to how we construe Doctoral education.

We have provided such an account – working up from foundations to key functions. We have been arguing that we need to systematically integrate our approaches, concepts and frameworks and determine their level of fidelity with the lived experience of intelligent agents (in this account Doctoral candidates). In those circumstances where we have had insufficient data or evidence we have speculatively proceeded, with caution, using the naturalist doctrine as our litmus test for our conjectures and thought experiments (Christensen, 1999).

We now need, in this chapter, to add to this account an understanding of how individuals evaluate the behaviours and knowledge they generate through their interactions in the world. To do this we need to start shifting our focus from generalised knowing, to that of scholarly knowing and decision-making. On what basis do we organise our interactions with the world? What organisational structures and norms would we need to produce scholarly knowledge? What is the cognitive organisation that we need for achieving Doctorateness? We will address these questions by illustrating how we can connect naturalised cognition and reason together in this chapter, thus furthering our overall objective of recasting Doctoral cognition as an act of naturalised intentional knowing.

As we have explained the attributes of autonomy, interaction, construction, intentionality, adaptation, and regulation are instrumental in the processes of knowing, cognition and learning (see Part A). These attributes allow intelligent agents *to find rather than know the answer* (Hooker & Penfold, 1995). As the complexity of the interaction process (which can be measured in terms of the numbers and the types of constraints and options being managed) increases, the effectiveness of pre-prepared or hardwired 'responses' decreases. Instead, we progressively need to be able to develop skilled context sensitive responses and heuristics. We need to be capable of self-determining what we need to know. To do this we need some kind of framework, reference condition, normative matrix or procedure to assist us in knowing.

Skill acquisition (defined here as adaptable, fluid, resilient, context sensitive action modulation) becomes central to our account. Moreover, there is a need to be able to learn, anticipate, remember, compare and imagine (Christensen & Hooker, 2000c). Intelligent systems as we have discussed need to provide *the right interaction, at the right time, for the right context, for the right effect*.

> As a mobile organism navigates through the world, sensory data flows into a vast array of parallel systems. Changes in the predictability of these data streams act as important markers, flagging epochs during which attention should be redirected or learning should occur (McClure, Berns, & Montague, 2003, p. 341).

The interdependency between self-directedness, learning, interaction and construction gives intelligent agents an internal locus of control with which to respond to their dynamic environments and to direct their attention and to learn from their experiences and environment.

The capacity for *self-directedness* is a crucial aspect of higher order intelligent behaviour[277]. To learn, intelligent systems need some capacity to modulate their action (to switch and shape interactions), anticipate their performance (to develop a predictive set of norms), evaluate their performance (reference interactions and predictions against the global constraints of the system) and to improve the context sensitivity of their performance by tracking actions, norms, and feedback against the environment (Bickhard & Campbell, 1996; Christensen, 2004a). So, this is what intelligent agents need to do – but how do they go about it?

[277] Christen and Hooker (2000c) typify low order management as involving the satisfaction of global constraints without the system necessarily modulating across large sections of its norm matrix. There is limited constraints management involving only a small number of parameters in guiding interaction. As such, low order management involves dealing with discrete aspects of the overall normative matrix. High order management involves more than simply an increase in the number of parameters or amount of the norm matrix. This modulation involves an expansion in the amount of feedback that is required to determine the appropriate 'steering'. With more degrees of freedom comes as associated coordination/regulation burden, which requires a shift from low to higher orders of regulation. As such lower order cognition can been see to deal with the sensor monitor level (or the lower levels of Powers' model) and higher order cognition dealing with the domain of concepts and reasoning (Christensen, 2004a). See Thelen and Smith (1995) and Craver and Scheier (1998) for further detail relating to this type of distinction.

9.2 Reason, rationality and rationalism – the basics

Perhaps one of the most enduring philosophical questions, in regards to knowing, is what is the basis for arriving at truth? Following on from this: How do we know what we know? And how do we evaluate the quality of our knowing? The response to this, while complex and multifaceted, can be sketched as involving *reason* – which has typically been seen as a capacity for sense making, determining facts, and justifying practices and beliefs (but more of this in the coming paragraphs).

Reason has been argued, at times, to be a distinctly human characteristic (which raises some questions in terms of how it fits within evolutionary theory and the *natural* world). In fact at times the proposed absence of reason has been used to delineate the line between humans and other forms of life. For the purpose of this work, reason will be approached as a cognitive mechanism or organisation that we use in sense and meaning making. As has been the custom in this work, when we move into a new area of theorising, we will now devote some space to the discussion of definitions and their background context.

Reason shares with the notion of intelligence, a range of technical and vernacular meanings. It is useful at this time to differentiate between rationalism, rationality and reason. Although these three terms are interconnected, they identify discrete types of activity. The western rationalist project has been prodigious in its development and distribution of its particular doctrine for rationality (Feyerabend, 1975, 1978, 1987; Gaukroger, 1978, 2006). Given the challenge of summing up this project[278] (something well beyond the scope of this discussion), we will opt instead for providing pragmatic definitions as aids to thought rather than as absolute statements.

Reason is the foundational element in this triarchy of concepts (i.e., reason, rationality and rationalism). Historically, reason has been defined simply as that which differentiates humans from animals (Barrett, 1958; Danto, 1990; Hayek, 1973; Toulmin, 1990)[279]. More specifically reason was characterised as an ability to transcend imperfections, delusions, limitations, ignorance and prejudice[280]. This ability offers an 'objective' means for understanding of the world and making judgements (Hooker, 1991, 1995). Thus reason has

278 See Saul (1992), Redner (1986), Newton-Smith (1981), and Miller (1994) and Barrett (1958) for critical overviews of the western rational project

279 This has resonance with the cynical notion that intelligence is what 'intelligence tests' test.

280 Popper (1968) illuminates this distinction in his examination of Plato's construct of the soul: "Plato's structure of the soul is characterised by an unstable equilibrium – indeed a schism – between its upper functions, reason and will, and its lower functions, the instincts and appetites" (p. 162). It is of value to compare this description to Aristotle's (1941) model of the soul which argued for an integrated framework construing the soul as kid of capacity contained in, and of, the body (although maintaining a weak dualistic stance).

typically been associated, especially since Descartes, with the mind's capacity to objectively represent the world and make decisions or judgements based on universal, or transcendental, principles (Cherniak, 1986; Edwards, 1954; Leighton & Sternberg, 2004; Lewis, 1981; Skyrms, 1980, 1982, 1984; Thrall, Coombs, & Davis, 1954; Toulmin, 1990)[281]. Baker (1986) describes this as "the attempt to find certain ultimates, certain identities from which a whole theoretical system will flow" (p.18). Mathematical formalisms and deductive logics are instrumental examples of this orthodox view of reason (H. I. Brown, 1988; Hooker, 1991; Popper, 1962, 1979). Where "reason is characterised by finitely stateable, simple rules, finite sequences of which yield algorithms for the generation of rational solutions to problems, solutions therefore characterised by necessity and hence universality" (Hooker, 1991, p. 45).

Rationality is the process of applying this capability, or instrumentalisations of it, to make decisions and judgements. For example, Anderson (1990) interpreted rationality as involving a "cognitive system that optimises the adaptation of the behaviour of the organism". This process involves:

1. Precisely specify the goals of the agent/system
2. Develop a formal model of the environment to which the agent/system is adapted
3. Make minimal assumptions about the computational costs
4. Derive the optimal behaviour of the agent considering 1-3
5. Test the optimality predictions against data/literature
6. Iterate (Based on summary in P. Pirolli, 2004)

From this thumbnail sketch of Anderson's model we can see how different definitions of reason leads to different types of rationality[282]. As discussed in Chapter Two, a narrow account of reason, and by association rationality, provided the infrastructure for 'Good Old Fashioned AI' (Searle, 1980). This approach in turn advocated a formalist and essentialist approach to cognition. The rationality 'type' that underpins AI assumes that decision making or problem solving strategies are based on consequential (an anticipation of future effects or cost) and preferential (evaluation of options) conditions (March, 1994; Pollock, 2006; von Neumann, 2000; von Neumann & Morgenstern, 1953).

Rationalism is a philosophical doctrine that seeks, in the first instance, to explain by using the concepts of reason and rationality, the source and nature of knowledge. This doctrine is

281 Refer to Luce and Raiffa (1957) for a user-friendly introduction to the key concepts of decision making and game theory.

282 For example, Max Weber's notion of instrumental values, affectual and tradition orientated rationality or Habrmermas' (1987) instrumental and critical reasoning.

traditionally contrasted with the doctrine of empiricism (Maslin, 2001; G. McCulloch, 1995). Rationalism is strongly associated with the work of Descartes, Spinoza and Leibniz. The central message of the western rationalist project has been one of 'pure reason' driven by a metaphysics of idealism and rationalist epistemology (Collier, 1996; Gregory, 1981; Hooker, 1982, 1987, 1991, 1995, 1996; Saul, 1992). While the broader debates about rationalism have significance to the meta-philosophical position of this thesis (Hooker, 1987, 1995) , we will be focusing, in this chapter, more specifically on reason and rationality. Consequently, the fundamental issue is "how well do the postulates of ideal reason capture the decisions and actions of intelligent agents in real world problem solving"?

For our purposes here, the key distinction is that where rationalism is expressed by a historically defined set of epistemic and ontological commitments, reason and rationality are descriptions of capabilities and processes and as such are subject to the possibility of re-drafting (Gaukroger, 2006). Correspondingly it is best to construe reason and rationality as labels for a group, or family, of hypotheses and axioms that can vary with regard to their degree of inclusiveness (from wide to narrow).

9.3 The rational agent and problem solving

> For 'reason' in this sense is nothing but 'reckoning' that is adding and subtracting, of consequence of general names agreed upon for the 'marking' and 'signifying' of our thoughts; I say 'marking' them when we reckon by ourselves, and 'signifying' when we demonstrate or approve our reckonings to other men (Hobbes, 2010, p. Chpt V).

The notion of a 'rational agent' has perpetually been "grist for the mill" for artists, scientists, economists, jurists and philosophers (Baron, 2000; G. McCulloch, 1995; Saul, 1992)[283]. There is much equivocation around 'reason', 'reasonable', 'rational' and 'rationality' depending on the issue at hand (W. M. Goldstein & Hogarth, 1997; Leighton & Sternberg, 2004; March, 1994; Pollock, 2006). Yet, as is often the case with such fundamental, or integrative, concepts their ubiquity is only matched by their polysemity. Nonetheless there do seem to be some enduring attributes (e.g., evaluating, deciding, judging, comparing) within this

[283] While this discussion here focuses predominately on reason and problem solving it is important to acknowledge that the issue of reasoning has been fundamental to the philosophy of science and has been at the centre of sustained debate about the nature of science and knowledge (Feyerabend, 1987; Gregory, 1981; Hooker, 1987, 1991; Kuhn, 1970; Latour, 1987; E. Nagel, 1961; Poincare, 1952; Popper, 1979, 1994; Rescher, 1977).

complexity[284]. Leighton (2004) offers the broad definition of reasoning as 'the process of drawing conclusions'. But there are many different ways to draw conclusions – are they all reasoning? Mainstream rationalist doctrine would say 'no', that there is a set of objective criteria and verifiable procedures for the determination of a justified conclusion[285] - anything outside of this scheme does not qualify as reason nor is it defensible as rational. We will refer to this position as narrow rationality, which involves the application of an idealised type of reason. The combination of these two elements (ideal reason and narrow rationality) describes an ideal rational agent.

An 'ideal rational agent' (IRA) (Pollock, 2006) behaves in such a way that it is possible to represent their actions, thoughts, and decisions in terms of abstract, symbolic or formalistic meta language (Baron, 2000; Dennett, 2003; Lakoff & Johnson, 1999; Mainzer, 2004). This meta-language, for example deductive logic, provides a framework from which an agent is able to determine the 'best' course of action.

> The human being striving for rationality and restricted within the limits of his knowledge has developed some working procedures that partially overcome these difficulties. These procedures consist in assuming that he can isolate from the rest of the world a closed system containing a limited number of variables and a limited range of consequences (Simon, 1976, p. 82).

Newell and Simon (1972) articulated a vision[286] of this type of rationality, and reasoning, as a production system. "A production system is a set of production rules – each of which represents a contingency for action – and a set of mechanism for matching and applying production rules" (Lovett & Anderson, 2005, p. 401). The bases of this framework, and associated behaviour, are an enduring set of 'objective' principles, axioms and formalisms that are seen to be context independent, if not universal (Feyerabend, 1987; Kuhn, 1970; Lakatos, 1977, 1978; Latour, 1987; Popper, 1979)[287]. From the perspective of ideal reason a production system approach makes perfect sense. Under this paradigm a problem is a "goal" whose achievement requires the application of reasoning to obtain the (desired) end state. Problems are not necessarily difficult to identify because they occur, by definition,

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284 For initial reviews of the research in the decision and judgement research see (G. M. Becker & McClintock, 1967; Edwards, 1954, 1961; Rapoport & Wallsten, 1972; Slovic, Fischhoff, & Lichtenstein, 1977). For more recent retrospective analysis see Fishburn; Hogarth; and Kahneman (see, Fishburn, 1988, 1989a, 1989b; Hogarth, 1993; Kahneman, 1991).

285 Pollock has come to distinguish between what he terms 'ideal' and 'real' rationality. The key difference being that ideal rationality is unconstrained by computational, psychological and biological limitations faced by intelligent agents. As Artificial Intelligence discovered, there is an incredible burden involved in gathering all the data about a problem to make determination as to all consequences of a conclusion (see Part A). Where as 'real; rationality seeks to represents how real agents, with all their attendant limits, make decisions about how to act.

286 Newell and Simon contributed for decades to research on problem solving, intelligence and cognition. The majority of this discussion will be concerned with the concept of a general problem solver (GPS).

287 Boole's logical framework is of this type.

when an agent needs to decide how to achieve a goal. Consequently goals are construed as internalist (a closed system) in nature.

General problem solving, according to Newell and Simon's model, is about searching the 'space' that surrounds a goal (Newell, 1980b)[288]. To do this involves the application of rules (production systems) to the problem space, which allows judgements or decisions to be made that connect the current situation to the desired end state (W. M. Goldstein & Hogarth, 1997; Novick & Bassok, 2005). The underlying objective of ideal rational agent is to maximise or optimise their particular responses[289]. This action is aimed at a pre-specified performance level that equates to the best, or most rational, solution. "The crux of classical decision theory is that actions are to be compared in terms of their expected utilities, and rationality dictates choosing an action that is optimal, i.e., such that no alternative has a higher expected-value" (Pollock, 2006, p. 6). As such the required solution (response) can be determined by using a standard rational choice approach, which can then be implemented via a traditional control solution (see Chapter Two)[290].

Optimisation is one of the central tenets of problem solving and reasoning within the cognitivist doctrine (e.g., Pylyshyn, 1984). But this perspective does not fit well with the *ad hoc* and counter intuitive ways agents go about solving real world problems (Broadbent, 1977; Dorner, 1991; Finke, Ward, & Smith, 1992; Kahneman, 2002, 2003; Klein, 1998; Lave, 1988; Tversky & Kahneman, 1974, 1981). It also fails to capture the individual differences in the ways in which agents identify aspects as salient and determine a course of action (Gigerenzer, 2000; Gilovich, Griffin, & Kahneman, 2002; Kahneman, Solvic, & Tversky, 1982; Klein et al., 1995; Sternberg, 2002; Sternberg et al., 2000)[291]. A good example of this limitation is seen in the notion of fixedness – standard optimisation perspectives fail to adequately represented how the perspective of the problem can influence the nature of both the framing of the task and the solution offered (*pace* Duncker).

Newell and Simon (1958), in response to psychological, biological and computational limitations, acknowledged the essential contribution of heuristics[292] to general problem

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288 This is a broad-brush sketch of the GPS theory and should be read as being indicative of the key concepts rather than an exhaustive description of the theory.

289 Newell termed this the principle of rationality " If an agent has knowledge that one of its actions will lead to one of its goals, then the agent will select that action"

290 In this simplified description we have the essence of the 'Good Old Fashion" AI process.

291 Meehl (1954) and Hammond's (1955) classic studies of clinical judgement were instrumental in initiating the study information's role in judgement.

292 For a general introduction to early use of heuristics see Polya (1957). Gigerenzer (Gigerenzer, 2000; Gigerenzer & Selten, 2002; Gigerenzer & Todd, 1999b) provides extensive discussion of heuristics and there role in problem solving.

solving. But the orthodox position on problem solving remained dominated by a means-end standpoint driven by an optimisation view of decision making (Castellan, 1993; Gigerenzer, 2000). Perhaps this can be explained by the fact that original work on problem solving focused largely on *puzzles* (e.g. Tower of Hanoi[293]) as a method for constructing a general theory of how people solve *problems* (Anzai & Simon, 1979; Simon, 1975). This method assumed that puzzles are isomorphic with real world problems[294]. Given that puzzle solving, unlike problem solving, almost exclusively involves the attainment of an externally predetermined end state, a means-end approach is likely to dominate. The means-ends approach proves to be efficacious for problems that are similar to the puzzle condition, but not so for those which are more dynamic and complex in nature (Beach & Lipshitz, 1997; Brehmer, Jungerman, Lourens, & Sevon, 1985; Funke, 1991, 1992; Janis & Mann, 1977).

As an aside, there is also the issue we raised in Chapter 7, that the very notion of what would constitute the difference between a problem and a puzzle. At a metaphysical level it could seem that true problems relate to issues such as meaning, ethics, or the existentialist dilemma. Here, as even the most sophisticated or complex problems of science are more issues of resolving 'technical' puzzles. There is value in noting this issue – but for the sake of the discussion here the idea of problem is a function of the type of cognitive, conative, and volition needed to resolve the issue. So whatever the domain we choose for framing our idea of a problem – and in this work it was been determined that ill defined or open tasks are an appropriate domain – the key issue becomes what kind of thinking or reasoning, from the point of view of the agent and context, is required by those circumstances.

The ideal rational agent principle does not offer a good fit with how intelligent agents behave *in situ* (Chaiklin & Lave, 1996; Hutchins, 1995; Lave, 1988; Pollock, 1993). Simon (Simon, 1956, 1973, 1982, 1991b) tried to address this inadequacy by introducing the notions of satisficing and bounded rationality as an alternative to the optimisation strategy. Rather than using ideal reason to identify the optimal solution, bounded rational agents instead searched for a path through the problem space that was "good enough". Adoption of the satisficing condition involves shifting a rational agent's performance requirements from a

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293 For more details about the original research see Ewert and Lambert (1932)

294 Intuitively there seems to be little support to this view. Nonetheless the reductionist belief that the generic and decontextualised formats are sufficient for eliciting essential elements has dominated within decision sciences (P. K. Davis, Kulick, & Egner, 2007).

'complete solution' to that of the most attainable viable solution[295]. The purpose of satisficing is to try and trade off the limits (or finite resources) that interfere with the application of 'ideal' reason. Bounded rationality is thus concerned with qualitative or subjective aspects, such as motivation, self efficacy, perception, bias, and disposition, and their contribution to shaping decision making activity (Arrow, 1988; Duncker, 1945; Kahneman, 2002; Slovic, 1995; Solvic et al., 1988; Tversky & Kahneman, 1981). The aim of the satisficing postulate was to move from an ideal rational choice theory (J. R. Anderson, 1991; Pollock, 2006) to a constrained or 'bounded' theory of rational choice (Gigerenzer & Selten, 2002).

Simon's bounded rationality is, as a consequence, a refutation of the optimisation view of rationality (Gigerenzer & Selten, 2002; Gigerenzer & Todd, 1999b). While the idea of searching for a solution is retained in bounded rationality, problem solving was now seen to be explicitly constrained by the resources available (internally and externally) to the agent. Satisficing was also underpinned by a functional description of cognition, with an emphasis on how limited cognitive resources are organised to enable an agent to solve problems (Simon, 1955, 1956)[296]. This approach connected with information processing constructs, which were being developed at around the same time.

> Both from the scanty data and from an examination of the postulates of the economic models it appears probable that, however adaptive the behaviour of organisms in learning and choice situations, the adaptiveness falls far short of the ideal of 'maximising' postulated in economic theory. Evidently organisms adapt well enough to 'satisfice'; they do not, in general, 'optimise' (Simon, 1956, p. 129).

Bounded rationality is thus characterised by the concepts of utility, lower limits or boundaries and heuristics (Gigerenzer, 2000; Gigerenzer & Selten, 2002; Gigerenzer & Todd, 1999b). The introduction of heuristics (e.g., hill climbing and means ends analysis) broke with the earlier algorithmic approaches (e.g., exhaustive search and optimisation) that had informed classical decision theory (Dawson, 1998; Kahneman, 1994)[297]. Simon's bounded rationality negatively defined the capacity of agents to 'find' solutions. This model compromised on the optimisation postulate of 'ideal' rationality while at the same time seeking to maintain a commitment to operationalising problem solving via

295 Goodrich, Stirling and Frost (1998) observe, a satisficing solution is different to a sub optimal solution.

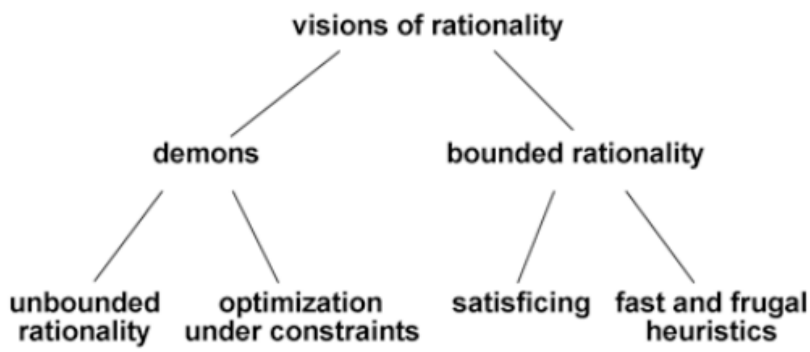
296 Bounded, or limited, rationality offered a different account of cognition, compared to Anderson's (1991) notion of 'optimal rationality'. It could be argued that these differences are matters emphasis rather than irreconcilable in nature. Simon (1991a) has been critical of Anderson's adherence to the principles of optimisation as fundamental to rationality. Anderson defines rationality as – "The cognitive system operates at all times to optimise the adaptation of the behaviour of the organism".

297 "Bounded rationality is what cognitive psychology is all about. And the study of bounded rationality is not the study of optimisation in relation to task environments" (Simon, 1991a, p. 35).

empirically grounded computational models (Hatchuel, 2001). The achievement of this end involved the diminishing or constraining of the problem space to a sub space, within which the agent is then able, with their limited resources, to identify a solution. Simon (1990) explained bounded rationality by using a metaphor of a pair of scissors, where one blade represents the structure of the environment and the other blade the cognitive structures of the agent. In this metaphor Simon was canvassing an interactive stance, but this remained largely under developed and speculative within his overall theory (Hatchuel, 2001)[298].

Rationality, agency and problem solving have thus been intimately entwined from the beginnings of decision and problem solving research. But this has been more than mere collocation; this has been a situation of co-dependence between rationality and agency. There have been two different modelling paths explored (see figure 6) – one path exploring reason as an unbounded capacity and the other that reason is limited by its instantiation in an agent.

Figure 6. Models of rationality (Gigerenzer & Todd, 1999a, p. 7)



Simon's oeuvre demonstrates that it would be inaccurate to characterise rationality (even of the ideal kind) as an unchanging edifice. Nonetheless there has been a persistent commitment within the mainstream program of work to see computation as the appropriate paradigm for capturing reasoning and cognition. The adoption of a functionalist perspective in bounded rationality provided considerable traction on what agents do, but how these functions are instantiated in neurological architecture, and behavioural repertories, was largely able to be dismissed. Thus bounded rationality did not substantially change the picture in terms of agency. Dimensions such as: creativity, collaboration, interaction and construction were still unavailable to the rational agent. As

[298] Gigerenzer and Todd (Gigerenzer & Todd, 1999a; Todd & Gigerenzer, 2003)explain that Simon felt that his notion of bound rationality was consistently misunderstood or misapplied by overlooking the contribution of the environmental structure.

Simon noted, the goal of classic decision and problem solving research was to represent a closed system, but experience has come to show us that closed computational systems are particularly poor at dealing with the kinds of real world problems that intelligent agent solved every day (Dreyfus, 1992).

9.4 Out of bounds: trying to move beyond bounded rationality

It would be presumptuous to assume that bounded rationality is devoid of value. If nothing else it offers an object lesson of the benefits of progressively refining our theoretical positions in response to critical and empirical feedback. In fact, the concept of bounded rationality initiated a watershed in the area of economic psychology (Kahneman, 2002) and forced a closer examination of the role of preferences and perception in decision making. But as even Simon (1991b) himself acknowledged, there were clearly limitations to the original conceptualisation of bounded rationality that restricted its explanatory power. We shall begin by briefly examining two refinements, based on Simon's speculative assertions, of the bounded rationality approach – the ecological and expanded rationality models. These two approaches, in different ways, try to make Simon's framework a better fit for the 'real world'. From here we will then move to discuss an alternative model of rationality and cognition that attempts to break with Simon's notion of boundaries and satisficing and offers a re-defining of rationality and cognition from the ground up.

9.4.1 Ecological rationality

Gigerenzer and Todd's (1999a) ecological rationality[299] seeks to augment bounded rationality by explicitly incorporating the structure of the environment into the problem solving domain. Consequently problem-solving actions (in particular heuristics) are determined to be "rational" based on the degree to which they are adapted to the structure of both the agent and the environment. As Gigerenzer and Todd (1999a) state

> Traditional definitions of rationality are concerned with maintaining internal order of beliefs and inferences … But real organisms spend most of their time dealing with the external disorder of their environment trying to make the decisions that will allow them to survive and reproduce (p. 18).

The aim of ecological rationality is to match, or fit, heuristics to environmental contexts, in such a way that the agent is able to exploit the environment (and reduce disorder). This context sensitivity eschews optimisation and in its place looks to "fast and frugal"

[299] The term "ecological" has only superficial similarity with the ecological perspective used by Bateson, Bronfenbrenner, Nessier and Gibson (Bateson, 2000; Bronfenbrenner, 1979).

responses. *Fitting*, rather than computing, is a paradigm for this type of approach[300]. Correspondingly, agents seek to match their strategies to the information they receive from the environment – identifying patterns and structures, which reduce disorder. We shall refer to this approach as "narrow fitting".

In ecological rationality the environment is largely passive and is construed simply as a source of information that can be exploited for the "easing" of the burden on an agent's decision-making processes. Agents extract from the environment a coarse grained set of constraints which they then use to match with their "fast and frugal" heuristics. Ecological rationality is an ongoing research program and continues to seek empirical support for the "adaptivity" of heuristics from evolutionary psychology (Cosmides & Tooby, 1987, 2002; Goertzel, 1997; Goodson, 2003; Roth & Dicke, 2005). Todd and Gigerenzer (2003) suggest that "there are cases where cognitive limitations actually seem to be beneficial, enabling new functions that would be absent without them, rather than constraining the possible behaviours of the system" (p. 160). This observation indicates a shift away from the implied "impairment" of reason that is suggested in bounded rationality[301].

9.4.2 Expanded rationality

Hatchuel (2001) argues that Simon's bounded rationality is too diminished an image of reasoning – that instead of boundaries we should be seeking expansion. In Hatchuel's assessment neither satisficing nor heuristics adequately encompass the social and creative aspects of problem solving. Hatchuel's main hypothesis is that "human agents are limited decision makers but "good" natural designers (including social interaction as a design area)" (Hatchuel, 2001, p. 270). These shortcomings are particularly apparent in regards to open or ill-defined problems. Hatchuel uses the example of planning a "nice party" to demonstrate that real world problems have a type of complexity and degrees of freedom that are unlike the circumstances that lead to the combinatorial explosion involved in puzzles like the Towers of Hanoi. Concordantly finding solutions for well defined, simple (low complexity), closed problems are not necessarily isomorphic with finding solutions to problems that are ill defined, open and complex. In particular optimisation and satisficing may be the wrong lens, as shown in the "nice party" problem, for understanding intelligent behaviour. The notion of a party, in Hatchel's argument, is an infinitely expandable concept. There is no finite set of "parties" and as such this problem is resistant to heuristic

300 Pask (1975a) describes heuristics as non-deterministic programs or fuzzy algorithms.

301 The general concept of bounded rationality does appear to have some similarities to both Plato's idealism and Aristotle's realism.

strategies that are based on an individual's capacity to define and constrain a problem space. Thus an agent needs to be able to cope with uncertainty and seek to shift the boundaries of the problem space in such a way as to allow 'new possibilities' to be introduced. Expandable rationality, where agents seek to open up the problem space, is not necessarily antagonistic to bounded and unbounded rationality[302]. It is probable that there are combinations of computation, heuristic and design aspects involved in problem solving, and that it may be necessary to adopt a broad rather than narrow position. This will refer to as wide fitting.

9.4.3 Real rational agents

Pollock breaks with many of the Simonian assumptions about rationality and agency. Instead he construes that there are two basic types of reason and rational agents - ideal and real. Furthermore he explicitly incorporates cognition and behaviour as principle components of his analysis. The key differentiator, for both cognition and rationality, is Pollock's distinction between epistemic (concerning beliefs) and practical (concerning evaluation, plans and actions) dimensions.

> Rationality represents one solution to the problem of survival in a hostile world. A rational agent has beliefs reflecting the state of tis environment, and it likes or dislikes the situation. When it finds the world not entirely to its liking, it tries to change that. Its cognitive architecture is the mechanism whereby it chooses courses of action aimed at making the world more to its liking (Pollock, 1993, p. 563).

Goals, action and plans are axiomatic to rationality in Pollock's model. He identifies that real real rational agents (RRA) are characterised by two cardinal traits: 1) the need for action; and and 2) the capacity of agents to change their minds (Pollock, 1995; Pollock & Cruz, 1999). RRA engage in non-terminating reasoning – they are faced by a complicated and complex world that ensures that they will never have 'all the facts' and as such ratiocination is open ended. This level of ignorance is matched by a need for action. RRA are temporally and contextually sensitive and naturally active. Yet with increased interactive capacity and cognitive sophistication RRA also acquire fallible beliefs and shifting dispositions[303] as a basis for making choices. Additionally, the environment is an active participant in rationality, as an RRA's beliefs, goals and actions are (see

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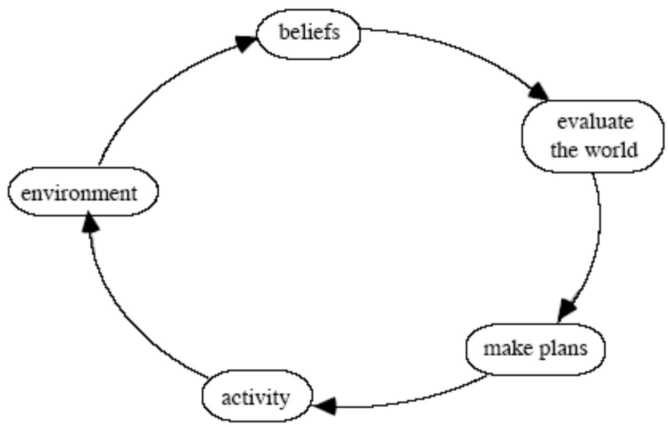
302 Russell's (1997) notion of mutli-level rationality and bounded optimality may be one way of conceptualising "agents" who incorporate these three types of rationality. Dawson (1998) offers a model for what the underlying architectures might look like for a combination of this type.

303 There is a subtle difference between the autonomy condition, as described by Christensen, and preferences. There are global constraints that are manageable but cannot be revolved without catastrophically disrupting the system. For example, there is a difference between preferring one type of food to another and choosing to consume no food at all.

). In the RRA model it makes no sense to discuss optimisation strategies that are based on an exhaustive comparison of options.

Figure 7. RAA model (Pollock, 2004)



Classic decision theory assumes that a utility value can be ascribed to decomposable actions and then probabilities and cost-benefits calculated (Baron, 2000; W. M. Goldstein & Hogarth, 1997). Furthermore it is inherent in classical decision theory that agents have discrete, or at the least, known set of actions to choose from (Pollock, 2003). This creates a large computation burden on agents (as previously discussed). Yet Pollok observes that deciding between competing non-utility differentiable actions is by far the most critical barrier, rather than simple computational explosion, to rational cognition. RRA are faced by strongly (mutually exclusive) and weakly (restricted and/or interdependent) competing actions and goals. Given the fallibility and ignorance of real rational agents this engenders the question of "on what basis is a decision best made"? Does it make any sense to talk about warranted or justified decision in weakly competing activities when "carrying out one decision may alter the probabilities and utilities involved in another decision" (Pollock, 2004)? Choices between discrete alternatives under an optimisation condition, is in Pollock's argument the Achilles heel of classical decision theory (Pollock, 1993, 2006). Not only don't real rational agents behave in this way when making decisions, classical decision theory completely fails to address the ways in "actions can both interfere with each other and cooperate to achieve goals collaboratively" (Pollock, 2004). Furthermore, for Pollock, actions are only significant in so far as they pertain to plans that are constructed as means of achieving goals. The central difference between Pollock's approach and bounded rationality is that under a bounded rationality condition we are only concerned with describing the rules for how choices are justified; whereas Pollock wants to understand where choices come from, the conditions under which choices are made, and how choices are enacted[304].

9.4.4 Ratiocination in the world

> We must make a distinction between rational thought, which concerns the mechanism within the agent, and rational behaviour, which pertains to the agent's interaction with the environment (Pfeifer & Scheier, 1999, pp. 283-284).

From the aspirational notion of a General Problem Solver (GPS) to real rational agents, decision and problem solving theorists have gradually sought to widen the type of 'relevant' factors and assemblages that need to be included to provide an adequate model of reasoning. Increasingly the 'real world' has intruded into both the internal (beliefs) and external (environmental stabilities and fluxes) domains of agents. The sensitivity to the interplay between these domains (perception and action) has also been given an increased prominence. The once dominant notion of algorithms and formalisms, while still a powerful tool for understanding particular types of rationality, no longer holds sway over the whole field (W. M. Goldstein & Hogarth, 1997). Instead, we see a host of types of reason and rationality being proposed – but there still remains the open question of what is the relationship between reason and intelligence[305]. Given the somewhat deterministic nature that both of these concepts began with, it is not surprising that there are sensitivities to bringing these notions together – especially if this is under the auspices of biological/evolutionary constructs. By using a generalised notion of intelligence, which is separated from any particular instantiation, we may be lead to a generalised theory of reason. As Christensen (1999) observes "[t]he strong implication is that to gain closure on what it is to be intelligent we need to understand the system of interrelated constraints between evolutionary, developmental, learning and reasoning processes" (p. 18).

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304 Pollock's notion of rational agency is compatible with I-C model. The primary disparity between IC and RAA relates to the scope of analysis. Hooker's stated concern is with rationality writ large across the biological and social domain, where as Pollock is more interested in domain RAA decision making. Pollock's doxastic-contaive loop represents cognition centric representation of rationality.

305 Hubert and Stuart Dreyfus (1986), in their work on expertise and decision-making, propose a difference between calculative and deliberative rationality as a means of more effectively describing the difference between 'real world' and theoretical constructs. Their analysis shows the benefits of adopting an aspected representation of reason to integrate reason and intelligence. As Pascal (1961) notes "there are two equally dangerous extremes – to shut reason out and to let nothing else in".

For example, if we accept that agents understand, and manipulate, their world through a combination epistemic and practical reasoning, which Pollock construes as being cognitive mechanisms, then we begin to see that if intelligence is the capacity for fine grained modulation of interaction, and reasoning as the capacity to comprehend and manipulate information about 'world' then they may well be two aspect of the same assemblage. Pollock's notion of epistemic (beliefs) and practical (activity based on beliefs) cognition faintly echoes Fromm's (1990) description of the difference between reason and intelligence, noted earlier.

> Reason is man's faculty for grasping the world by thought, in contradiction to intelligence, which is man's ability to manipulate the world with the help of thought. Reason is man's instrument for arriving at the truth, intelligence is man's instrument for manipulating the world more successfully; the former is essentially human, the latter belongs to the animal part of man (p. 64).

So how can we integrate the various elements of cognition, behaviour, intelligence, reason and context? Clearly there is some common ground here but there are also some essential differences. What is crucial here is that we adopt not only a wide view of reason and rationality, one capable of encompassing the previously narrow approaches (as exemplified by Pollock's IRA), but that we undertake a program to develop a general theory of rationality.

Hooker's (1995) key proposition for developing this type of program is that reason is best conceptualised as a form of regulatory control that can be ascended and expanded to allow increased levels of sophisticated individual and collective Inter(action). "Reason then is to be theorised as a particular kind of regulatory structure to intelligence, grading off down the evolutionary sequence in rough proportion as intelligence grades off" (Hooker, 1995, p. 313). Within a regulatory framework, norms (epistemic utilities) become crucial for understanding the behaviour of rational agents (Carver & Scheier, 1998). Furthermore regulatory principles are closer to cybernetic/system methods than they are to computational/cognitivist doctrine. Thus rationality is a particular form of generalised intelligence – it is a way of adaptively interacting with the world when we are faced with complexity and openness. Rationality is thus the way in which we tackle problems.

9.5 Concluding comments

At the beginning of this chapter we posed the question of "how cognition could be organised to accomplish Doctorateness"? We have evaluated *reasoning* as a candidate for understanding Doctoral students' capacity to respond to research problems and determine the fit of particular constructs against the world. In this discussion we have seen that much like in Part A where we redrafted the notions of intelligence and cognition, that we can redraft the idea of problem solving and rationality to provide a consistent account of Doctoral behaviour and knowing that is based on interaction and construction rather than idealised and transcendental accounts.

The significance of this outcome is twofold. Firstly it adds another critical piece to our overall case for naturalising Doctoral cognition and knowing; and secondly it contests the underground justification of the Doctorate – that Doctoral education is fundamentally rational (in the narrow and transcendental sense of the term) in nature. If anything, our understanding of the Doctorate should be based on a practical rather than transcendental or 'pure' foundation. We need to free the Doctoral experience from the platonic metaphors of *revelation* and *pure forms*. We would argue instead, that it is much more a matter of *exegesis*, *hermeneutics* and *meaning making*.

To sum up – Doctorateness involves a candidate cultivating a particular kind of cognitive organisation or *mode of knowing*. That this type of organisation or mode of knowing is an emergent form of *reasoning* that makes use of constraints, expectations and anticipations (both germane to the individual and the context) to navigate the world and determine a course of action. Far from it being a process that is transcendental in nature, the acquisition, cultivation, and refinement of reason, in particular in research activities, is an interactive and embodied learning process.

I should, from the start, have systematically distinguished between knowledge as the outcome of special inquires (undertaken because of the presence of problems) and intelligence as the product and expression of cumulative finding of the meanings reached in these special cases
(Dewey, 2008, p. 6).

CHAPTER 10

INQUIRY AND THE MIND

10.1 Orientation

We have established that Doctorateness is shaped by a particular complex mode of knowing. That this mode of knowing is a particular way of manipulating and dealing with the world to resolve ill defined or open problems. Furthermore Doctoral candidates in particular, and intelligent autonomous agents in general, have the capacity to develop and cultivate this mode of knowing through inquiry driven interaction, expressed as reasoning, with the world.

When an individual is able to not only perceive the world, but also to construct frames of reference, systems of meaning and a lens for viewing the world, then we can significantly look to the role of knowing in their actions. For to interact with the world, to classify the perceptible conditions of the world based on this interaction, in short, to draw distinctions, to construe meaning, to form concepts and to anticipate outcomes is to engage in a creative (or constructive) mode of *knowing* and *being*. Doctoral education is intended, in principle, to elicit this mode.

In this chapter we will devote our attention, at a broad level, to an analysis of the *art of knowing*, as well as the conceptions employed by reasoned or scientific thought in interpreting the world (G. A. Kelly, 1991b). This will complete our theoretically based conceptualisation of Doctoral cognition. In this we are looking to *close the loop* between the internal and external worlds of the Doctorate[306]. Although the pragmatist and constructivist traditions have a strong influence on this work, the account offered here is based on more than mere plausibility within other traditions. Instead we are looking to connect a range of discipline areas, and to offer an account that adds to our current

[306] But not close off the inquiring systems from the world.

thinking by reshaping the epistemic topography of the debate about Doctoral education. We wish our argument to have philosophic integrity, to eschew shallowness and superficiality, and to be scientifically rigorous and robust.

10.2 Knowing

In this work there is a degree of convergence with Peirce's, Dewey's, Piaget's and Gibson's thinking without necessarily committing to the meta-philosophical aspects of these theorists. Instead we would like to adopt a 'pragmatist commitment to process and action' (Bickhard, 2003). This line of approach will take us into contact with Dewey's *Instrumental Naturalism* and Kelly's *Constructive Alternativism*. We see these two models as offering us an effective way to understand inquiry and knowing.

Instrumental Naturalism and *Constructive Alternativism* were introduced as part of the *Prolegomenon* and have been indispensable to the conceptual foundations of our discussion. We have taken several key themes from Dewey's theorising (e.g., the centrality of inquiry and reflection), and examined them against the patterns and trends that are emerging out of empirical and theoretical projects in philosophical psychology. What we have found is that experience and inquiry, as Dewey construed them, remain a valid and applicable grounding for thinking about knowing. Kelly's approach, in general, adds extra dimensions to Dewey's thinking, by more intimately linking the processes of inquiry, knowing and the self. The relationship between identity and construing directs us to consider that Doctorateness is more than just a way of doing, but also as a way of *being*. This is a type of *being* that is constituted in both the actions, and the patterns of a person's understanding and construction.

In this regard individuals are general meaning makers (Dennett, 1995, 1996); and this general and generative mechanism, of viewing the world through patterns of action and meaning, is employed in the specific task of the Doctorate. As we have noted in the *Introduction* this can result in multiple types of Doctorateness; but these alternative constructs are, in the view argued here, deploying the same fundamental act of grounding scholarly knowledge in the process of an individual's knowing and inquiry. Kelly, as we have observed repeatedly here, went so far as to establish this process of meaning and knowledge making as a fundamental aspect of his view of what people 'are'.

We argue that *knowledge* is best understood as having a relational function – linking the (life) world and the individual in complex and multi-dimensional ways. In turn this definition of knowledge has implied a new theory of cognition. In this we take inspiration from Bickhard's work[307] (which builds extensively on Piaget's research and theory) on knowledge, development, representation, and interaction.

> Knowing is the successful goal-directed interactive process: to know something is to interact with it successfully according to some goal. Correspondingly, knowledge is the ability to know, to engage in successful interaction. Knowledge is constituted in the organization of the system that allows it to engage in knowing interactions (R. L. Campbell & Bickhard, 1986, pp. 38-39).

Bickhard's theory of interactivism is based on a commitment to a process metaphysics, a naturalist ontology, the centrality of emergence, and a normative view of representation and rationality (Bickhard, 2003)[308]. Instead of symbols as the fundamental, or root, representational unit[309] Bickhard identifies interactively constituted invariances and the interaction opportunities that they afford, as essential to both perception and representation (Bickhard, 1993, 1998a, 1998b, 1999, 2000, 2007a). Put more simply, the world is, for the individual, constituted by stable patterns of meaning and action. These patterns of meanings and action potentials are shaped through interaction, experience, construing and anticipation.

One of the key reasons we look to Bickhard is that he has given considerable thought to how to articulate a comprehensive view of meaning making that does not require an idealist or correspondence theory of representation. In this he draws upon Gibson's work on affordances and active perception, as well as developmental and biological psychology. He adopts a realist position, but has argued this does not necessarily commit him to an internal representation model – where cognition is mere symbol manipulation and processing (*a la* GOFAI).

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307 Bickhard has had ongoing collaborations with a range of other thinkers, but these collaborations serve primarily to articulate his fundamental vision and retain a high level of consistency with his individual writing. As such, we will refer to Bickhard's *oeuvre* as a whole and use references to identify when a quote is sourced from a piece of co-authored work.

308 One of the challenges in reading Bickhard' work is that although he in persistent, almost to the point of dogmatism, in attacking encodingism (Bickhard, 1993, 1998a; Bickhard & Terveen, 1995), his approach is equally abstracted. It is almost endemic to the *systems* and *functionalist* approach that in avoiding a commitment to any particular instantiation or organisational structure they have adopted an idiom, or meta-language, so far removed from the vernacular that it becomes difficult to perceive concrete connections between the basic process examples (e.g., cells, candle flames, rocks, gases, etc.) and the higher order ones that they seek to explain. Indeed this was the struggle that Piaget faced in characterising the more abstracted aspects of intelligent behaviour and epistemology.

309 Bickhard challenges the notion that there is a single natural kind for representation. He proffers a range of representational types that break with the encoding view. Across these types of representation he identifies a common thread as interaction (see Bickhard, 1998a; Bickhard & Terveen, 1995 for detailed discussion).

In Bickhard's view cognition cannot depend (solely) upon symbolic representations and closed internalist mechanisms (Bickhard, 1980a, 1992c, 1995, 1998a, 2000; Bickhard & Richie, 1983; Bickhard & Terveen, 1995). By adopting a Gibsonian orientation, Bickhard (working with his long time collaborator Campbell) has demonstrated the criticality of interaction (i.e., process) in the emergence of knowledge and knowing (Bickhard & Richie, 1983)[310].

> From an interactive standpoint, physical objects are epistemologically constituted as patterns of potential coordinations among various manipulations and visual scans. These patterns, as interactively reachable potentialities, remain invariant over many other kinds of interactions, such as covering, placing behind, translation through space, location by the individual, etc. Such invariances of patterns of potential interactions serve as anchors for extending one's representations of the world beyond the immediately accessible. Because of their invariance properties, such patterns remain part of the realm of interactive potentiality even when they are no longer immediately available for interaction. Such invariances, together with their properties and the relationship among them, are what epistemologically constitute our familiar world (R. L. Campbell & Bickhard, 1986, p. 38).

With this as a foundation, Bickhard articulates a model of cognition as knowledge construction that is the result of developmentally sensitive dynamic interactive processes (Bickhard, 1980b, 2007b; D. T. Campbell, 1990). In this he is *parsing* Piaget, using the language of systems' thinking – providing an account that scales across the biological world.

> Knowledge, in other words, is interactive competence in some domain of interaction. Conversely, competence is the potential success aspect of any goal-directed interactive system. … Representation is the differentiating aspects of knowing systems, and competence is the goal-reach aspects (R. L. Campbell & Bickhard, 1986, p. 39).

The generic agent in Bickhard's interaction paradigm is a cohesive action system. An action system is realised by a "system that is autonomous, stable, and which could perform actions on the environment it inhabits and sense the effects of those actions" (Stojanov & Kulakov, 2003, p. 2). Consequently, this view of activity implicates both feedback and feedforward actions. Stojanov and Kulakov describe the relationship between activity and sensory input in the following terms:

$$S=f(A,E)$$

[310] There is a degree of commonality between Bickhard and Lakoff on this point. Both have argued that cognition and representation need to be fundamentally redrafted, and that there is a significant bottom-up component to the development of abstractions and conceptualisations. Bickhard, due to his Piagetian influences, has done more work within developmentalist tradition than Lakoff, but it is worth considering their work as complementary. For a recent review of representational debate see Manzotti (2001).

"Where the sensory input (S) is affected by the actions (A) that the agent performs, and by the environment (E) which imposes certain constrains" (Stojanov & Kulakov, 2003, p. 3). This formula offers a substantially different characterisation of information than that offered under traditional information processing paradigms (see Part A) (Cisek, 1999; G. R. Taylor, 1979) and aligns more directly with information seeking theorising (see prior chapters in Part B). For Bickhard input is actively constructed through an iterative and dynamic interaction rather than the result of *closed* cognitive processes or as an *a priori* constructs. The system is, in the terminology of Quick, Dautenhahn, Nehaniv and Roberts (1999), *coupled to the world* via perturbation channels.

It is crucial that interactive sensory input be interpreted with an awareness of the structural constraints that exist for a particular system's perturbation channels (Quick et al., 1999; Quick, Nehaniv, Dautenhahn, & Roberts, 2002). To paraphrase Merleau-Ponty (1962), the body is a medium for having the world. A different type of body (or organisational structure) will be necessity generate a different world[311]. Bickhard has been careful to construe representation in such a way as it can sit within a developmental context (Bickhard, 1980b, 1992c, 2001; Bickhard & Campbell, 1996). Thus the types of inputs, or representations, that are available to an agent are dynamic and subject to developmental (structural and organisational) change.

In this regard there is at least sympathy, if not synergy, with Kelly's constructive alternativism. There is in our view a concordance between Kelly's *individuality, experience, commonality* and *sociality* corollaries and how Bickhard views the ways we shape and are shaped by our perceptions and interactions with the world. Our constructs are thus determining, rather than deterministic, structures (*pac*e Bourdieu's *habitus*), and as such can be a mechanism for both change and stability.

This view of sensory input also provides some acknowledgement of the fact that interactive differences or limitations (e.g., damage or degradation) have an impact on perception and cognition[312]. By considering the developmental trajectory (or history) for an agent, their interactive windows (proximal, distal, temporal), and their global and local constraints, we have the constituent elements for building a normative matrix. This matrix will include the

[311] Consider the difference in the interactive capacity between a single celled and multicellular creature. They functionally have the same basic interactive goals but the input they receive from the world because of their organisation is vastly different (Christensen & Bickhard, 2002).

[312] As discussed in chapter two there field of cognitive neuroscience has identified the impact of neurological disorders on perception and cognition. This places a nominal requirement on our modelling of cognition to offer some description of impaired, degraded or hyper extended performance (cf., Blakeslee & Ramachandran, 1999; Gazzaniga, 1998; Gazzaniga et al., 2002; McCrone, 1999).

discriminative preferences for particular environments. These preferences, and associated constraints, provide channels (or in Kelly's words *anticipations*) that represent the contextual, experiential, epistemological and ontological aspects of intelligent behaviour. As Kelly describes "a person's processes, psychologically speaking, slip into grooves which are cut by the mechanisms he adopts for realizing his objectives" (G. A. Kelly, 1995, p. 49).

Bickhard argues that the processes of dynamic supposition, fallibility, detection, and switching are necessary conditions for the kind of non-symbol based learning system needed to channelize psychological processes. Indeed, as we have contended, learning and adaptability are two sides of the same coin. The following two quotes by Campbell and Bickhard are instructive in this regard:

> We have explicated knowing in terms of the interactions of certain system, including living systems. We have explicated learning in terms of constructive metaprocess on underlying knowing (living) systems. Any living system will be a knowing system, and any living system will be more successful as such, will be adaptive, if it is capable of learning tries, recovery, tries, in the face of interactive failure. Learning is the modification of knowing that improves the adaptability of living systems (R. L. Campbell & Bickhard, 1986, pp. 45-46).

> A learning system must be able to detect conditions of undefined or ill defined process in the underlying knowing system in order to try and recover the failed or failing interaction of the knowing system. If a system were to evolve that differentiated such conditions of process uncertainty in the knowing system and fed them back into the knowing system as input, then the knowing system would be able to interact with its own internal condition of uncertainty. Such conditions of process uncertainty would correspond to a lack of knowledge of the environment or failure to anticipate the interaction. They would correspond to conditions of danger, or interference, or novelty and opportunity to learn etc. (R. L. Campbell & Bickhard, 1986, p. 45).

Pask has similarly provided a general theoretical framework for how we might best describe the nature of the interaction or dialogue between the world and knowing. Pask saw this interaction as a form of conversation. Pask was deeply concerned with the domain of learning, rather than with the broader system maintaining processes that overshadow much of the work of Christensen, Hooker, Bickhard, Maturana, and Varela. Although it must be kept in mind, as discussed in Carinai (1993) and Scott (2000), that this difference is more a matter of degree, than type.

Admittedly on first glance, these kind of universal or non-specific idioms (which can at times be open, regardless of the specialist nature of their style, to accusations of ambiguity) being used by Pask, and by Campbell and Bickhard appear to be too removed from the actual experiences of Doctoral education. There is no tangible immediacy to the processes they are describing and the activities of research and postgraduate study. Nonetheless Bickhard is drawing our attention to the centrality of interaction to cognition and learning. But what metaphor or descriptor best captures this interaction when we wish to look at the processes of higher order cognition used in the Doctorate?

10.3 Inquiring and Doctorateness

We have selected the notion of inquiry as the way forward in this regard. Inquiry moves us beyond searching or seeking, to a mode of interaction that is generative in nature. Most importantly, this is a mode that allows for adaptive learning (especially when combined with a normative frame, memory, anticipation and self adjustment or regulation). When we conglomerate inquiring processes with self-maintenant processes, then this provides a mechanism for the construction of not only alternative ways of understanding the world, but also the self in the world. In the case of the Doctorate this suggest that the process of inquiry allows the candidate to learn about knowing, knowledge, Doctorateness and the Doctoral self.

Dewey was deeply concerned with inquiry and he saw it as the mechanism or process that drove learning. He provides a variety of exemplars of how this process would unfold in general. At times these resonate with Rousseau's narrative account of experience and behaviour *in situ* and Dewey often uses a similar style of analogy to demonstrate his point[313]. The common theme of Dewey's exemplars is that inquiry is an impulse from the individual; it is the learner acting, rather than simply reacting. In the same way, Piaget's *cognitive constructivism* theory and Vygotsky's *social constructivism* theory also identify inquiry as a decisive element of learning and change[314].

In Dewey's framework investigation; communication; construction; and reflection each represent different elements of the inquiry experience. What is noteworthy here is that this inquiry process is cyclical and closes upon the learner. This does not mean that the environment is unimportant, far from it. What it does mean is that the locus of control sits within the 'learning system' and not the environment (Hooker, 2009). As such, systems of

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[313] The notion of inquiry has very deep roots within the western philosophical tradition. Connecting most obviously with Socrates, and is evident in the works of Vico, Rousseau, Vygotsky, Piaget, and Dewey each speak to the nature of inquiry and knowledge.

[314] Piaget proposed that children learn through personal interactions with physical events and objects in their daily lives. Vygotsky put forward that children learn through their interactions and dialogues, when they are engaged in socially mediated activities.

control and circumstances that trigger them should be distinct. It was this issue that Gibson was speaking to in his idea of affordances – that depending upon what *we need, and what we know and how we interact*, the environment will afford us options based on the different systems of inquiry and change will be available to us. Let us flesh out this intuition in a way that relates it to a broader understanding of Doctoral cognition.

The significant theoretical challenge in modelling these interactions, in the case of the Doctorate, is that there are both local (individual level) and social (macro or collective level) systems of regulation. Put differently, there are some affordances, constructs and roles that are the result of normative frameworks that are beyond the individual (i.e., discipline or professional constraints). Similarly there are some modalities of inquiry (i.e., scientific inquiry) that involve external observers who provide regulatory input to the individual. In principle we are observed, whether this be by ourselves or by others. This observation, in the case of Doctoral education, matters[315].

In this regard Doctoral candidates play a *role* in the psychological process (cognitive and social) of the Doctorate. The acquisition and development of this role requires both the capacity to understand the belief systems of supervisors, peers, institutions, disciplines and examiners (as related but distinct construction systems); as well as the development of similar constructions of experience to these systems. The candidate must negotiate their role by expressing action and constructs that are consistent with Doctorateness (as defined *in vivo*) and disciplinary reference frames for scholarly work (as construed through the communications and interactions of those who make up the discipline or academy). In other words, the act of inquiry is an act of becoming.

10.4 Concluding comments

In this chapter we have attempted to understand how inquiry has come to be central to cognition and how inquiry is structured. We have discussed how there is a non-coincidence of action, process and organisation in cognition. The interaction with the world instated by active intentional and anticipative interaction with the world is part of a more general process of meaning making and construction of self. The construction of the Doctoral self iteratively links constructions of knowing, reason, knowledge, discipline and education with particular *in vivo* roles for individual candidates. In the next section we

[315] Foucault observed this general point as well – drawing our attention to both the micro levels of regulation as well as the larger regimes of truth that shape social practice.

shall illuminate this process in more practical detail by looking to the lived experience of Doctoral candidates.

PART B: SUMMARY

In Part B we have examined the domain of research; with the overall goal of formulating a theoretical account of how Doctoral cognition (and Doctorateness) would need to be operationalized to be consistent with the position taken up in Part A.

Our starting point for this discussion was that in adopting a meta philosophical position, with construction and naturalism at its core, we needed a new theory of cognition. To obtain this formulation we focused on how knowing in general would need to be understood. To direct our discussion we examined research (as the core aspect of the Doctoral experience). Throughout Part B we have identified a wide range of concepts and frameworks that can assist us in our elaboration of Doctoral cognition. All of these concepts have been woven together in a philosophical psychology account that aims to be both coherent and plausible. In overview, our elaboration of Doctoral cognition is as follows:

1. All experiences, and especially their psychological aspects, should be understood as occurring naturally.
2. Perception involves a knowing and intentional relationship with experience.
3. Intelligence is the discrimination of the coordination interactions, norms, constructs, skills, and habits for the purpose of maintaining a viable self.
4. All intellectual functions are practical (in that they are temporal), having a specific natural origin and definite cessation.
5. Intelligence is an aspect of self coordinating, organising and regulating of activities.
6. Reasoning is that organisational process within intelligence that directs inquiry during problematic circumstances (internal or external).
7. Inquiry aims to address an indeterminate situation or relationship (internal or external) and restore coordinated, viable, and unproblematic experiences and self.
8. Inquiry uses norms and anticipations to assess the problematic situation and then direct a course of that that may restore an unproblematic experience and viable self.
9. Successful inquiry develops new organisation, norms, constructs and skills and hence increases the fund of *intelligent moves* available for dealing with future problematic situations.
10. The constellation of *intelligent moves*, when referenced against social networks, results in, individuals and collectives, constructing roles and common constructs.
11. Doctorateness is an expression of a set of constructs about knowing, knowledge and roles.

PART C

APPLICATION

> The world must actually be such as to generate ignorance and inquiry: doubt and hypothesis, trial and temporal conclusions … The ultimate evidence of genuine hazard, contingency, irregularity and indeterminateness in nature is thus found in the occurrence of thinking. Dewey (1929, p. 169).

CHAPTER 11

DESCENDING TO THE PRACTICAL

11.1 Orientation

With our theoretical preparation in place we are now equipped with the necessary tools for the next stage of our work. But these tools need to be balanced for our hand and sharpened for use. To do this, we will hone our elaboration of Doctoral cognition against the empirical grain of the world. We will be, in essence, testing the fit between our preliminary elaboration and the actual behaviour and thinking of doctoral students. In this we are looking for a *proof of concept* – to verify that our elaboration (and its associated concepts and theories) have the potential for real-world application. But this is but the first move in a larger theoretical and methodological game (discussed further in Part D).

The topic of Doctoral cognition is in need of further study and clarification. What is provided in this chapter is primarily an exemplar of how we can collect data in a way that is consistent with the underlying philosophical position and conceptual elaboration used in this work. This approach provides us with not merely an opportunity to develop a research approach (as important a contribution as this would be in its own right); it also offers us a sampling of *Doctoralness in vivo*. This description of the experience of Doctoralness is necessary for sharpening our formulation of Doctoral cognition.

The objective of the first chapter in Part C is to describe the research methodology and method adopted for this study. This account will include:

I. the rationale and theoretical framework for the research approach adopted;
II. an overview of the design and assumptions the projects;
III. a discussion of the issue of the trustworthiness of the data.
IV. the limitations of the study;
V. a description of the sample selected; and,
VI. an outline of methods of data collection.

The chapter concludes with a brief summary. The subsequent chapter will report and examine the data collected using the proposed method.

11.2 Rationale for the research design

Constructivism[316] (and in particular the ideas of Kelly and those who have extended his ideas) is a significant conceptual driver of this work. Concordantly, when selecting an appropriate research methodology, consideration has been given to ensuring that the eventual approach chosen will broadly align with Kelly's *constructive alternativism*. Much of the qualitative research tradition has been built on constructivist philosophy (Seale, 1999; J. K. Smith & Heshusius, 2004). Constructivism is deeply concerned with how individuals experience, interpret, understand and make meaning of the world. Moreover the role of context (including chronology) is identified as essential for interpreting meaning making behaviour.

Matching this work's theoretical commitment to constructivism is a methodological commitment to qualitative research. The objective of qualitative research, in broad-brush strokes, is to undertake inquiry that examines particular situations, interactions, organisations or events through the process of the researcher entering into the inquiry space (Malterud, 2001). In doing so the researcher is striving to achieve a *holistic* rather than *reductionist* understanding. As we will discuss in this chapter, these broad objectives are clearly in contrast to those that motivate the quantitative researcher, where arguably the primary concern is usually more with the explanation of causal relationships and patterns in terms of law like behaviour (see *Prolegomena* for comparison of these approaches).

11.3 Parameters of naturalistic inquiry

The entire process of data elicitation, interrogation and analysis in this work is underwritten by the principles of *naturalistic inquiry*. A naturalistic research paradigm has been selected as being the most consistent with the metatheoretical position previously articulated in this work. As noted in the initial chapters, a commitment to metaphysical naturalism[317] means an alignment between our theorising of the mind and processes in the

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316 As noted earlier Warren's (1998b) description of the differences between constructivism and constructionism is helpful here. "While matters are more complex than this might convey, it is helpful to use constructivism for views that see our understanding of our understanding of the world significantly constructed by the individual; and constructionism for those positions which understand our understanding more in terms of social factors, even if that understanding of our understanding is not itself understood in similar way" (p. 61).

317 Rouse (2007) identifies two forms of naturalism, "For many philosophers, naturalism is a commitment to understand mind, knowledge or morality as part of scientifically-comprehended nature. I call this approach "metaphysical naturalism". A different conception of naturalism is widespread in

world. Moreover this stance contains a disavowal of mysticism, idealism and anti-realist attitudes. This commitment to empirical credibility and consistency demands of us that the previous theoretical discussion be connected, through empirical exemplars or *representative anecdotes*, to the lived experience of learners within the higher education setting. The goal of this connection is to offer a richer description and understanding of Doctoral cognition *in the wild* (Hatch & Gardner, 1993; Hutchins, 1995; Perkins, Shari, Ritchhart, Donis, & Andrade, 2000; Zsambok & Klein, 1997).

The doctrine of naturalistic inquiry sets out a particular orientation towards the practice of research (and a series of principles or axioms) that describes the range within which naturalistic research is most comfortably applied. Lincoln and Guba (1985) have been chiefly responsible for articulating and defining the notion of naturalistic inquiry which in turn extends the seminal notion of 'grounded theory' first developed by Glaser and Strauss (1967). Naturalistic inquiry sits within a family of approaches that offer an elaboration of how to establish and maintain credible links between qualitative data and theorising (Crotty, 1998; Seale, 1999). Grounded and naturalistic research methods seek to ensure that sufficient empirical fidelity is maintained during the development of conceptualisations and explanations.

Lincoln and Guba, articulate what they see as the primary divergences between naturalistic approaches and what they term the "positivist paradigm" in the following way (see Table 4. Comparison of Positivism and Naturalism by Lincoln and Guba).

Table 4. Comparison of Positivism and Naturalism by Lincoln and Guba

Axioms about:	Positivist paradigm	Naturalist paradigm
The nature of reality	Reality is single, tangible, and fragmentable	Realities are multiple, constructed, and holistic
The relationship of the knower and the known	Knower and known are independent – a dualism	Knower and known are interactive, inseparable
The possibility of generalisation	Time and context independent generalisations (nomothetic statements) are possible	Only time and context bound working hypotheses (idiographic statements) are possible
The possibility of causal linkages	There are real causes, temporally precedent to or simultaneous with their effects	All entities are in a state of mutual simultaneous shaping, so that it is impossible to distinguish cases from effects
The role of values	Inquiry is value-free	Inquiry is value bound

philosophy of science, however. Here, naturalism concerns how to do philosophy rather than how to understand mind, knowledge or morality within nature. I call this second conception "scientific naturalism". Scientific naturalism demands that philosophy answer to *science* rather than nature." (p. 66).

Lincoln and Guba apply these four axioms in the development of their 14 operational characteristics for naturalistic inquiry. These characteristics flesh out the importance of research being conducted in a natural setting; that the data gathering instrumentation is *human centric*; that qualitative methods and purposive sampling are key; and that the research design is *emergent*. Given these circumstances, analysis is inductive, with an emphasis on *case study* and *idiographic interpretation*.

Of course, none of these characteristics are unique or exclusive to the naturalist paradigm. It is critical to remember that experimental research also possesses a great deal of interpretative and technical flexibility. The key differences are found, not in the flexibility or context sensitivity of the methods, but in the underlying distinctions about the nature of reality, knowledge, generalisability and causation (J. K. Smith & Heshusius, 2004). Concordantly, it is in the domains of application and interpretation we find the obvious differences between *laboratory* based approaches and those conducted *in situ/in vivo*.

Patton (1992) explains it is naturalistic inquiry's concern with the contextual and dynamic nature of phenomena that creates the major differences between it and experimentation. In Patton's view experimentation is "where the investigator attempts to completely control the condition of the study" (p. 42); whereas in naturalistic inquiry neither the phenomena of interest nor the conditions in which it is observed are able to be subjected to tight control. It is this orientation that sets naturalistic inquiry apart from, although not necessarily in conflict with, experimental research paradigms. We need to better understand these differences. To do this we shall look at how qualitative research methods use the *particular* to illuminate our *general* experiences.

11.4 The search for representativeness within the particular

The purpose of this work, as a whole, is to engage with Doctoral cognition. As described in the introduction, in this work the weight of analysis sits primarily in the theoretical domain, but there is a need, and a role, for an empirical component to aid our understanding. In this context the empirical section of this work (Part C) supplies us with an illustration of Doctoral cognition with which to assist in refining our theoretical elaborations.

Francis Bacon's *Novum Organum* draws our attention to the usefulness of what Bacon termed "striking" or "shining" instances of the phenomena of interest. A *shining instance* displays a general or essential character of (natural) processes. For instance, Bacon suggests quicksilver is an example of the nature of weight because it demonstrates, counter intuitively, that weight depends on the 'quantity of matter' and is not necessarily a property of 'compactness of the frame'. While Bacon advises that we "must use caution, and check the hurry of the understanding" (section XXIV) when looking to employ shining instances, he also notes that such instances offer us an unimpeded display of the processes or form under investigation[318].

Bacon's thinking offers us a doctrine for considering how particular instances may be able to be excavated for the more general principles they contain. With ubiquitous phenomena such as learning, thinking, remembering, or reasoning the use of representative or striking examples gives us a way to engage with psychological processes that would otherwise be intractably obscured or dispersed. There is a kinship between the general importance of *shining examples* and the notion of '*representative anecdotes*'.

Burke (1945) first coined the idea of *representative anecdotes* to describe the ways in which meaning was constructed and transmitted in dramatic practice. In particular, Burke (1945, 1950, 1966) was concerned with how reality came to be represented, in the dramatic or synthetic context, by the deliberate selection of particular images, tropes or forms. Burke disavowed a transcendental account of reality. Instead he was committed to understanding how images or tropes were used to create a vocabulary that spoke to an audience (by using terms that reflected their experiences of the world).

For Burke, dramatic practice relied upon the deliberate selection and use of a vocabulary that would draw the audience into the dramatic experience and assist in creating a sense of meaning in the action (Burke, 1945, 1950, 1966). Essentially the dramatic form has to, in Burke's view, represent 'reality' in some way – there must be some underlying resemblance with a class of things in the world. In describing this concept Burke began with the following commentary, "Men seek for vocabularies that will be faithful reflections of reality. To this end, they must develop vocabularies that are selections of reality." (Burke, 1945, p. 50)

What Burke offers our analysis is a methodological, and philosophical interrogation, of how we can credibly explore reality through selective anecdotes. Essentially, Burke wanted to

[318] Harre (2006) illustrates the application of the power notion of 'shining examples' by making reference to Darwin who was able to expose the underlying processes of organic evolution through the detailed examination of finches of the Galapagos.

be able to capture the way in which we seek out, or select, particular forms as a means of expressing broader or deeper themes and experiences. In this vein, Burke claims that his notion of a representative anecdote has a clear affinity with Spinoza's *adequate idea*.

In Spinoza's (1876) writing an *adequate idea* was representative of the 'eternal' and can be understood clearly and distinctly as a *common thing*. For example in Spinoza's metaphysics the attributes of extension, the infinite, motion or rest are understood as common things. As such, we could say that the measure of the representativeness or information transferred by any particular Burkean anecdote is its degree of Spinozian 'adequacy'. In other words, for a representative anecdote to be adequate, it has to encompass a distinct and 'common' idea for the audience.

Crucially for Burke, representative anecdotes were a means for initiating conversations about the nature of things. They are best understood as jumping off points for developing our understanding of the world. As Burke explains:

> The informative anecdote, we could say, contains *in nuce* the terminological structure that is evolved in conformity with it. Such a terminology is a "conclusion" that follows from the selection of a given anecdote. Thus the anecdote is in a sense a summation, containing implicitly what the system that is developed from it contains explicitly (Burke, 1945, p. 60).

Pursuing Burke's general line of thinking, the Doctoral interview data collected for this work will be prospected for units or structures of meaning that reveal something deeper or 'common' about the processes of Doctoral cognition as a whole. These components will then be used to further refine the theoretical constructs developed herein. Given this is our goal the question is: 'what methodological approach will allow us to achieve this end'?

11.5 Phenomenographic approach

Phenomenography has been selected as a framework well suited for identifying, integrating and reporting on the thematic aspects of the interviews that will be used here to explore Doctoral cognition. Phenomenography is a method "for investigating the qualitatively different ways in which people experience, conceptualise, perceive and understand various aspects of, and phenomena in, the world around them" (Marton, 1986, p. 31).

There are two broad assumptions that underlie this method or approach: 1) That the world exists; and 2) That different people construe it in different ways (Bowden, 2005; Marton & Booth, 1997). Phenomenography has as its principal research product notions of understanding. Unlike positivistic approaches, it does not look for causality or universal laws that direct behaviour; instead phenomenographers looks to understand behaviour by examining the meaning people make of the world. As Reed (2006) explains "meaning comes about through our interaction with realities in our world and is constructed, not discovered" (p. 1).

Phenomenographic principles have informed a substantial proportion of the early research undertaken into learning in higher education (Bowden, 2005; Bowden & Walsh, 2000; Marton et al., 1984). Research into the process and experience of learning in Universities has involved a distinctive blend of quantitative and qualitative methodological and theoretic commitments (Reed, 2006). Within the American higher education context the pragmatist and empiricist traditions have largely held sway, with considerable effort going into the *psychological* character of adult learning. In the European context an explicit link between the experiences of learning and pedagogical intervention has been a more standard mode of interpretation (Reed, 2006). Marton, Housell and Entwistle (1984) explain:

> Our task is thus to describe more clearly how learning takes place in higher education and to point out how teaching and assessment affect the quality of learning. From these descriptions teachers should be able to draw their own lessons about how to facilitate their students 'learning' (p. 1).

A concern with the regulation of learning and in particular the role of metacognition, motivation, conceptual change and epistemology has emerged from this style of research. The 'high road' to these processes has been characterised as primarily being qualitatively orientated analyses of learning but in practice quantitative and qualitative analyses have tended to inform each other (Baxter Magolda, 1992; Bransford et al., 2002; Brownlee, Boulton-Lewis, & Purdie, 2002; Entwistle & Ramsden, 1983; Kember, 2001; Kitchner, 1983; Kitchner & Fischer, 1990; Kitchner & King, 1981; Klahr, 2000; Laurillard, 1999; Marton & Booth, 1997; Marton et al., 1984; Prosser & Trigwell, 1999; Schommer, 1990).

The contribution of phenomenography to this exchange has been as an effective means of eliciting data about the experience and character of learning in higher education contexts (Sin, 2010). Phenomenography takes as its research object the character of knowledge. Data collection techniques typically involve close interviews with a small, purposive sample with the researcher "working toward an articulation of the interviewee's reflections on experience that is as complete as possible" (Marton & Booth, 1997, p. 130). To better understand the character of phenomenography (i.e., a research approach or method), let us contrast it with phenomenology (i.e., a philosophical approach or method).

Phenomenography does share some links with phenomenology – through a common connection to the Gestalt tradition (Ujens, 1996) but there are important and distinctive features that differentiate the two.

The term 'phenomenography' was coined combining the Greek '*phainomenon*' meaning appearance and '*graphein*' meaning description (Pang, 2003) - therefore phenomenography can be characterised as a *description of appearances*. The key methodological assumption here is that descriptions of how people experience the world around them can justifiably be taken as data for empirical analysis (Reed, 2006).

> From a non-dualistic ontological perspective, there are not two worlds: a real, objective world, on the one hand, and a subjective world of mental representation on the other. There is only one world, a really existing world, which is experienced and understood in different ways by human begins. It is simultaneously objective and subjective. An experience is a relationship between the object and the subject, encompassing both (Marton, 2000, p. 105).

In practice this sort of analysis has long been conducted by anthropologists, ethnographers, developmental psychologists, and sociologists (Saljo, 1996). When people attempt to explain an aspect of the world that they have experienced – they are describing *their* experience of the world (what Marton calls 'first order'). This description can in turn be read by someone else, who does not have first hand knowledge of the individual's experience (what Marton calls 'second order'). In simple terms, the researcher looks at these *second order descriptions* for the most significant characteristics that clarify how people describe their experience of a phenomenon (Ashworth & Lucas, 1998).

The phenomenographical process involves trying to uncover all the possible experiences a group of people have of a certain phenomena (such as the phenomena of the Doctorate experience) and to sort these experiences into conceptual groupings or categories. This is an important methodological point - phenomenography cannot be used to objectively describe the Doctoral experience as it actually is in reality, it can only be used to describe how candidates experience this situation (i.e., how the Doctoral experience and cognition appears to the students) and to categorise these. Nonetheless this type of data is an important step in building up our picture of Doctoral cognition and will provide invaluable insight into how we might best tackle illustrating Doctorateness and Doctoral thinking.

Phenomenographic data analysis typically sorts experiences and perceptions, which emerge from the data collection techniques, into specific 'categories of description'

(Akerlind, 2005; Marton, 1981, 1986; J. T. E. Richardson, 1999; Ujens, 1996). The set of categories of description and the structure linking them, the primary outcome of the research, is sometimes referred to as an 'outcome space' (Marton, 1992). These categories (and the emerging underlying structure) become the *phenomenographic core* of the phenomenon of interest (Uljens, 1996).

Individual experience is thus characterised by two connected components – structural and referential. The structural components are constituted by elements of an individual's experience and the relationship the individual forms between them. The referential component is the overall significance attributed to the structural components or systems (Marton & Booth, 1997). As Reed (2006) explains "it is not enough simply to determine a set of qualitatively different categories to have a phenomenographic result. In fact, it is not so much the categories *per se* that are important, but rather the differences and similarities that serve to link and differentiate one category from one another, i.e. the structure and meaning related to the categories" (p. 3).

The process of phenomenographic analysis is designed to be strongly iterative and comparative (Bowden & Walsh, 2000). It involves the persistent sorting and re-sorting of data and ongoing comparisons between data and the developing categories of description, as well as between the categories themselves (Akerlind, 2005; Bowden & Walsh, 2000; Marton, 1981, 1986; Ujens, 1996). The aim of the analysis is to reveal aspects of the world as people *describe* their experience of the world.

By contrast, phenomenology focuses on 'the essence' of an experience, or what remains constant or is common to different forms of experience (Giorgi, 1999). Methodologically, phenomenology seeks to capture the richness of individual experience, and the abundance of all the ways in which an individual might describe an experience. This is in contrast to the (relative) thinness of the categories of description and the relational structure that are outcomes from a phenomenographical analysis. Concordantly, phenomenography is less interested in the discrete individual experience and more interested in emphasising *collective* meaning (Barnard & Gerber, 1999; Saljo, 1996). A phenomenologist might ask: 'What is the *essence* of Doctoral cognition?' whereas a phenomenographer would instead ask: 'What are the *critical aspects* of Doctoral cognition, and what is the relationship between these critical aspects?'

11.6 Criticisms and limitations of Phenomenography

Phenomenography sits within the qualitative domain and as such it is open to the general constraints germane to qualitative research methods (Malterud, 2001; Reed, 2006; Sin, 2010). In particular, since phenomenographic research is traditionally based on individuals' descriptions of their experiences and interpretations of their perceptions, it is open to criticism that it may be unreliable, invalid and not generalizable (Bowden, 1996; Kvale, 1996; Saljo, 1997; Sandberg, 1997). Considerable effort has been made by researchers to address these limitations; but there still remains, at the core of qualitative process, an interpretative nuance in qualitative research that is distinct from the probabilistic and rule like nature of most quantitative techniques (Creswell & Miller, 2000; Larsson, 2009; Morse, 2006; Morse, Barrett, Mayan, Olson, & Spiers, 2002; l. Spencer, Ritchie, Lewis, & Dillon, 2003).

For the sake of this discussion we shall divide these into theoretical and methodological. Theoretical criticism address questions to the fundamental assumptions or propositions behind phenomenography. Methodological criticism are concerned with questions of research integrity and procedure. We shall begin with the methodological constraints.

By way of a general introduction to the methodological concerns surrounding phenomenography, Kvale's (1996) summary of ten standard criticisms of interview research is a good starting point. Much of the methodological criticism of phenomenography is in practice part of the broader critique of qualitative research in general and interview based research in particular. Kvale draws our attention to the fact that qualitative research is typically framed in terms of what it *lacks*, as opposed to determining the merits and strengths of its methods. Kvale (1996) frames the qualitative interview as a valuable process for obtaining a description of the "life world of the subject with respect to interpretation of their meaning" (p. 124)

Table 5. Kvale's (1996) Ten Standard Reactions to Qualitative Interviews

The qualitative research interview **is not**:

1. scientific, but only reflects common sense
2. objective, but subjective
3. trustworthy, but biased
4. reliable, it rests upon leading questions

5. intersubjective, different readers find different meanings
6. a scientific method, it is too person dependent
7. scientific hypothesis testing, only explorative
8. quantitative, not qualitative
9. generalizable, there are too few subjects
10. valid, it relies on subjective impressions (p. 284)

We can see in Kvale's list the methodological challenges that need to be addressed, as well as the complications of seeking to replicate the quantitative research criteria in the qualitative domain. Obviously the key requirement to responding to both of these is ensuring that evidence is collected to support phenomenographic research findings; but as Giorgi (1988) also tells us in the case of qualitative research the "manner of achieving the evidence is different because of different assumptions which, in turn, inspire different criteria" (p. 175).

Whatever the criteria we adopt they must be congruent with the epistemological and ontological assumptions that inform phenomenography, namely "that human knowledge is intentionally constituted through individuals' experience of their reality" (p. 208). To better understand how this position influences phenomenographical research let us look, at a general level, at the core criteria typically associated with research practice.

11.6.1 Objectivity

Phenomenography in particular and qualitative research in general are commonly questioned in regards to the degree of objectivity that is possible in research that relies so heavily on the researcher's interpretation of data; where the researcher is imbedded in the data collection process; and interaction between the researcher and subject is critical to the extracting of the data. Again the solution to these limitations has been the development of an alternate construct that shifts the attention from the question of objectivity to that of how the researcher should address their involvement in the process. Lincoln and Guba (1985) argue that a commitment to *reflexivity* is the most appropriate response.

In broad brush strokes *reflexivity* is a process of deliberately and systematically minimising the influence of the researcher on the research process. Reflexivity is "done by certifying that the findings and interpretations are based on raw data and by making transparent the methods and processes of the research (e.g., raw data, data reduction and analysis products, data reconstruction and synthesis products, process notes)" (Miyata & Kai, 2009, p. 71). As discussed earlier in this chapter the phenomenographic interview process should be designed to encourage participants to clarify their meanings and reflect on the questions they are being asked (Kvale, 1996).

11.6.2 Validity

Phenomenography relies heavily on interviews to provide accurate accounts about the self and/or the individual's experience of the world. The use of interview data has been the subject of much debate and critique (Kvale, 1996). Concerns such as the difference between language and meaning, the variety of interpretations that subjects can make of interview questions, and the difficulty of analyses form the themes of a large amount of the literature discussing the validity of interview techniques (Gillham, 2005; Kvale, 1996; Minichiello, Aroni, Timewell, & Alexander, 1995; Mishler, 1991; H. J. Rubin & Rubin, 1995). For example, Saljo (1997) has questioned what the degree of congruence between subjects responses (utterances) and their conceptions (the object of analysis) can be.

This challenge to the phenomenographic interview process and analysis, as Saljo notes, reflects a healthy level of critique that all maturing research methods should experience. Nonetheless his challenge goes to heart of the phenomenographic process – to question the degree to which different word choice validly reflects different meaning (in regards to the conceptual content). Anderberg's (2000) research offers us a useful attempt to address this constraint by using an intentionally expressive approach that iteratively engages the interview subject with the goal of clarifying and confirming the meanings used. Kvale (1996) sets out six criteria that make for a quality interview and that speak to the importance of clarification as part of the interview process:

I. The extent of spontaneous, rich, specific, and relevant answers from the interviewee.
II. The shorter the interviewer's questions and the longer the interviewee's answers, the better.
III. The degree to which the interviewer follows up and clarifies the meanings of the relevant aspects of the answers.
IV. The ideal interview is to a large extent interpreted throughout the interview.
V. The interviewer attempts to verify his or her interpretations of the subject's answers in the course of the interview.

VI. The interview is 'self-communicating' – it is a story contained in itself that hardly requires much extra descriptions and explanations (p. 145).

In summary, the key factor in responding to this constraint is the adoption an approach that ensures that the interview subject is encouraged to reflect on the meanings they intend when they are expressing their responses to the interview questions. While this strategy does not eliminate this constraint, it provides a reasonable mitigation of the issue of how best to ensure validity.

11.6.3 Generalisability

There is ongoing debate in the literature about the nature of generalisability in phenomenographic research. In relation to qualitative research the case has been put that generalisability is in fact an inappropriate criterion for evaluating qualitative research processes (Kvale, 1996; Larsson, 2009).

> Validity, reliability, and generalizability are widely used as criteria for the evaluation of quantitative analysis. However, many qualitative researchers, who do not assume an objective reality or a confirmatory perception, tend to question this holy trinity (Miyata & Kai, 2009, p. 66).

Transferability has been proposed instead, which examines the degree to which findings can be used in other contexts or situations, as a proxy for generalisability. This is a significant shift from generalisability which typically refers to the degree to which research "findings obtained from a specific sample are representative of the target population" (Sin, 2010, p. 309).

Mason (2002) has argued that a broader reading of generalisability, one that focuses on the wider applicability of research, is something that has value. On the other hand, Schwandt (1997) has proposed that meaning is inherently context-dependant and as such it fundamentally resists generalisability. Both these views have merit (Cronbach, 1975) and roles to play in disseminating phenomenographic research findings to wider audiences.

Miyata and Kai (2009) have observed that a strategy that focuses on *external validity* can be used to address the limits of the generalisability of qualitative findings. In their view external validity can be enhanced or extended by considering the type of information that should be provided to those looking to make use of the research. Miyata and Kai argue that with sufficient detail the transferability of research can be assessed and determined. An important observation that can be taken from this attitude is that if "the transferability of findings is the motivation of a study, it would be important that the research design considers the possible context and the extent in which the findings can be usefully applied at the outset of the study and also in determining the scope and adequacy of the selection of participants" (Sin, 2010, p. 309).

11.6.4 Reliability

Reliability is the final element in the standard triumvirate of research quality parameters. Broadly speaking reliability represents the extent to which the findings from a research study can be reproduced consistently. Again debate surrounds the degree to which this parameter can or should be applied to qualitative research methods. Those sceptical of the value of reliability in qualitative research have argued that context is central to qualitative research and by definition this limits the degree of replication that is practicably possible. The argument has also been put that qualitative data and analysis both involve emergent processes and as such this makes reproducing results problematic. Nonetheless as Morse (2006; Morse et al., 2002) has contended some form of checking is necessary, and perhaps even more so when the interpretive burden of the research is high.

Reflexivity is identified again as a core strategy for mediating the methodological limits of phenomenography. Morse's (2006; Morse et al., 2002) view is that we need to shift our attention from the research outcome to the research process to address concerns about reliability. There needs to be a deliberate and explicit practice on the part of the researcher to both examine and minimise the impact of their assumptions on the research analysis (Ashworth & Greasley, 2009; Ashworth & Lucas, 1998, 2000). Sandberg (1997, 2000) expounds the view that common verification procedures used in quantitative research, should be replaced with attention given to data fidelity and interpretive awareness. Sandberg (2000) explains "Reliability as interpretative awareness means acknowledging that the researchers cannot escape from their interpretations but must explicitly deal with them throughout the research process" (p. 14).

To review, phenomenographic research requires careful development and implementation of interviews, data collection, and analysis to ensure that evidence collected is in a rigorous and principle manner. Alongside this methodological critique is a theoretical critique which questions the degrees to which individuals are able to make available their psychological processes for collection and analysis. This issue has the core of a long-standing debate about consciousness, reflection, communication and mind. It is not

sufficient to simply dismiss this concern as a matter of philosophical perspective because we need to speak to the question of 'what we can know?'
In this work we have adopted the stance that individuals do intentionally make meaning and that this meaning shapes not only their internal processes, but also their interactions with others. Under these conditions we can look at *what people say and do* – how they construe their worlds - as credible and useful instantiations of their psychological processes. As noted in the introduction we hold a credulous view of this position and accept that this position can be subject to revision. For the sake of this analysis we will proceed with this as our ontologic and epistemic frame.

11.6.5 Course of action

Given some of the methodological (and functional constraints) that exist on obtaining rich on-line real time descriptions of Doctoral cognitive processes this analysis will adopt a thematic analysis approach (i.e., phenomenography) based upon the retrospective consideration of the research process. This approach is predicated on the view that traces of Doctoral thinking can be assayed within individuals' reflective accounts.

We take the view that the process of responding to open interview questions can provide a demonstration of Doctoral thinking itself (or at least thinking at a Doctoral level or Doctorateness). Such qualitative investigations are of course, as we have just discussed, beset by the challenge of representativeness and limits to generalisability (Creswell & Miller, 2000; Seale, 1999). We accept these limits and shall make sure that we are careful to work within them.

Given the limitations, and ambitions, of this work a case study design is proposed as the 'best fit' for this project. As Merriam (1998) describes, qualitative case study is a perfect design for understanding and interpreting educational phenomena. As she explains it,

> A case study design is employed to gain an in depth understanding of the situation and meaning for those involved. The interest is in the process rather than outcomes, in context rather than a specific variable, in discovering rather than confirmation. Insights gleaned from case studies can directly influence policy, practice, and future research (p. 11).

This project fits well with Merriam's principles because the primary objective of this work is to better *understand* how Doctoral candidates experience the cognitive task of undertaking research and their reflections on the transitions and changes that they experienced as they sought to 'solve' the *problem* of completing a Doctorate.

11.7 Methodological framework

The use of observation, protocol analysis (verbal/written), interviews, and laboratory tasks has typified a majority of the research into cognitive domains of scientific reasoning, problem solving, and personal epistemology (Bloom, 1976; Bloom & Broder, 1950; Bruner et al., 1956; Davidson & Sternberg, 2003; Dunbar, 2002; Ericsson & Simon, 1992; Hofer, 2002; Holyoak & Morrison, 2005; Nersessian, 2002; Perry, 1970). In particular problem solving and scientific thinking research has preferentially, and some would have argued to its detriment (Lave, 1988; Lave & Wegner, 1991; Suchman, 1987), made use of laboratory-based experiments to elicit the behavioural (doing) and cognitive (thinking) aspects of problem solving (Newell, 1980b; Newell & Simon, 1972; Simon, 1973, 1975).

Attempts to quantify the cognitive, epistemic, information, and knowledge, contribution to inquiry and problem solving have largely tended to involve scales around beliefs, attitudes and strategy preference. The underground argument of this metric based approach is that role of epistemology, knowledge, and reasoning can be access by assaying what people can *believe*. We propose that the domain of *how* people believe, and the ways in which this allows them to notice issues and select '*smart moves*' also needs to be considered (See Part A and B).

Dunbar (1995, 1999) has developed a methodological stance, *In vivo/In vitro,* that combines the use of observation in naturalistic settings and laboratory based experiments into a unified technique that goes some way to reconciling these different approaches. Dunbar's approach attempts to maximise the benefits of *in situ* observation, while also allowing for experimentation and investigation of cognitive processes. Unfortunately circumstances did not allow for this kind of intensive observational and experimental design.

Nonetheless the method discussed here will look at one way of examining meanings, beliefs, and actions (on the part of supervisors and students). We propose that by the reflective examination of key normative constructs that inform, on some level, the *behaviour of students and supervisors engaged in doctoral cognition* as well as their experience of solving problems that we will be able to deepen our understanding of the psychological (including social psychological) processes involve in the Doctorate.

11.7.1 Selecting a domain

To look at *productive thinking* (and associated construct systems – *meanings, beliefs, actions, predictions, etc.*) at a tertiary level required an activity that explicitly, and publicly, involved the deployment of knowledge frameworks. Any situation where individuals were presented with a significant and sustained problem, that was both ill defined and open, could serve to create the required context. As discussed in Chapter One, Doctoral education provides us with such a context where students are required to *solve* the problem of their study. This process requires a student to anticipate and plan a solution that meets a set of dynamic criteria and constraints[319]. In essence, Doctoral cognition is the *intelligent* and *intentional* process of testing and refining choices, actions and predictions.

11.7.2 Selecting a method

One of the major factors in selecting interviews for use in this case study was the practical challenge of data elicitation from a dynamic, unbounded and ongoing cognitive and social process. Given the difficulties of observing *research in practice* and *protocol* or *think aloud* analysis of extended problem solving (Dunbar, 2002; Lave, 1988), interviews offered the next most viable alternative to these methods, for capturing a "snapshot" of learning events. Laurillard (1984) contends that "the power of this type of research is that allows us to investigate a process that is essentially internal by obtaining students' descriptions of their experiences of learning" (p.137).

Additionally, the open-ended format of the question (one of the most commonly employed approaches in personal epistemology research) provided a means of generating reflective (time), contextual (situated) and interpretative detail (construction) across a range of issues. Duell and Schommer-Aikins (2001) identified that there are an array of instruments that have come to typify contemporary epistemology research. These include: production-type tasks, open-ended interviews, vignettes, observations, ill-structured problems, and Likert-type questionnaires.

Here we have selected the phenomenographic interview technique as our preferred approach – firstly, because it is consistent with the theoretical orientation of this thesis; secondly, it is an established approach used within the higher education research genre; thirdly, it allows for both retrospective and prospective elements; and finally it meets the requirement of aiding understanding.

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319 The additional value of focusing on the PhD is that the supervision process provides a potential externalisation of the regulation mechanisms involved.

11.7.3 Selecting subjects

This study targeted final year Doctoral students, in the Arts/Humanities discipline, and their supervisor/s. The primary requirement for inclusion in the study was the reasonable expectation of completion/submission of a Doctoral thesis within 12 months of being initially interviewed. Student participants could be enrolled either on a full or part time basis. As this project was also concerned with the ways the supervisory process contributes to cognitive frameworks, there was a complementary recruitment of supervisors. The study aimed for a maximum of 10 and a minimum of 5 student-supervisor pairings.

The requirement of voluntary participation, and the need for student-supervisor pairing, meant that it was important to adopt a very flexible framework for organising student/supervisor ratios. Supervisors were able to participate in this study, if they chose, with more than one student and a maximum of three. The adoption of this flexible organisational structure allowed for the possibility of comparisons between the "supervisory experiences" of different students with the same supervisor. This decision provided for the opportunity of another dimension to the interaction between student and supervisor background, goals and expectations and their relationships to epistemological understanding and change. As a result purposive sampling was to be used to maximise information but this will of course limit the degree of generalisability.

The overall target population was selected for three instrumental reasons:

1) The large number of potential candidates;
2) The accessibility of discipline areas to the researcher (by selecting a broad field of study familiar to the researcher, this reduced the possibility of *disciplinary misunderstanding*); and
3) Doctoral students in final year of their study are engaged in the process of clarifying and reporting on their projects.

The final sample contained a broad range of experience in terms of supervisors (with professorial to lecturer positions; experienced supervisors to those commencing their supervisory careers; male and female) and students (part time, full time, continuing and returning students).

11.7.4 Sample

The sample for the analysis reported in this work was 6 pairs of Doctoral students in their final 12 months of study (i.e., intending to submit) and their primary supervisors. There were four male students and two female. For the supervisors there were five male and one female. Two of the students had progressed from undergraduate study directly into a Doctoral program. The remaining four students had returned to enrol in a Doctoral program after a period of employment and/or further study. All of the supervisors had experience as researchers. Supervisors had a minimum of 5 years' experience supervising Doctoral students. One supervisor held the position of Professor; two were Associate Professors; and the remaining four were Senior Lecturers.

11.7.4 Procedure and design

Student involvement in interviews required the completion of a one extended semi-structured open-ended interview (approximately 1 to 1½ hours in duration). Supervisor involvement in interviews required the participation in one semi-structured open-ended interview (approximately 1 to 1½ hours in duration) to discuss their perspective on changes and development in student thinking during the doctoral supervision process.

The interview questions for both students (see Appendix I) and supervisors (see Appendix II) were constructed to mirror each other. The interview format contained three levels: 1) background experiences and attitudes to study, discipline knowledge and supervision; 2) reflective investigations of self perceived change (in terms of either advancement or difficulty) in thinking and learning about projects; 3) a discussion of open statements to engage participants in a *productive thinking* environment.

Although the supervisors' interview dealt predominantly with the student's project, it also gathered information about: the supervisors perceptions of their role; their style of supervision; how they defined good research; and the differences they saw between their and the student's goals, as it related to the Doctoral process. The basic aim of this approach was to cover an expansive range of issues – supervision, scaffolding, conceptual change, problem solving, and attitudes to research - to see what elements of cognition, epistemology, and problem solving might surface. It was explicitly descriptive and exploratory in its intent. By using dyads it was possible to look at these issues both internally and externally. Each member of the dyad reported their perceptions of the process, the project, the involvement of the other member and the differences and similarities in their understanding of issues.

To direct the discussion towards moments of change, a critical incident protocol (Flanagam, 1954; Stromberg, Brostrom, Dahlstrom, Fridlund, & Halmstad, 1999) was adapted for this study. This protocol allowed the dyads to self-select moments where they could "see" something critical or significant happening in the Doctoral process. The use of separate interviews also permitted the supervisor and students to select different moments. Two critical incident sections (Flanagan, 1954; Stromberg et al, 1999) were included in the interview. The critical incident approach "provides concrete descriptions of incidents of importance to the activity under investigation. A critical incident is a major event of great importance to the person involved" (Stromberg et al., 1999, p. 335).

In summary, the interview process addressing six broad research questions is recommended: (a) What did Doctoral candidates (near completion of their study) and their supervisors understand to be the most important characteristics of good research? (b) What did they both see to be the purpose of Doctoral education to be; (c) What did they perceive to be the key differences between undergraduate and postgraduate research work? (d) What were the cognitive challenges the candidates faced during their study and how had they responded to these challenges? (e) What did candidates perceive they had needed to learn to successfully complete their project? (f) What changes did the candidate perceive in their thinking as a result of the Doctorate?

11.7.5 Limitations and issues

We have already discussed above that the qualitative nature of the proposed analysis presents methodological issues in regards to the data collection and analysis. As these have already been examined from a conceptual standpoint, here we shall devote our comments to the more practical and technical issues as they relate to the actual research design. The primary limitation is the small purposive sample constrains the generalisability of the data and analysis discussed here. But as the purpose of this empirical component is to enhance the previous theoretical discussion and to amplify and concretise the theoretical connections that we have made, this limitation is not necessarily fatal to the analysis represented by this thesis.

A heuristic case study approach, combined with phenomenographic data collection and analysis, has been used to maximise the detail that can be extracted from a small sample. When combined with the larger theoretical discussion this has traded-off generalisability for, hopefully, bringing Doctoral cognition out into the open and into clearer view.

Other limitations relate to the domain of investigation, as the focus was with the humanities this has limited the degree to which difference and similarities with other discipline areas are revealed. Given the *exploratory* nature of this study this, in the context of the wider focus of the present work, can be addressed, in future and more targeted work, with the application of this procedure to other discipline areas for comparison.

To practically address the issues of the validity and reliability of the data collection and analysis employed several basic tactics (drawing on Kvale's (1996) concept of *communicative and pragmatic validity*): 1) the use of dialectical follow up questions during the interview process to help the researcher further understand the concepts being discussed; 2) asking students and supervisors to provide practical examples or instances of what they were discussing; 3) asking students and supervisors to be as specific and detailed as possible in their responses; 4) continuously checking if the responses being provided where grounded in the experiences of the student or supervisors; and, 5) treating all statements provided by students and supervisors as of equal importance (in regards to follow up or elaboration).

11.7.6 Data analysis

The aim of the subsequent analysis was to make explicit the basic meaning structures used by supervisors and students. Furthermore the analysis is intended to search for what variation there might be between students and supervisors and their construal of research practices and problem solving strategies. To do this, all the interviews were transcribed verbatim and entered into Nvivo for thematic analysis.

The transcripts where analysed using phenomenographic techniques. As an initial step all interviews were read through to establish an awareness of the particular issues, themes and differences that were emerging from the responses. Subsequently the interviews were examined several more times, during which sections of text were organised into topics or themes. Once the preliminary topic areas were established, these were then studied in more detail. Characteristic aspects of Doctoral research and cognition were recorded as features in each topic. These features were subsequently group into categories based on similarities and differences. Once the categories were established the most essential or fundamental features of each category was identified[320]. Each category was then further illustrated with quotations or key terms.

> The process of constituting categories of description in a phenomenographic analysis differs from a typical content analysis approach … where categories are determined in advance and interview extracts are classified based on these categories. A phenomenographic analysis is quite different. The difference is primarily because, in the analysis, the way in which an individual experiences a phenomenon is only part of the ways that phenomenon can be experienced and categories of description represent the variation in the different ways of experiencing the phenomenon (Reed, 2006, p. 8)[321].

To clarify further, Dahlgren and Fallsberg (1991) describes the overall process as involving the following stages:

1. **Familiarisation**: The interview transcripts were read closely to become familiar with the data.
2. **Condensation**: The most significant statements made by each participants were identified. These statements were selected as being representative of the participant's experience of phenomenon. These statements were examined in relation to statements from other interviews and in relation to the participant's interview as a whole.
3. **Comparison:** All significant statements were compared to identify variations and agreement.
4. **Grouping:** Statements that appeared to be similar were group together.
5. **Articulating:** An initial description of the essence of the similarity between the statements was made. These groups of statements, identified as being similar, were examined for the relationships between groups of statements, and structural elements were formed
6. **Labelling:** The various elements, structures, and associations were then denoted by appropriate descriptors.
7. **Comparison:** The obtained aspects were then compared in terms of similarities and differences.

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320 To do this Marton and Booth (1997) criteria were used: "i) each category tells us something distinct about a particular way of experiencing the phenomenon; ii) the categories have to stand in logical relationship with one another and iii) as few categories should be explicated as is feasible and reasonable, for capturing the critical variation in the data" (p. 125).

321 There is some debate in regards to how distinctively different the phenomenographic approach is. It has been argued that it is much closer to the processes of *grounded theory* than some of its advocates might explain (Reed, 2006).

This iterative and reflexive approach was undertaken in this study. In using this approach we are not looking so much for proof positive, but instead a consistency of our understanding with the expressed thoughts and ideas of those studying at a Doctoral level.

11.8 Concluding Comments

In this chapter we have examined how we would be able to see a credible indication, example of the possibility or an expression of the underlying cognitive processes that is consistent with the notion of an interactive and constructive view of Doctoral cognition. The criteria used to determine the appropriateness of research approach needed were three fold: firstly, an methodological stance that was consistent with the broader meta-philosophical approach and objectives that has shaped this thesis; secondly, an approach that would gather the appropriate type and amount of data required; and thirdly, an approach that was congruent with the extant research literature in the field.

The outcome of our discussion was the determination that a qualitative methodology, using an open ended interview format, for the purpose of provide a heuristic case study of Doctoral students and their supervisors would be most fit for purpose. We acknowledged that this approach brought with it some challenges in operationalizing the analysis and data collection, but these were traded off against the fit between the type of data needed to refine the methodological work done so far. Thus while the empirical component of this work is of a smaller scale than that of the theoretical, it nonetheless provides a vital piece of the puzzle. We will now move on to discuss the results of the data collection and analysis.

CHAPTER 12

LISTENING TO THE DATA

The purpose of this chapter is to sharpen the analytical tools, which have been developed in the previous chapters, and to amplify and concretise the theoretical connections that we have made. To conduct this 'sharpening' data will be drawn from in-depth interviews with paired research supervisors and Doctoral students (in the final stages of their candidature). These interviews aim to provide a *thicker* and more *nuanced* description (Geertz, 1973) of the type of interactions, and associated constructs, that occur as part of Doctoral education, and by association – Doctoral cognition.

This chapter will then be predominantly devoted to a discussion of the outcomes from the interview analysis and their implications for our understanding of productive thinking, intelligence and cognition. To do this we will examine how we can more *strongly couple* our ideas about cognition, mind and rationality to our description of the research process in general, and Doctoral cognition and inquiry in particular. As part of this examination we will also explore the proposition that supervision is best understood as a cognitive system (*a la* Pask). Moreover, that the adoption of a system stance offers us a way to extend the notion of problem solving (or productive thinking) as developed in this work, to encompass *shared* or *collaborative* research activity. This approach is also informed by Kelly's (1991b) *commonality*[322] and *sociality*[323] corollaries in personal construct psychology.

With regards to the analysis reported here, there are obvious potential limits on the validity of explanations based on small samples (as discussed in the previous chapter) but this does not preclude, *apropos* Ditherley and Lewin, a contribution to our understanding. This section offers a means of further refining, rather than completing, our conceptualisation of Doctoral cognition. The intent of the following discussion will therefore be to investigate the types of *exemplars* that can be read off from these interviews, rather than striving for developing laws. This chapter will instead rely heavily upon the notion of the *representative anecdote*.

[322] "Commonality Corollary: to the extent that one person employs a construction experience which is similar to that employed by another, his psychological processes are similar to those of the other person" (G. A. Kelly, 1991b, p. 63)

[323] "Sociality corollary: to the extent that one person construes the construction process of another, he may play a role in a social process involving the other person" (G. A. Kelly, 1991b, p. 66).

Our prediction is what will be revealed, through this discussion, is that within Doctoral education there are dynamic and interactive forces at play. What is more, that the thinking of the candidate and supervisor integrate to operate in a way that is consistent with our previous discussions about cognitive systems; and that there are also important normative constructs (such as what constitutes 'good research' or the 'purpose' of a thesis) regulating this system. These constructs are involved in *driving* the decisions[324] and the behaviours of both the supervisor and student (e.g., Bansel, 2011; Becher, 1989; Brew & Phillis, 1997; Bruce & Bahrick, 1992; Cantwell, Scevak, Bourke, & Reid, 2008; Halse, 2011; Jenkins, Blackman, Lindsay, & Paton-Saltzberg, 1998; Kiley, 2009a; Pearson & Brew, 2002). Importantly there appears also to be some sense of transformation or at least transition during Doctoral education – that amongst the doing of the research there is a fundamental and sustained act of learning occurring.

12.1 Sharing concepts, finding questions and doing research

There is a limited body of research that has sought to directly elicit students' constructs with regards to research (Becher, 1989; Brew & Phillis, 1997; Bruce & Bahrick, 1992; Jenkins et al., 1998; Kiley, 2009b; Meyer, Shanahan, & Laugksch, 2005; Neumann, 1993; Pearson & Brew, 2002; Startup, 1985). In general, scholars have been more concerned with either discrete elements within the research process or alternatively the mechanisms of learning and performance of particular tasks. This has created a gap in our understanding of what is occurring, at the level of the individual, during sustained research activity (Brew, 2001b). Psychological, sociological and anthropological work has revealed that science is not the rational process that it is often portrayed as, but is instead a very *human* endeavour (Bhaskar, 1998; Carruthers et al., 2002; Christensen & Hooker, 2000d; P. M. Churchland & Hooker, 1985; Collier, 1996; Dunbar, 1997, 2001; Elton, 2003; Feyerabend, 1978; Fong, 1996; Gaukroger, 2006; Gholson, Shadish, Neimeyer, & Houts, 1989; Giere, 1988; Gregory, 1981; Hooker, 1987, 2003; Hull, 1998; Jantsch, 1981; Klahr, 2000; Lakatos, 1970; Merton, 1957; E. Nagel, 1961; Nersessian, 2002; Newton-Smith, 1981; Searle, 1984; Whitehead, 1925). The difficulty here is that there has not been a substantial cross disciplinary discussion of how we can reconcile the scholarship about the mechanics of scientific thinking on the one hand, and the scholarship on science as a human enterprise, on the other. As a consequence there is not a neat or intuitive fit between the different perspectives (e.g., administrative, technical, operational, psychological, sociological, etc.) on the nature of the

[324] Apologies to Kelly who had serious concerns about the notion of *drives*, but this context we are using this term in its more non-technical and vernacular sense.

Doctorate, nor how it should operate as a general rule (Cantwell & Scevak, 2004; Denicolo & Park, 2010; Green & Powell, 2007; Lee, Brennan, & Green, 2009; Park, 2007; A. Taylor, 2007; UK Council for Graduate Education, 1997).

But it might be raised by a voice of dissent, surely these are questions for the philosophy of science – how do they pertain to Doctoral cognition? Well these questions are relevant, indispensably so, because there is a disconnect between what we know about the *lived experience* of research (and thinking in general) and how the Doctorate is characterised within the context of institutionalised education (not to mention by the students and supervisors themselves). Well then, perhaps the most reasonable response to this is to state that what the student does during the Doctorate is not the same as what is done during research. In fact, maybe the Doctorate is better understood as a rehearsal for this future experience? But is this how we currently frame or describe the Doctorate? What would be the critical differences between rehearsal and independent performance when it comes to research? Furthermore, when and how does the student learn these processes, if not during rehearsal, for fully-fledged research thinking and behaviour?

Given this context, the interviews commenced with an exploration of interviewees understanding or construal of the nature of research – with a particular emphasis of what might constitute *good research*. The intent was to examine what the similarities and differences might be between supervisors and students (Barnacle, 2005; Cantwell & Scevak, 2004; S. K. Gardner, 2008b; Jazvac-Martek, 2008; Kiley & Mullins, 2002, 2005; Lovitts, 2005; McAlpine & Norton, 2006; Orton, 1999; Petre & Rugg, 2004; Scevak, Cantwell, & Budd, 2010). Intriguingly of all the possible indicators, supervisors and students both identified the notions of answering a *needed question* and adhering to some form of *systemic principles of inquiry* as the clearest proxies for *good research*. Let us look deeper at this outcome from the data.

12.1.1 Research or Researcher

Doctoral students and supervisors were both asked to identify the key elements, in their view, of good research. The notion of good research was selected as a means of externalising the parameterisation and interpretation that researchers conducted when evaluating research quality (including their own). From the descriptions given, the identification of good research involved three dimensions. Firstly, there was the extent to which good research is an expression of specific technical features; Secondly, there was the impact of the research in terms of personal and social change; Thirdly, was the degree to which the research was 'do-able'.[325]

In terms of discrete indicators of research quality there was a clear separation between students and supervisors. Strikingly it was supervisors who provided the broadest indicators of good research. Supervisors, as a group tended, towards a principle based vision of research in which they identified key large-scale features of good research (while at the same time leaving open much of the particular nature of how these domains would be examined or conducted) (Kiley & Mullins, 2005). This could in part be explained by the fact that the students are the ones 'doing' the research and therefore directly invested in practical concerns. As such students are more likely to be immersed in the activity of evaluating research, whereas the supervisors are far more concerned with providing strategic vision or direction and as such leave the majority of the specifics or practical details for the students to resolve[326].

For supervisors, good research was framed in terms of an integrated modality of thinking and doing. As one supervisor observed, good research is the expression of a particular type of 'common sense' in response to a meaningful problem.

> Well a problem worth tackling, with clear research question; a methodology that is likely to be able to answer those questions and a clear plan about how to go about it. … research being a formalised form of applied common sense problem-solving. [S5][327]

In addition to the identification and resolution of a research question, there was for some supervisors a conative flavour that was important for distinguishing good research. Desire and persistence were seen to be significant factors for conducting good research (Kiley & Mullins, 2005).

> [They need to] believe in the topic enough to give them the motivation to work. So I think that this is more important than any single technique or strategy because a strategy or technique can be learned … what is really important is a determination and ability to pursue a research question. [S1]

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325 This finding is consistent with the categorisation developed in other studies into the nature of research (Brew, 2001a, 2001b; Brew & Phillis, 1997; Bruce & Bahrick, 1992; Bruner, 1999; B. Davis & Sumara, 2006; Kiley & Mullins, 2005; Long, 1994; Meyer et al., 2005; Pearson & Brew, 2002). For example Brew's (2001a) phenomenographic work on conceptions of research identified: "*Domino* (a process of synthesising separate elements so that problems are solved, questions answered or opened up); *Layer* (process of discovering, uncovering or creating underlying meanings); *Trading* (a kind of social market place where the exchange of products takes place); and *Journey* (a personal journey of discovery, possibly leading to transformation)" (p. 280).

326 However this limitation was mitigated, to a degree, by the fact that the interview required students and supervisors to discuss the notion of research in general, rather than just examining the specific Doctoral project in which they were both involved. In cases where the discussion became overtly focused on the Doctoral project itself prompts were used to bring the discussion into the domain of research in general.

327 Interview transcripts are identified by codes. The letter *C* identifies a response from a Doctoral candidate. The letter *S* identifies a supervisor. The numbers identified the pairing of responses C1 and S1 – this equates to Candidate1 [C1] and their Supervisor 1 [S1].

> Having a research question or a research problem that is important to at least some people … an attitude of mind of thoroughness or being willing to explore all the options. [S2]

As can be read in these three statements, the supervisors' principle-based outlook on research is capable of including both *dispositional* and *procedural* concerns in equal measure. Moreover, their characterisation of research often implicated, at some level, the notion that a 'good researcher' was needed for good research. This stance suggests that the process of producing 'good research' also involves some process of 'becoming' or 'being' a good researcher – that there is some transformative or developmental element to the acquisition of this capacity.

The nature of this transformative pathway appears to be shaped, to some degree, by the individual research style (quantitative or qualitative) of supervisors within different disciplines. For example, a high degree of overt personification – *research as researcher* – was a peculiar characteristic of supervisors working within the domain of qualitative research. For supervisors of qualitative Doctoral research projects, the quality of the research product or artefact was directly associated with the performance of the individual doing the research. Whereas for supervisors of more quantitatively orientated projects, there was an expressed tendency towards a process orientated view of good research that avoided any obvious dependency on personal attributes.

While all supervisors saw the importance of both good research technique and commitment to exploring a domain in depth as significant parts of what makes good research, there were different interpretations on what makes the *essence* of good research. The distinction here was between the idea that good research primarily relies on either: qualities like determination and investment in the topic (i.e., a meaningful question pursued with commitment); or alternatively on the capacity to skilfully execute an inquiry process (i.e., a clear plan and the application of higher order technical skill). This point of emphasis is crucial – for some supervisors good research is embodied in the metaphor of research as the individual pursuit of a powerful integrative idea while for other supervisors good research is best represented by the implementation of a powerful process of inquiry.

By contrast, Doctoral students adopted a criterion based research vision that saw research in terms of sequenced activity. When characterising their ideas about good research, Doctoral students explicitly pointed to methodological features. No sustained consideration was given to the contribution of the researcher to the production of good research. Instead, students were far more likely to express particular elements or features as crucial for determining the relative quality of a piece of research (Meyer et al., 2005). Clarity of ideas, methods, theory, and design were all proxies for the quality of the research product.

> It is about answering the question you ask … so asking a question, tight design to go about answering it, and then answering it. [C1]
>
> There are a lot of issues about quantitative issues there that are important to me, in terms of how they statistically define the question and answer them and so on and what populations and all the contextual issues; validity of the questions asked; the reliability of the way they go about answering them …. [C3]
>
> Not just [that] the outcomes were good but how they came up with the sample, how they came up with the data what statistical tools they use to analyse the data sample size. … [Considering question such as] Why are you asking this question? What use is it going to be if you get the answer? Can you implement the answer? [C6]

These descriptions were all congruent with the supervisor constructs about research. Accordingly, the differences between student and supervisor responses did not demonstrate incommensurate, or even privileged, views about research being possessed by either group. Instead what is revealed here is that when asked to engage with the issue of "what is good research?" two distinct patterns of response emerged.

In broad terms the supervisors were able to embrace a more flexible vision of research that relied on the possibility of greater interpretive depth and breadth. Students instead adopted an approach that was based primarily on reading off the quality of the research by its adherence to particular structural and methodological features. For the students these elements were instrumentally important for ensuring the quality of research and as such needed careful attention and assaying.

Cantwell, Scevak, Bourke and Holbrook (2012a; 2012b) applying Biggs and Collis' SOLO taxonomy (J. B. Biggs & Collis, 1982) to Doctoral learning, have proposed that there are different modalities of thinking involved in Doctoral research. What we may be seeing in the responses of the students in a *multistructural view* of research in which all the necessary components of good research are identified but they remain unintegrated (Cantwell & Holbrook, 2010; Cantwell & Scevak, 2004; Cantwell et al., 2010; Cantwell et al., 2008; Scevak et al., 2010). By contrast, in the supervisors' description we are exposed to a *relational view* that subsumes the particular elements to focus on the overall purpose or nature of research.

Research exists as a meaningful whole for the supervisors. There is coherence to the practice for research, which is more than understanding or applying a stepwise procedure. We will return to this issue when we examine the purpose of the PhD – which for supervisors deeply implicates the development of a particular modality of thought and disposition towards inquiry and the management of knowledge (Cantwell et al., 2011).

These differences in thinking about research raise some interesting instructional issues with regards to how the specific or discrete evaluation strategies of Doctoral students interact with the more extended conceptualisations used by supervisors (Cantwell & Holbrook, 2010; Scevak et al., 2010). The desire for specificity and certainty, implied in the discrete parameters identified by students, sits in direct contrast to the more structured uncertainty and openness of the supervisors approach. This tension may well provide the necessary catalytic conditions for the development of a more nuanced and fine-grained capacities needed to deal with the dynamic nature of research (Kiley, 2009a; Trafford & Lesham, 2009).

> … One occasionally finds that people who have peaked at honours are magnificent up to that point but are not very good at the less structured world of research. [S1]

The somewhat predictable distinction between novice-expert operationalisations of research quality becomes more complex when the dimension of impact is added in. In terms of research impact there was no clear division that could be drawn between the supervisors and students (as there had been with the first dimension). A commitment to research that made an impact or was transformative was distributed amongst both supervisors and students. Although supervisor-student dyads tended to be more closely affiliated in their requirements for the type of research that should be considered worthy of the epithet of 'good'.

> So research has to make a difference to advance what is going on in the field now. [S6]

> … also the applicability …. I do think research that has some applied value is useful … [C6]

The primary differentiator in the responses was between the need to enact change (achieved through transformation or advancement) and the need to encourage change through 'good' work (achieved through adherence to established academic standards). In this dimension good research was seen to be convertible into different epistemic currencies. For some of the supervisors and students the most profitable research leads to tangible improvements in practice and transformations in debates.

> It has to change things it has to be a novel idea that you explore. That is what research is to me. [S6]

> that there is the end product and that it is going to be useful for somebody else to read. [C1]

Whereas for others impact was the necessary consequence of a well executed project.

> My research questions are quite definite. I know at the end of the research I am going to present the answers, one, two, three, four to those questions. And I am going to be able to defend them. Or defend what I have said about what I have found. [S5]

The final dimension of good research was the degree to which the research is 'do-able'. From the supervisors' perspective good research was connected to more than a clear question and good technique, it also involves the selection of something that can *be researched* and completed. This stance moves beyond the idea of relevance (i.e., is this a meaningful question?) into the issue of whether the topic is one that can *be researched* (i.e., is it possible to conduct meaningful activity about this question in the time frame provided?).

> You want something this is eminently researchable rather than something that is just a farce. Something that you can draw some lines around so you can say this is in, that is out. … Basically make the thing coherent so what you are actually talking about makes sense to who you are talking to by and large. So that if the question is "well what will happen now?" "What does that mean?" or "How does that relate to that?" or something and they are not answerable then either answers have to be found or the questions have to be reworked or the study has to be reshaped so that that question is raised differently or taken care of or something. [S5]

Supervisors repeatedly identified the need to find a realisable (or realistic) project as central to the development of Doctoral research project and fundamental to their work as supervisors (This theme will be taken further and developed in our discussion of the purpose of the Doctorate).

When asked to reflect on which experiences or influences have shaped or formed their view of research, supervisors clearly marked the reading of other research (and in particular research that was seen as poor or inadequate) as having an influence on their understanding of good research (Halse, 2011; Halse & Malfroy, 2010).

> But I read so much junk. You know? I read research for a living by and large and course preparation and course delivery and things like that. … In a way

> all I am looking for in that is good writing, clear thinking. I don't really mind in a way what it is that they research it isn't really much the point. [S5]

Alternatively, Doctoral students saw the processes of conducting a literature review, supervision and prior study as the primary influences that had informed their views about good research.

> … I am doing literature searches, speaking to people like X who are far more knowledgeable and have far more experience than myself they direct you to good research and then you, through a process of comparing and contrasting, you understand, or I understand to me at the end of the day this thing is like the requirements for a good piece of research. [C5]

For supervisors their stance on good research was very much that of a consumer of research products who feels competent and confident to weigh the worth of particular pieces of work. For Doctoral students the distinction was much more of an emergent or developing sensibility towards research (Irvine, 2003; Meyer et al., 2005). Although students were able to express a critical attitude this was highly contingent upon a standardised format.

Doctoral student's can be seen as being in the process of acquiring a *maximum grip* (*pace* Merleau-Ponty and Dreyfus) on and recognition of the notion of research. In particular their focus on discrete indicators and commitment to an idea of impact or contribution provides an interesting tension between the act of doing research and the application of results or products. Those researchers who maintained a commitment to a discrete set of indicators for good research and the adherence to a procedure for ensuring the desired outcome had a stable view of research. For those who embraced a conceptual or principle driven stance on good research and desire for transformation, research was a far more ill defined and open practice. This is not to suggest that a conceptual and transformation view is the *better* way to be. Rather the key point is that there are particular affordances offered by either approach. For example, these two approaches tap into the discourses surrounding the idea of the Doctorate as *training* (in a particular technical process) or alternatively the idea that the Doctorate is about producing a *well rounded scholar*.

12.1.2 The purpose of the PhD

Supervisors and students were asked to explain what they saw to be the purpose of the Doctorate. This line of discussion was used as a means of further exposing the expectations at play in the thinking of the students and supervisors (Cantwell et al., 2012a; Cantwell et al., 2008; Irvine, 2003; Scevak et al., 2010). Obviously there are many intermediate goals that contribute to progressing a Doctoral candidacy – but what is the outcome that these elements are aiming for? This discussion begins to uncover the end state that lies behind the Doctorate.

While there is an explicit objective in terms of a *thesis*, both students and supervisors paid little attention to these expectations and instead focused upon the transformative nature of the Doctoral candidacy. This seems somewhat incongruous when compared to the notion of what constituted *good research*. There appears to be an 'air gap' between the purpose of research and the purpose of the Doctorate. Furthermore, the different perceptions with regards to the purpose of the Doctorate are instructive not only of the role of epistemic institutions in shaping our expectations as to what is a cognitive valid and reliable process for making claims about the world (research); but also how these claims become instantiated in a particular modes of *being*. It would seem there is more to being Doctoral than just 'doing research'. Importantly this modality is something that is transmitted via the artefact of the thesis (which is itself an expression of individual and collective cognitive actions).

> People get into PhDs for all kinds of reasons. Altruism and things like that. They want to … most people want to make a major contribution. Which is after all the essence of this sort of thing. Which is why it just can't be parochial it has got to be. Good punchy level stuff. But when people come in they have the dream. They don't realise, the plumbing nature, the essential pragmatic nature of this thing. A product of this thing you can actually pick up. You can feel the damn thing it has got to have the right weight. It has got to look right. It has got to be about as perfect as about anything you have ever done. It has got to be more perfect than you imagined you could ever do. When people pick it up they have got to open it and say "you clever bastard" when they look at it. [S5]

In this description we can see a combination of the transformative and normative elements identified in the previous comments about 'good research'. We can also observe that the 'researcher' is present in the Doctorate – that making a contribution is more than merely the sum of the methodological parts (although these have an important contribution to the process). Moreover there is recognition that there is a 'feel' or 'character' to the artefact produced that embodies both the actions and learning. The purpose of the Doctorate clearly appears to be around learning (Irvine, 2003). This is not merely a demonstration of established skills; but rather the graduated and scaffolded acquisition of particular dispositions, behaviours, capacities, and aptitudes.

12.1.3 Becoming Doctoral - Doctorateness

A consistent theme contained within the supervisors' descriptions of the purpose and nature of the Doctorate is that Doctoral education results in a change in the student (Bansel, 2011). The concern with particular processes and procedures are merely the means for achieving a more global goal of becoming a researcher. This 'becoming' is predicated on learning and deep structural change to how the student thinks and approaches 'the world'. Consider the following statements:

> I do think that its main value is to equip people with a certain level of analytical and problem solving and problem finding ability. And perhaps the last one is what distinguishes it off from a professional training degree. The person who comes out with a good Doctorate will be able to find himself or herself new problems, know how to go about getting the where with all to solve them. [S1]
>
> … it does it sets you up as being an inquirer as being somebody who is always looking to innovate to push boundaries, that's what it does I think. [S6]
>
> it is developing a frame of mind to think about things in a problem solving sort of manner; a formalised problem solving sort of manner, and to develop skills to actually solve those problems so that you're a competent researcher in that sense at least for some bits of research. [S3]
>
> … there is a physical process with this that has to be observed and that has to do with things like diplomacy, organisation, good work habits, good study habits all these kinds of things. The state of mind. You can be Albert Einstein but if you can't put it together you are not going to know. [S5]

Here we can see the ability to formulate problems, to innovate, to have a *frame of mind* and the development of the habits of a researcher all emerge as the purpose, or *raison d'être*, of the Doctorate. These are obviously cognitive and behavioural elements crucial for sophisticated and successful interactions with the world. Being Doctoral or Doctoralness involves an expressed capacity to think and act in Doctoral ways. Yet when supervisors were asked to identify what they saw as the purpose of the Doctorate for the students they focused more heavily on the credential.

> … it's a technical exercise that stamps your union ticket so that you can work in this sort of thing. [C5]
>
> Students think, I suppose, that it is career advancement. I think that they believe that to make a difference to stand out amongst the group you probably need an extra qualification. [C8]

In contrast to this view students did not directly discuss the role of a PhD in terms of career advancement. In fact some students identified the opposite that their Doctorate was driven by their interest in research. Students as a group were more aligned with the supervisors' view of the developmental purpose of the PhD.

> For me the goal as a PhD is learning how to do good research that is a goal. If you have, if you happen to produce something that really benefits the field then I think that is something that is a fantastic offshoot. But I think the main purpose of it is to learn how to do good research. … I said in the beginning to me a PhD isn't about what you produce at the end I think that it is totally irrelevant. If it happens to be something good and add something then it's terrific. I think it is about learning to research, about as you say learning to problem solve. And think clearly and be patient. [C5]

This stance does seem to give weight to the idea that then Doctorate is more about research training than a particular research topic. Yet the characteristics of what constitutes a good problem solver or researcher appear to be more than mere *technical mastery*. There is a sense of being able to '*think clearly*', be '*innovative*', '*push boundaries*'. So, given these types of objectives the interaction between the supervisor and student seem to be a significant component of achieving both the instrumental and transformative objectives.

12.1.4 Supervision as a cognitive system

So how is the transformative purpose of the Doctorate achieved? In organisational terms the Doctorate is distinguished by an extended period of supervision (although this is of course not unique to the Doctorate). The supervision processes, and the supervisor, are intended to provide more than mere subject matter expertise. They are actively involved in both the epistemic artefacts being produced and steering the Doctoral process.

The role of a 'steersman' can be clearly seen in the act of determining a topic. The identification, refinement and evaluation of a research topic provide us with an explicit example of supervision operating as a cognitive system. To adapt Pask's (1975b) observation about teaching – *supervision is the control of learning*. Where the supervisor informs and shapes the epistemic parameters of the study through their interactions with the student. This control is expressed in the interview responses though the notion of a 'doable' project.

> I like them to at least get to that point where we both know what the project is and I have agreed that it is something that they can do. [S3]

While much of the language often used by the supervisors pertained to methodological and administrative issues in the first instance, there was a deep normative and constructive character to these interactions. As one supervisor notes, it is about the transformation of ideas into a 'topic'. This work of finding a topic and shaping a project was central to the contribution of the supervisor to the research process. While the development of the topic is to a large degree collaborative, supervisors spoke in terms of approval, agreement or endorsement of topic and project.

> She was with an unresearchable idea for a year, year and a half or something. She had these ideas but they started off being grandiose and they finished being less grandiose. … But I think that in this particular process you get a good idea and you work it along and you think oh my god. And then all of a sudden you start refining, refining, refining. Wham! And away you go. That is the nature of this particular process. [S5]

For this supervisor the process was *iterative* and the idea that the student's research would involve some aspect of refinement was part of the standard narrative. The idea that research involved the construction of your topic, in collaboration with the supervisor, was clearly well understood, and to a degree was almost seen as a necessary step in the process.

> C1's original idea of what she was going to do has changed monumentally. … And looking back now those obstacles made her think about the reality of doing what she is trying to do. It made her I believe, a better researcher. The fact that she's had such a tough time. … And has come out I think a better … I think it is a better project. Amazing. Because it is not really what she thought she was going to do. We have changed track. … So she's a much more mature person and stronger because she's had to fight, she's had to change she's had to reframe what she's got and what she can do with it. [S1]

In this view the project emerges from the students' interaction with the supervisors. The topic is identified and then over time this topic is translated into a project that is 'do-able'. This situation was such that some supervisors were much more comfortable with a grand and unformed idea than the reverse.

> I am very opposed to what I called the little black book approach whereby the humble student comes in clutching his or her honours degree and says find me topic and the supervisor has a list of things so appallingly remote or trivial or tiny that no one has yet bothered to write about them and says "well why don't you do so and so"… I came into research with some very strong ideas about what I wanted to pursue and found it a very healthy process to go through in the first year, a process of dialog with a good supervisor who kept at me until I turned my ideas into a topic. Which is more or less what I do to my own students but I do want the student to come in with an idea. I think if a someone comes in and sits where you are sitting with their postgraduate prospectus in their hand and says "look I've got to do this typed statement to go with, and I have no idea what I am going to do". I do worry a bit. If they have got a big excessive grand idea of what they would like to do that is fine we can trim that down. But the other way does not work. [S1]

In this context the supervisor is operating like a 'governor' on the process, providing additional regulation to thinking about the project. In some terms they are modelling what it means to think like a researcher. This kind of expectation on the part of supervisors' runs in the opposite direction to that some students who have developed a very clear ideas as to what they are going to do and may be looking to the supervisor as primarily a technical resource.

> To me the supervisor, as much as I adore my supervisors they are like a book. They are a tool. They give you a bit of feedback like a journal article does on this might be the way to do it or it might not be. They just provide feedback when you need it. [C5]

But feedback and assistance can take many different forms. By far the most common input or intervention made by supervisors was into the thinking of their students about their projects. This influence is most apparent where students had very established ideas about their projects.

> You see I think like I always understood my project, that is the thing. That is why I think that I should have been finished by now because I think I had my whole project developed in my fourth year and I knew exactly what I wanted to do and I knew exactly how I wanted to do it. I had done my literature search and that was current and I knew that I knew a fair bit about the topic so all I really needed to do was collect my data and interpret it. So I have always like known what I have wanted to do. … I felt as though I started to lose my direction … So my experience would be different to a lot of people because I know a lot of people just enrol next year they don't really know what area they want to look at or they have a general idea but they don't have a specific question. Whereas I had all of that. I had my specific question, had my area, knew what I wanted to do, and I just sort of felt like I had my hands pinned behind my back and for me that is not a good thing. … we were forced to re think the direction of my project and personally I think it is heaps better now, than what it would have been if I had just run my project. Because like I am just developing, I have developed so many additional components to the actual paper. [C6]

> I came with a set of ideas about what I thought I wanted to look at and I didn't know much about the area of phonological processing which is key to this whole area I was researching and I wanted to look at predictive things. I wanted to look at what are the predictors, screening some ideas of helping kids before they got down the track of learning disabilities and so on. I had this very nicely packaged question and it was beautifully focused … then [Supervisor] threw some readings at me and had some discussions with her and some other students she had, working in areas and read some of the things that they had written. And I thought, oh this is a bigger area than I thought. This conception about what it might be had changed dramatically. … my whole concept about predictors changed because, predictors aren't just saying do this and later on this will happen. It was about when you look at the whole scheme in development if I look at a later point I can reflect back and see that this was actually predicted by this, you know? It was different, it turned it on its head for me. It changed my whole thinking about well what do I do with this study. [C3]

The transitions apparent in these statements are not simply the adding of more knowledge. Instead the students are coming to perceive their projects, and themselves, very differently. In both cases the intervention of the supervisor initiated significant changes not only to the research projects at a technical level, but it also contributed to changes in the students thinking about the nature of research in general.

The experience of disequilibration in the research process and the supervisors input into how students responded to these circumstances provides an important component in the development of *productive thinking* in the students. As part of this cognitive system the supervisor him or herself is able to extend the capacity of an individual student and share the epistemic load when it comes to generating actions and evaluation opportunities (Bansel, 2011; Halse, 2011; Halse & Malfroy, 2010; Irvine, 2003). In particular the supervisor is able to offer an interpretation of the affordances they see in relation to a particular situation.

> Mainly they don't realise that they are stuck. They are at the limit of what they know and they don't realise that there are other things they could use in this context if it is to be cutting edge research and so that I think is probably the limitation. So I think that's what it is they just don't know, just don't know. [S3]

This circumstance is a paradigm example of an ill-defined problem. The student is faced with a situation where their previous strategies and techniques are not sufficient to generate e solution. There is potentially a poor fit between their perception of the problem and what they need to do to progress their work. They have become stuck.

12.1.5 Getting stuck – disequilibration

Students had a very clear sense of when they were reaching the limits of what they understood about their project (Kiley, 2009a). As one student noted they felt they were "in a cloudy haze and can't see for anything" [C6]. Getting unstuck involved at a fundamental level coming to understand the nature of the problem and what possible options are available.

> I think that the whole process for me is about getting to the point that oh, I thought I knew where I was going and suddenly there is this wall. Hmmm what do I do about this? And then it has been quite a process some times to get round that, through it, under it, over it. Sometimes it has been through the supervisor directly sometimes it is talking with colleagues, sometimes it is hitting the books and trying to find is this issue a real issue or is this not. Defining the question in another way to. The multiplicity of ways of looking at it because, oh, may be I ask the wrong questions, you know how long is yellow? And it just didn't go any where. I was asking the wrong question

> and well that would just lead to that wall. Well may be I need to refocus my question may be I have defined the problem in a way that is inappropriate or may be this wall doesn't really exist I have just the way I am looking at it. I have had that constantly through the whole process. [C3]

As noted here this student experienced a recurrent sense of boundaries and transitions. Importantly there are multiple sources for responses to 'hitting the wall' this could include the supervisor, colleagues or the broader discipline base literature. These transitions are not without significant affective components – at times the realisation that the old way is not working required setting aside considerable work.

> When I realised on one proposal I put a lot of work in, months and months, and I realised that I would not be able to measure it really well so that there would not be loopholes in it. X and Y did not tell me that in the beginning. And that is not their role to. You have to come to these things yourself. And I was stuck then I realised I had to throw away months of work and that really hurt and I realised I had to start again on something new [C5].

Yet for all these difficulties and setbacks there was also a sense in which these experiences form the basis for becoming a better researcher for developing a more sophisticated approach to the technical and conceptual elements of the Doctorate.

> I have realised that I have had to go back and read and reread and make detailed notes and comparative notes between articles where as I have never had to do that before and really get to terms with some of the key concepts and how different writers approach those concepts in different ways. And try and see where they are different and where they are writing really in parallel, even though they are using different terminology. And now that I have started to do that on a much more consistent basis, I really do feel a lot better about the whole thing and I really feel as if I am being a researcher and starting to get some understanding about what I am doing [C8].

12.1.6 Seeing change

The transformation described by the supervisors as part of the Doctoral process was almost visceral in nature. To better understand how this change could express itself, supervisors were asked to provide examples of what they saw as an indicator that a student was undergoing a change in their thinking about their project. A common indicator of developing the ability to find problems, to innovate, to have the right *frame of mind* (i.e., development of the habits of a researcher) was in the way information flowed between the supervisor and the student.

> … "[student comments that] when I was doing this I thought about this". And it is not something I had thought about or put him up to think about he had actually seen this connection and I'd say oh that's interesting and he'd say should I be following that up? And then we discuss how germane it is to the main thrust it is to his work whether it is a side issue that we put aside

> until he's finished his PhD and he investigates or whether it's a minor that should appear in his appendix or whether it's a major thing that needs to be added. But he has come up with that himself and I got the feeling and have had for some months now that he is now thoroughly on top of his field and his project and what he is doing. And my role is now very much more relaxed, just sit back and read and talk about what he writes. He sort of do it, I don't have to do the hard thinking any more he is doing that. And that is the crunch point I guess. [S3]

Not only is this transition about knowledge in the field, it is also about who is taking the primary role in regulating the project. Once the student has moved beyond just responding to the parameters being given by the supervisors and is internalising and adapting these to suit their particular circumstances and beliefs about the project, then a shift is occurring in the centre of gravity for the cognitive domain. A common metaphor for this shift is the idea that the student 'sees' something that the supervisor has not seen.

> [An] indicator would be somebody who is starting to tell you things. Come back with ideas, initiatives that you haven't asked for. Somebody who is able to add something that you couldn't see. [S6]

Here the suggestion is that the growth in knowledge is not simply additive. The student is not merely accruing more 'facts', but instead is offering something *new* which is the result of their perspective on the project. In this case *new knowledge* is the result of a qualitative difference in the way in which the student is thinking about, and doing their, project. The 'freedom' offered by this situation can lead to a change in the type of regulatory role that the supervisor plays – with a shift from research mentor to that of *de facto* or *proxy* examiner.

> Instead of initially me saying everything and then us talking with them and looking to me for leads, they start telling me what it is they are planning on doing or have done or whatever. And I start agreeing or may be asking the odd difficult question. I sometimes say to them I am starting, you might notice, now to play the role of the examiner. It's now my job to make sure that this is going to be acceptable to other people. And so certainly the more we head down this track the more you take on that role. [S3]

The distinction is being drawn here between the kinds of things that a supervisor attends to when they are providing the momentum for the project (or at least ensuring that momentum is maintained) and the view that is taken as a de facto Examiner. With the student becoming more autonomous in their understanding and ability to respond to the project, the supervisor is able to start to bring in a new layer of constraints.

Fundamentally, once the student is able to *see* their project in the way others including potential critics or Examiners do, the supervisor is then free to refine this perspective by bringing in more fine-grained requirements for how the research will be evaluated. For the research student they have developed an initial level of knowledge about research practices and principles, from these a more abstract set of epistemic and strategic affordances can now be accessed by beginning to construct high levels of 'knowledge' about the research process. From here the student then seeks to understand their research not just from their perspective, but also from the perspective of an Examiner.

The student learns to produce and consume their research – through the act of producing and consuming research. This iterative and bootstrapping mode of interaction and construction means that the supervision allows for a sequence of scaffolding that allows for not only increased administrative independence of the candidate, but more importantly increased cognitive autonomy. As one supervisor explains it is about the student "becoming more discerning" [S8].

12.1.7 Developing an epistemic horizon

In examining what the differences may be between postgraduate and undergraduate *thinking* - the supervisors provided examples of how there can be a vast difference in the how students, at different levels of study, perceive the options and responses before them. In this circumstance the supervisor sought to advise a student with regards to their failure to include a relevant domain of research in their project development.

> I said to go and explore the novice – expert literature … she wrote back saying she hadn't been able to find that article yet. [S8]

This advice was intended to direct the student towards a broadening of their engagement with their research topic. For the student the understanding of literature was far more prosaic and concrete. The boundaries that we place on the forms, types and modes of knowing we bring to a specific issue create an epistemic horizon or window within which we conduct our inquiry. The frame is not only our interpretation of what has been done, but critically also *what can be done*.

> You have got to be really clear about what you think you are on about. And that is an ongoing process it never stops getting more and more clear about what you are on about. [C8]

Increased 'clarity' and the expansion of our repertoire of actions involves more than mere mastery of the 'content' or a method it involves the capacity to continuously construct and reconstruct our understanding of the world in response to our interaction with it. As we the student moves towards engagement with their topic they seek to expand the breadth and depth of what they know while trading off a doable project against a sense of 'contribution' and change. This is a process of increased sensitivity, selectiveness, discrimination and competency developed through the interaction with epistemic institutions and agents

> It is also how you sit and deal and think and process what it is that you are doing. I can think of no better word than process. And how you reflect on that and how you start to develop other ways of doing it. [S8]

Yet while is process may be open ended and recursive in nature, it is also developmental in orientation. The transformative role of 'doing research' or inquiry into the world is such that the learning can de controlled but its pathway is one of development.

> It is developmental - I have come to conclude. And that is you can't … you can only guide. You can only suggest and you can only say well what about if you think about this. You can only do so much and if they don't come along with you then you have to make do with what they have got. [S8]

Students do not simply pile knowledge higher and deeper – the Doctorate either attitudinally or function is not simply about the accumulation of more knowledge. It would seem that implied in the notion of contribution is additive to some degree. The Doctorate is not for the student simply about 'knowing more' in a blunt way. It is about knowing more in a deep and substantive way. In transforming their knowledge students are taken, as Perry (1988) describes it,

> over a watershed, a critical traverse in our Pilgrim's Progress . . . In crossing the ridge of the divide, . . . (students) see before (them) a perspective in which the relation of learner to knowledge is radically transformed. In this new context, Authority, formerly a source and dispenser of all knowing, is suddenly authority, ideally a resource, a mentor, a model, and potentially a colleague in consensual estimation of interpretations of reality . . . (Students) are no longer receptacles but the primary agents responsible for their own learning . . . As students speak from this new perspective they speak more reflectively. And yet the underlying theme continues: the learner's evolution of what it means to know (p. 156).

12.2 Construing Doctoral cognition

These findings, taken in conjunction with work already conducted with higher education learning research, suggest that intellectual development in higher education involves the gradual integration of previously separate personal characteristics and ways of thinking, leading to an expanded awareness of the complexities of academic knowledge (Entwistle & Walker, 2000).

> Learning in terms of changes in or widening of our ways of seeing the world can be understood in terms of discernment, simultaneity and variation. Thanks to the variation, we experience and discern critical aspects of the situations or phenomena we have to handle and, to the extent that these critical aspects are focused on simultaneously, a pattern emerges . . . Effective action springs from the way the situation is seen . . . (from focusing) on critical aspects of professional situations . . . The capability of

> discerning and focusing on critical aspects of situations and seeing the patterns characterising those situations is a far more holistic capability than those commonly defined in competency-based approaches. Moreover, such holistic capabilities represent the links between disciplinary knowledge and professional skills. They are the results of the transformation of the eyes through which the professional world is seen, brought about in, and by, the scholarly world (Bowden & Marton, 1998, pp. 8, 11-12).

The analysis of Doctoral students' and their supervisors' accounts of the Doctoral process has provided us with strong signals that the standard Doctoral narrative (Denicolo & Park, 2010; Lee et al., 2009; McAlpine & Amundsen, 2008; Park, 2007; Schon, 1995) is an impoverished one. At a minimum there are psychological processes that need to be more fully exposed to analysis so that we can better understand what is happening during the Doctorate and more importantly if this is what is *meant* to be happening. In essence, to what degree are Doctoral programs fostering the necessary cognitive dimensions or modalities needed for deep outcomes?[328]

The need to further illuminate the Doctoral process fits with the general trajectory of the theoretical conjectures that brought us to this analysis. For the Doctoral process to be most effective, based on the categories we have explored, and the emerging theoretical model we have sketched out in Part A and B, Doctoral education needs to: scaffold learning and development; it needs to address maladaptive or pathological regulatory regimes; it needs to allow for sufficient time for the disruption and consolidation of constructs and systems of constructs; it needs to focus on the interactive and constructive psychological processes; and most importantly it needs to consider the roles constructed for and by the student and supervisors (and the attendant systems of constructs that facilitate and maintain these roles).

These conjectures are also borne out by research work approaching this issue from the empirical sphere. For example, Cantwell and his colleagues (Cantwell & Holbrook, 2010; Cantwell & Scevak, 2004; Cantwell et al., 2010; Cantwell et al., 2012a; Cantwell et al., 2012b; Cantwell et al., 2008; Cantwell et al., 2011; Scevak et al., 2010) have identified as series of regulatory aptitudes that provide a compelling account of the differential performance of Doctoral students and their associated cognitive modalities. At this stage the kinds of regulatory control discussed by Cantwell appears to be consistent with both the theoretical expectancies and inferences that this work sets out and the phenomenon characterised by

[328] As Biggs (2003) cautions, deep outcomes that don't have an achieving goal can be equally as vacuous as a tick a box approach. There is a need to master not merely the production of an artefact for assessment but the cognitive process as well. The interview data presented here shows us that we need to dig much deeper.

the interview data. Again further research needs to be done to convert these possibilities in to confirmation but these resonances reinforce the value of a credulous and open attitude towards the Doctoral process.

Overall the data suggests that the bedrock assumptions involved in the Doctorate, even as a technical or mechanical process, do fit with our instinctive intuitions about higher education as a transformative or enabling experience. The notion is that the Doctorate delivers through some threshold processes both a qualification and conferring the quality of Doctoralness. Yet, and at the same time, these ideas are crowded out when we attend to the surface rather than deep features of the Doctoral process. Let us circle back to this conclusion for a moment.

What we see in these exemplars is the complexity, and the contingency, of the psychological processes at play in productive and intentional thinking. We also see how the roles of the *Student* and the *Academic* in the supervisory system, the way they are construed and how these constructs shape the anticipations and expectations, have a non-trivial impact on moulding Doctorateness. Moreover the act of channelling this transformative experience into the endeavour of research, and writing, involves the student (and the supervisor(s) but to a lesser intensity) getting a *grip* on their project.

'Getting a grip' is a regulatory process, one that requires the transmission of global and local norms. It is about understanding that the researcher (in this case the student) is invested, embodied and engaged in the research. This is not the *old saw* of objective/subjective states, but instead an understanding that the student's psychological processes are inherently implicated in the act of knowing. They cannot be separated out from the Doctorate without obscuring the fundamental mechanisms that constitute the purpose of the Doctorate in the first place. This is as much an ontological as epistemic effect. Indeed we could characterise the constructive alignment of agency, regulation, cognitive modality, disposition, and aptitude, as instrumental for creating the *Doctoral effect*; which is inturn the necessary, but perhaps not sufficient, condition for the transition to Doctoralness.

12.3 Concluding comments

This chapter has explored some of the dynamic and interactive forces at play in Doctoral education and learning – for both the student and the supervisors – exposed through phenomenographic methods. We have illuminated the possibility that the student and their supervisor interactions operate in a way that is consistent with our previous discussions about cognitive systems; and that there are also important normative and role constructs (such as what constitutes good research or the purpose of thesis or the role of supervisor and student) regulating this system. We have also seen that knowing involves a process of disequilibration, consolidation and reformation. That these processes implicate to different degrees the student and supervisors (depending on the way their role is construed at the time). Decisively a great deal of the regulatory norms appear to be transmitted through the sharing of constructs (i.e., *commonality*) and contingent roles (i.e., *sociality*).

It is also probable that commonality and sociality have latent or long term effects, if and when the Doctoral student makes the transition to supervisor. It is this interactive effect that is in the background to the discussion we have been having – what does Doctoral cognition and Doctorateness mean in terms of the supervisor (perhaps this is a kind of second order or second stage of Doctoral cognition – Doctoral cognition about Doctoral cognition). We have gone some way to teasing this out here, but is a matter that will need to eventually be address by a robust theory of Doctoral cognition.

To review, this chapter has provided us with a concretising of the concepts we have been considering in this work. We have located exemplars that amplify or echo our previous speculative work. Although these exemplars are drawn from a relatively small sample, they are consistent with the extant research in this area. In summary the categories and associated analysis have contributed to the broader model we are making a case for. We are now ready to put the pieces together.

PART D

REVISION

"Simple solutions seldom are. It requires a very unusual mind to undertake the analysis of the obvious" (Whitehead, 1925, p. 4).

CHAPTER 13

DOCTORAL COGNITION

13.1 Orientation

In this chapter we will draw together the work conducted in the previous 12 chapters. Commencing with a summation of the arguments and key conclusions up until this point. We will then move onto a brief resolution of the core research question - "what are the knowledge-making processes, at the level of individuals, that underpin *Doctoral work, knowing, and education*"? Given the breadth of this question, as well as the stated objectives of this work (i.e., analytic, synthetic, descriptive and subversive), the conclusions drawn out here will be general and provisional, but justifiable.

This work has involved a lengthy and technical discussion, but it has had to be. Firstly, we have had to convince you of the *idea* of Doctoral cognition; knowing that this idea invites both scepticism and incredulity on the part of some. Secondly, we have had to work against a cultural framing of the Doctorate, to encourage a different kind of thinking. Thirdly, that speculation on its own was insufficient for making the case – we needed to amplify and concretise the theoretical connections that we were making; and, finally, we needed to show how we would begin to set out a theoretical approach and research techniques that would allow us to deepen our understanding of Doctoral thinking and learning.

Although there is still much labour to be done to shape a *deep* understanding of Doctoral cognition, this work hopefully contributes to a significant clearing of ground for the next stage of the empirical and theoretical work to proceed. Attention will be given to the generative nature of this work. To do in the subsequent chapter this we will look beyond the specific issue of the Doctorate to the broader questions of how educational theorising and research could proceed to build on the foundations (theoretical and metatheoretical) set out here.

13.2 The story so far

Our starting point was the objective value placed on Doctoral education. What is the expectation or anticipations that surround this experience in general and the thesis in particular? It is understandably easy, perhaps deceptively so, to accept the things that are before us. In higher education it is so *obvious* that Doctoral research involves cognitive actions, beliefs, desires, and dispositions that we predictably seek to quickly move on from these initial conditions to investigate other domains such as how best to prescribe the procedural and clerical aspects of the Doctorate.

In fact we typically *parse* the Doctoral experience into bureaucratic or instrumental elements such as: the administrative requirements of supervision; the production of a standardised document; the completion of the necessary procedural requirements or stages; the acquisition of research skills; and the examination of research practice (as abstracted rational processes). What is missing from this perspective is a deep understanding of what the outcome of the Doctorate is? What is the Doctoral student *doing* when they do a Doctorate? What is it that they are getting better at? And how is that different from their previous study? While these questions would seem to be largely speculative and metaphysical in nature, they are instead essentially *practical, empirical,* and concerned with *real world* issues. These questions in fact *matter*. What is more, the critical issue isn't how best to systematise or administer the Doctorate but instead the issue is *how* and *why* does (or should) the thinking of the Doctoral student change over the course of their Doctoral experience. In actuality what are the base conditions for Doctoral cognition?

Our understanding, and how we come to know, is a critical part of our engagement with the world. This work has been concerned deeply, and principally, with the process and mechanisms of knowing. Most importantly it has been an attempt to say that *before* we look at the *products or artefacts of knowing* (in this case the thesis), we need to examine deliberative *knowing* itself (in this case Doctoral cognition). We do not just *store* knowledge we *process* and *create* it, we *attribute meaning* and *value* to knowledge, and we materially experience the activity of knowing.

It has been argued here that higher education would be well served by different and deeper understandings of the foundations of knowing (and *being*). To argue this point we have had to range across a wide spectrum of theories, models and philosophical perspectives. This has been motivated by the circumstance that no single science has provided a compelling or widely understood solution to the question of "what is the nature of knowing"?

Throughout this journey we have been endeavouring to get an insight into the processes of Doctoral cognition, and by association establish greater clarity about the notion of

Doctorateness. This clarity has been sought through the application of a naturalistic, interactive and constructive lens to a particular instance of deliberative knowing (i.e., the Doctorate). This is a lens infrequently seen in current mainstream educational theorising, research, and debates.

Given the growing contribution of the 'mind sciences' to our understanding of psychological processes it is only judicious that we, as a minimum, review our understanding of knowing to see how this research impacts on our understanding. What we think with, what we learn with, is our mind. To grasp Doctoral cognition it is, in our view, necessary that we appreciate the embedded and embodied nature of the mind. We should see the intellectual and adroit activities of the Doctoral candidate as an instance of autonomous, interactive, effortful and intentional meaning making and problem solving behaviour.

We have argued that we need to glimpse the ways in which this set of circumstances shapes our knowing and being. A natural consequence of using this approach has been a conception of doctoral cognition that follows from our conception of the mind.

Part A introduced the basic ideas behind this thesis. Using the new knowledge about the mind gained over the last fifty years, Part A set out an alternative account of the Doctoral experience. In Part B we turned to the discussion of the more technical issues of linking the brain sciences to the account provided in Part A.

Part B sought to bring out into the open the key components of Doctoral cognition as well as giving some sense of the science that has revealed them. Part C began the location of these ideas to the lived experience of Doctoral students. The key points that have emerged from this discussion of Doctoral cognition thus far are:

- Doctoral cognition is practical (i.e., it is a real world phenomenon): it comes into existence in response to problems, and functions to resolve these problems.
- Doctoral cognition is the effort to form interactions, norms, constructs, skills, and habits consistent with what has been described as '*Doctorateness*.
- Contributing to knowledge is the experience of accomplishing this goal of Doctoralness by using interactions, norms, constructs, skills, and habits. This experience involves the reorganisation, modification, verification and regulation of how we know.
- The process of Doctoral cognition contributes to, if not manifests, *Doctorateness*.
- *Doctorateness* is a psychological and embodied process.
- *Doctorateness* is surrounded by other kinds of experiences. These other experience serve as the resources for Doctoral cognition and its verification.

13.3 Putting the pieces together

Given the complexity, as well as the breadth, of the literature that has been used to build our understanding of Doctoral cognition; we have had to sacrifice a certain amount of nuance in regards to some of the theoretical and empirical aspects of our discussion. Nevertheless, the case being put forward here doesn't stand or fall on a single stanchion or column. Instead we have been concerned with laying out the groundwork, a broad based and underpinning foundation; upon which particular elements can then be built up.

As Denicolo and Park (2010) expound "[t]he notion of Doctorateness should logically underpin and inform ideas about what a Doctoral award should be, what it should contain, how it should be evidenced, and by what criteria it should be judged" (p.2). To this we would add, how the student should be supported to *learn*, and what experiences, structures (social, psychological, cultural, etc.) and relationships are necessary for encouraging the *development* of Doctorateness.

These additions to Denicolo's and Park's lists are principally concerned with the issue of 'how do we awaken Doctoral cognition?' because it looks like Doctoral cognition is not always in operation[329] or available in individuals to the same degree of refinement. It is perhaps best construed as a system of psychological processes for meaning and decision making, learning and regulation that is brought into play when the appropriate interactions and environment (one that *supports* rather than *obstructs* Doctoral cognition) occur. Fundamentally, the environment needs to *afford* Doctoral cognition.

Doctoral cognition is an intentional, effortful and interactive regulatory response. But it is also a *skilled* and *intelligent* activity that needs refinement and development. At its core Doctoral cognition is the application of our basic psychological mechanisms for survival, inquiry, problem solving, and development to the epistemic dimensions of our life world. As Dewey (1917) explained in *Democracy and Education*, "Only in education, never in the life of farmer, sailor, merchant, physician, or laboratory experimenter, does knowledge mean primarily a store of information aloof from doing" (ch. 14). Doctoral cognition is a psychological *process* that is constituted by systems of construction, inquiry, affordance, meanings, anticipations, norms, intentions and behaviours. It is the means for us to navigate our world; to both identify and travel towards our goals. So this is loosely how it works – as a capacity that can be deployed or triggered, but where does it come from?

[329] Nonetheless it is a restless process once it is awakened.

From our discussion it appears that an individual needs to have the appropriate interactions, developmental trajectory and interactive history (internally or externally) to refine (*pace* Piaget) their regulatory capability for knowing from base level to that of Doctorateness. They need the opportunity to test and retest ways of *being in the world*, performing roles, enact meanings, solve problems and increase their knowledge. Over time proclivities for certain styles or types emerge from interaction and experience. These align to broader social and cultural regulatory frameworks and economies, as well as particular roles, norms and anticipations. Consequently the intent or essence of Doctoral education is to develop and refine Doctorateness – to create the normative framework and regulatory control for the roles of the academic, scholar or researcher. Let us examine this point again.

Critically in the context of higher education this increasing gradient of regulatory sophistication reaches a certain level or modality where knowing takes on particular ways of being. Ultimately Doctoral cognition depends on five key nutrients: intelligence (thinking), regulation (control), interaction (anticipation), learning (knowing) and development (change). The answer to the question of what is the knowledge-making process that makes use of these nutrients or resources? In a simple term – *construing*.

Kelly's observation that his experience of supervision of Doctoral students and his experience of working clinically with clients echoed each other is in our view basically correct: that when we are trying to understand and respond to ill-defined problems (like Doctoral research) we need to engage in the activity of intelligent, intentional and autonomous meaning *construction*. We literally need to *make* sense of the world – it is an active, invested and intentional process. In the case of the Doctoral student they are trying to *make* sense of their research and make sense of their *role* in doing this research. They are trying to make sense of Doctoralness.

For us Doctoralness swings off a different hinge than does the bureaucratic and instrumental constructs of Doctoral education. It directs us towards the cognitive, affective and conative dimensions of being. It directs us towards a naturalistic view of the mind. It directs us towards a metatheory of knowing.

To use a recurrent metaphor from this work, it illuminates a different aspect of the field to that illuminated by bureaucratic concerns. In this we can see that it is not simply a matter of discarding or ignoring instrumental issues in the Doctorate – this is neither reasonable nor realistic. But instead we need to work from intersecting perspectives, using Rychlak's *principle of complementarity*, to build up our understanding. We need to be aware that a narrow and impoverished view of Doctoral education may well be leading to policy and procedures that are eroding the very conditions necessary for the Doctorate to be an effective and meaningful enterprise.

13.4 Concluding comments

We have a simple choice here; we can cling to a view of the Doctorate that is based more on bureaucratic expedience than on the modern mind sciences. Or we can change to a view shaped by ideas like *Doctorateness* and *Doctoral cognition* that can be built up from the mind sciences. We readily concede that many may argue that this is not necessarily the most imperative issue confronting higher education at this time; but we assert that it is an issue that needs to be addressed *first*. Some may also claim that this is an ephemeral concern and that we cannot possibly address in higher education as the system is too widespread and/or idiosyncratic. Again we believe that this is a solvable issue – we can bring about adjustments in the Doctoral process by emphasising *understanding* rather than merely *explaining* the process. But we need a programmatic attitude to do this.

We must be cognisant of three points here: firstly, that the Doctorate is a *relatively* new *construct* in higher education (in terms of the *long duree*) and would benefit from a credulous rather than reverential approach; secondly, that the Doctorate is a purposeful and intentional activity that is grounded in our psychological processes of knowing; and thirdly, that the Doctorate is but one instance of how we are able to encourage productive thinking and interactive knowing. If the Doctorate experience and process is not consistently congruent with the learning objectives and cognitive modalities, dispositions and capacities that it aims for (and that are used to justify its *indispensible status*), then there is a need for change.

To apply an old adage (perhaps even the one that could have inspired Locke and others to be so explicitly focused on 'beginnings') we should start as we mean to go on. It won't be easy to change our assumptions behaviour about the Doctorate - disrupting stable and hardened views never is. It also won't happen quickly or without effort. So, let's get started.

CHAPTER 14

MOVING FORWARD
DEVELOPING A SYSTEMATIC APPROACH

14.1 Orientation

In this final chapter we will devote our efforts to formulating a way in which our discussion about Doctoral cognition can be used to help drive a larger sequence of work. This will require the development of a programmatic stance that places our particular issue of concern, Doctoral cognition, into a methodological, meta-philosophical and functional program that takes its range of convenience to be higher education, and its focus of convenience to be learning in higher education.

In shaping this chapter we have looked to Schoenfeld's method for delineating lines of theoretical and empirical activity. His work offers us an insight into the challenges and opportunities that exist in taking a meta-theoretical approach to education. In his call to action Schoenfeld echoes Brumbaugh's (1973) earlier work on the necessity of robust theorising and analysis of education.

We will commence with a discussion of the benefits of in a programmatic (and pragmatic) approach and then move to consider the specific implications and requirements for this in the context of higher education. In closing we will comment on the relative merits of the proposed approach.

14.2 Why develop a program?

In the spirit of Hilbert's (1976) generative program in mathematics, Schoenfeld (1999b) has identified a number of open problems of deep theoretical significance to educationalists. The solution of these problems, he believes, will help to advance educational theory and practice[330]. Schoenfeld's program of work aims to encompass emergent, enduring, and perennial dilemmas for Education. To do this he has named six crucial arenas for investigation: (1) unifying the cognitive and the social; (2) learning; (3) the brain; (4) transfer; (5) reconceptualizing the discussion of "nature versus nurture"; and (6) social systems. Schoenfeld wants us to systematically consider[331] how to build robust theories

[330] While inspired by the mathematical program of Hilbret, Schoenfeld (1999b) acknowledges that we need to remain cognisant of the fact that "problems in education are very different from problems in mathematics" (p. 5).

[331] Anderson (cf. 1962) offers us a useful characterisation of systematic inquiry. In Andersonian terms a system of philosophy was orientated on providing an understanding of the totality of things. By contrast, systematic philosophy is concerned with identifying underlying or root principles, which apply to

that offer us rigorous and detailed characterisations of the dilemmas that are central to each of these arenas.

To initiate his proposed program, Schoenfeld (1999b) adumbrates the core of his six arenas with the following questions – (1) How does the mind work in context? (2) How do people come to understand things, and develop increased capacities to do the things they want or need to do? (3) How do we integrate brain research with research on human performance? (4) How do we make sense of the ways in which people use knowledge in circumstances that are different from the circumstances in which that knowledge was originally developed? (5) Can we more effectively reframe the discussion of "nature versus nurture? And, (6) can we develop theoretical understanding and build functional models of complex social systems?

The generative power of the program, proposed by Schoenfeld, is conditioned upon the interconnection of these questions (cf. Hilbert, 1976 on the importance of interconnection). We need to conceive the extension of our *understanding of the particular*, as part of an extension of our understanding of the field of *research as a whole*. As such, the exploration of these arenas of research offers us not only the possibility of advancing our theories in relation to the specifics of learning, transfer, or the brain; they can also assist us in characterising a set of universal concerns that run across education - in essence a first step towards a (meta)theory[332] of Education.

In this way, Schoenfeld's questions *afford*s us both a means of cutting Education at its joints[333] and also appreciating Education as an aspected totality. This is a program of much ambition, perhaps even overly ambitious, but nevertheless of both great theoretical and practical importance. For in Education, as in other domains of inquiry, we are well served by having ambitious and comprehensive programs of work.

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all phenomena. In this spirit, systematic inquiry can be portrayed as seeking the general in the specific – we look to what are the properties, principles or processes that have the capacity for universality (for Anderson formal logic in particular provided the basis for this framework). In his commentary on Hegel Anderson stated:

> "…philosophy should be systematic. But its systematic character should appear in the form of a single logic, not in the form of 'totality' of a pretended solution of all problems. He [Hegel] is right, also, in maintaining that this logic should be historical, if we take this to mean that it is the theory of things as historical; but it should not itself be considered as advancing …"

In embracing Schoenfeld's call for a systematicity in our inquiry, we are well served in looking to Anderson's imperative for an explicit framework of inquiry, even if we may not necessarily embrace the centrality of formal logic in the way Anderson did. A more general statement of this idea is provided by Heraclitus "Wisdom is one thing: it is to know the thought by which all things are steered through all things."

[332] The term metascience has been used to describe a similar level of analysis – where the discipline itself becomes the object of study. The term metascience has been applied to the history, philosophy, sociology, and psychology of science (Gholson et al., 1989).

[333] In *Phaedrus* Plato uses the metaphor of a skilled butcher or carver being able to cut nature at its joints to illuminate the importance of careful division in offering a clear description of the world.

In surveying the breadth of Schoenfeld's program, there seem to be any number of lines of operation that could be opened up; as well as a wide range of strategic responses that could be deployed to transect each of the different intellectual domains (cf. Schoenfeld, 1999a; Schoenfeld, 1999b). In the first instance the central importance of inter- and trans-disciplinarity becomes apparent. The need to share models, constructs, postulates, conjectures, and dilemmas becomes the *raison d'être* for the development of some form of meta or proto language that can frame salient issues in such a way as to allow for multiple points of departure and entry[334].

Building the capacity, and opportunity, for conversation is crucial to the success of this style of capacity building program (Bruner, 1999; Pask, 1975a; Schoenfeld, 1999a). Without some coherent means of integration and shared situational awareness the promise offered by Schoenfeld's program could too easily give way to intractable stances and counterproductive contestations for territory (e.g., Langemann, 1996). While this situation may at times be a feature of any field of study (Bauman, 1987, 1992; Bourdieu, 1981, 1990, 1991, 1998), it would seem that the discipline of Education is particularly vulnerable to fracturing into isolated sub specialities, and adopting idiosyncratic or incommensurate stances around enduring issues (Bruner, 1999; Burkhardt & Schoenfeld, 2003).

Undeniably the post-modernist turn, which is replete with notions of hybridity and fragmentation (e.g., Barry, 1995; Bhabha, 1992; Chambers & Cutri, 1996; Groz, 1995; Lash & Friedman, 1992; R. J. C. Young, 1995). Concepts such as the death of the author (Barthes, 1967) and the end of grand narratives (Lyotard, 1984; Q. Skinner, 1985) are suggestive that systemisation on a 'grand' scale is not *neutral* and should be guarded against or at the very least should be rigorously contested. While a critical or sceptical stance is defensible, and even desirable at times[335], there rarely appears to be a balancing point between the extremes of relativism and absolutism in the style of critique touted as 'postmodern' (Archer, 1998; Colapietro, 1990; Frank, 1989; Norris, 1992; Scruton, 1994).

Therefore, before being able to progress programs like Schoenfeld's, bridges need to be built across the schisms that traditionally exist, or that have emerged as the result of post

[334] It could be argued that this has traditionally been seen as a responsibility of Philosophy.

[335] An examination of works of Kropotkin, Dostoevsky, Stirner, Nietszche, Foucault and Deleuze reveals benefits of a strong anti-authoritarian and subversive role to theorising. The critical stance offered by these thinkers towards the effects of 'grand narratives' serves as an effective foil against blind acceptance of the human condition and the circumstances of existence as simply a 'given'. Instead the broad stance taken in these theorists' different works is to call for the development of critical reflective judgement and practice in relation to our circumstances in general and theorising in about the world in particular.

and neo modern hyper-criticism, between the domains of philosophy, psychology, sociology and pedagogy of education. Schoenfeld's questions are the anchor points for these bridges. But stable footings are only one of the dimensions of complexity that need to be resolved in the building of bridges for educational theorising.

Schoenfeld's program of work must also be situated within the dynamics of development, identity and agency. We must allow for the lived experienced nature of the phenomenon of interest (R. Ellis & Newton, 2000; Entwistle & Ramsden, 1983; Marton et al., 1984) and as such, we would argue that these processes are best construed as *intentional* and *active* in character. To do this entails a consideration of our ontology and what the necessary degree of breadth and depth will need to be for our analysis (which may well require some form of multi stratification in our world view). However with increased depth and breadth of analysis comes with an increase in both latent and expressed complexity (Hooker, 1995).

One way to manage complexity, and increase leverage on a problem, is by using simplifying ideas or by narrowing the focus by developing a *model* to represent the germane factors (Coyle, 1996, 2004; Dawson, 2004; Dutton & Briggs, 1971; Lewandowsky, 1993; Mitroff & Mason, 1980). Modelling often trades off specificity for basic knowledge of a fundamental process. The corollary of this stance is the need to ensure that our models and concepts are shaped according to what we understand about the world empirically, and that we preserve a sufficient level of fidelity with the phenomenon of interest[336]. This viewpoint requires that our conceptual distinctions aim at being dynamically grounded in the world (Christensen & Hooker, 1997a). Empirical consistency (Lakoff & Johnson, 1999) thus becomes a core conditional for our thought experiments, postulates and models.

Sterelny (2003) explains we need to ensure that we *empirically constrain* our theorising. For example, at some point there has to be a connection between our understanding of cognition, intelligence and biology – without this, cognition is fundamentally disconnected, in essence causally separated, from the world we inhabit and from our biological history (P. M. Churchland, 1999; B. Davis & Sumara, 1997; Dennett, 1995, 1996; Donald, 1991, 2001; Gazzaniga, 1998; Godfrey-Smith, 1998; Lieberman, 1991; Searle, 1992; Sterelny, 2003; E. O. Wilson, 1988). Thus we need to consider what we know about the links between learning,

[336] Dawson (2004) explains: "Intuitively, a model is an artefact that can be mapped on to a phenomenon that we are having difficulty understanding. By examining the model we can increase our understanding of what we are modelling. For it to be useful, the artefact must be easier to work with or easier to understand than is the phenomenon being modelled. This usually results because the model reflects some of the phenomenon's properties, and does not reflect them all. A model is useful because it simplifies the situation by omitting some characteristics" (p. 5).

transfer, mind, brain and context (social, biological, psychological). Furthermore we need to identify where there are opportunities to test or add to our models. Finally, we need to then ensure that our practice is informed by this understanding; and that we apply our insights as an aid to decision-making and action. This approach attempts to strike a balance between ground-up and top-down theorising. To adopt a mid-position that seeks to work iteratively between the concrete and the abstract until a sufficiently stable (and falsifiable) picture is achieved[337].

We must consciously construct our investigations to encompass as much real-world complexity as is manageable and relevant to our concerns. In doing so, we need to 'break the back' of the underground arguments that place theory and practice in conflict, and instead conceptualise the practice of educational research as being able to equally contribute to both basic knowledge and professional practice. Indeed it seems, on the face of it, wasteful not to seek synergies between our basic and applied research. In fact, as Stokes (1997) observes, it is far more salient to map research activity against the axes of the search for fundamental understanding and considerations of use; rather than the adversarially construed basic (theory) and applied (practical) dimensions[338].

Adapting Stokes' construct to Education, Schoenfeld directs researchers to consider two questions: "How can the issues under investigation be framed so that the contributions to fundamental understanding are as large as possible"? And, "how can we situate this work so that the contributions to practice are as large as possible" (Schoenfeld, 1999b)? The type of knowledge elicited by these two questions is evocative of Gadamer's characterisation of the forms of knowledge involved in hermeneutic analytics. Parsing Aristotle, Gadamer identified distinctive but interacting, modalities of knowledge – *episteme* (theoretical knowledge); *praxis* (practical knowledge); *techne* (procedural knowledge); and *phronesis* (the prudent application of knowledge, and judgement, in context). Gadamer (1975) argued that the phenomenon of understanding "pervades all human relations to the world" (p. 10) and involved the interplay of these different modes of knowing and acting. Bernstein (1972) augments Gadamer's position by proposing that Gadamer's hermeneutic method is a continuance of a philosophical tradition concerned with the interplay between context, interpretation, construction, and action. Appreciating that knowing and doing is essential

337 This stance can be found in what Stoke's (1997) defines as *Pasteur's quadrant* – where utility, abstraction and abduction drive research in equal measure.

338 Lewin (1931) notion of Aristotelian and Galileian models of thought provides an interesting countering point to Stoke's description of types of scientific research. Lewin pushes us to considered that it is not just what our research is aimed at, but also the mode of thought we use to pursue these questions (whether they be applied or theoretical in nature).

to characterising not only an individual's engagement in life, but also the larger social and psychological institutions that develop to support and extend the capacity of the individual.

14.3 Bounded theorising – breadth and depth

So how can we best trade off our methodological, theoretical and practical requirements, while at the same time pursuing the opportunities afforded to us by Schoenfeld's program? Furthermore, what are the sites, test cases, exemplars or paradigm examples that need to be used to allow for an increased conversation, and parity of analysis, of these fundamental issues? Hilbert (1976) believed that the origin of 'problems' was to be found in the "ever-recurring interplay between thought and experience" (p. 4).

Problems, even theoretical ones, tend to emerge in the first instance from our experience of the world, the tension between our understanding, experiences and circumstances (cf. Darwin, 2002; Dewey, 1930, 1938, 1997; Dewey & Bentley, 1949; Hadamard, 1996; Hardy, 2005; Hilbert, 1976; Lakatos, 1977; Schoenfeld, 1992; Wiener, 1956). Problems also can emerge as the result of developing our understanding; with new insight often comes new issues and complexities. So what kinds of experiences offer us either sufficient richness for analysis or alternatively pose the greatest challenges for our current models or practice?

Our answer to this should be informed by how we want to trade off fundamental understanding against considerations for use. We can narrow and deepen our focus to a particular site, learning environment, or instructional event; or alternatively we can seek to cut through a sequence or series of events or sites. In either instance the motivating drive should be the generative possibilities afforded by such a choice (Lakatos, 1978; Lakatos & Musgrave, 1970).

But before committing to either direction a determination needs to be made as to the requirements of the analysis – what are parameters that will lend power to the research? What are the fundamental principles that should guide us in our work? Hooker argues that breadth (spread), precision, and depth should constitute a core set of principles for evaluating our explanations and guiding our understanding[339]. In particular, Hooker proposes that two independent dimensions should be used to measure the 'depth' of our explanations: ontological depth (or the degree of penetration to a deeper level of analysis

[339] Hooker (1982) identifies parameters such as: explanatory depth; explanatory precision; explanatory unity; predictive scope; predictive precision; heuristic power; simplicity conceptual, syntactic, and ontological; technical applicability; technical reliability; socio-cultural control; interpersonal communication range; and richness of cultural structure.

that affords a wider scope of examination) and coherent simplicity (the reduction in the number of independent basic parameters)[340]. Ontological depth can create the opportunity for the unification of understanding across a number of domains, or alternatively serve as the basis for the introduction of new, deeper underlying ontologies. As such deep insight require both methodological and theoretical practices of "great organizational depth (many interrelated layers and connections)" (Hooker, 2003, p. 73).

The dimensions identified by Hooker share much common ground with key components of Thagard's (1989, 1992, 2000) theory of explanatory coherence (TEC). TEC is based on seven principles: symmetry, explanation, analogy, data priority, contradiction, completion and acceptability. In this theoretical framework, greater explanatory breath (understood as more links to data), greater simplicity (reduction in constituent assumptions), and greater correspondence (links with analogous explanations of other phenomena) resonate with Hooker's notions of breadth, precision and depth. Both theories strive to realise basic principles of scientific explanation (e.g., parsimony, explanatory symmetry, propositional acceptance, system coherence, predictive power, data priority, etc.) as proxies for general notions of understanding[341].

Of course, greater ontological depth may come at the expense of precision at larger scales. This is one of the challenges faced by the brain sciences, where microscopic studies have vastly increased the appreciation of the complexity of the picture we have of the brain, allowing us to move from crude topographic feature based models to the level of nerve cells, neuro-transmitters, and even to touch on the level of quantum phenomena (Amit, 1989; Ashby, 1952; Blakeslee & Ramachandran, 1999; R. A. Brooks & Stein, 1993; P. M. Churchland, 1991; Damasio, 1996, 2003; Damasio & Damasio, 1994; Eccles, 1973; Feinberg, 2001; Gazzaniga, 1998; Goldberg, 2001; Goldblum, 2001; Luria, 1973; Marks, 1980; McCrone, 1999; Pattee, 1982; Penrose, 1999; Pribram, 1986; Quartz & Sejnowski, 1997). As such, it has been possible for neuroscientists to progressively increase the ontological depth of their analysis and in doing so have opened up an increasingly complex picture of the structure and function of the brain (P. M. Churchland, 1979, 1989, 1999; P. S. Churchland, 1986; P. S. Churchland & Sejnowski, 1992; Gazzaniga et al., 2002; McCrone, 1999). Yet there remains much work to be done to integrate this understanding at the micro, with the meso and

340 Perhaps we should describe this as Ockham's drill as opposed to Ockham's razor. Where we need to be able to not simply reduce through excluding factors, but reduce by seeking unifying principles that reach through deeper layers.

341 An example of how this work can be used in understanding everyday thinking is offered by Read and Macrus-Newell (Read & Marcus-Newhall, 1993) have taken up TEC as a means exploring individuals evaluation of explanations about social events.

macro levels of behaviour and cognition[342]. Furthermore, while the diversity of activity in the neuro and cognitive sciences has suggested many useful directions in which cognition could be explored (Christensen & Tommasi, 2006); much basic research is still largely silent on the fundamental issues of agency, intentionality and volition.

With Hooker's principles of ontological depth in mind and Schoenfeld's questions to hand, let us now consider the substantive issue of where to look for answers? Exposing the interplay between cognition, learning, transfer and brain in action requires an activity (or sequence of activities) that explicitly, and publicly, involves the deployment of knowledge frameworks. Any situation where individuals are presented with a significant and sustained problem, that is both ill-defined and open, could serve to create the required context.

In Education, teaching and research are perhaps the clearest examples of the last mentioned activity (but are by no means the only ones). These activities are not delimited temporally or spatially – they can be the expressed behaviour of particular social or institutional structures (e.g., schools, communities, workplaces, etc.) but this is not a necessary condition for their manifestation. This ubiquity has led to a variegated level of understanding in relation to both the particular and the general. Thus in adopting Schoenfeld's program we are presented with the opportunity to explore multiple sites or forms; and redress some of the imbalances in our current understanding, which have resulted from an impoverished view of education.

The domain of tertiary and adult learning, for example, remains somewhat underdeveloped when compared with the domains of schooling with regards to exploring learning, cognition, transfer and problem solving (J. Biggs, 2003; Bloom & Broder, 1950; Bransford et al., 2002; Kember, 2001; Laurillard, 2002; Marton et al., 1984; Perry, 1970; Prosser & Trigwell, 1999). By far and away the largest investment has gone into 'explaining' these issues within the domains and the age/stages of development particular to secondary and primary school levels. This investment assumes a level of isomorphism between school and post schooling contexts. Obviously at least some parity exists; but as to the degree, this seems to remain an open question. As such, there is an opportunity to add to our picture of

[342] Galison (1997) analysis of micro physics and the impact of striving for greater ontological depth through increasing levels of technological and institutional sophistication, serves as a cautionary note against the dangers of over simplifying the challenges of ontological analysis and critique. Galiston observed that greater 'depth' of understanding about this physical world, achieved through increasingly sophisticated laboratory devices for exposing the micro level world, does not bring with it a scalable macro level coherence.

learning, transfer and cognition by examining the upper levels of our structured learning organisations and developmental models (Cantwell et al., 2010; Cantwell et al., 2012b; Cantwell et al., 2008; Cantwell et al., 2011).

Even if this line of inquiry leads to a confirmation that there is sufficient isomorphism between adult and child processes to limit the need for separate theorising, this line of inquiry will still serve to provide an important contribution to our theorising about knowing and thinking. Concordantly, this thesis will offer both a philosophical and methodological viewpoint from which to begin exploring tertiary learning events. The overall goal of this approach is to provide a rich and robust description or picture of cognition 'in the wild' (Dunbar, 1995, 1997, 1999, 2002; Hatch & Gardner, 1993; Hutchins, 1995; Perkins et al., 2000; Sternberg, 2002; Sternberg et al., 2000; Zsambok & Klein, 1997) such that we are able to contribute to both our fundamental understanding and professional practices.

For example, the growth in interest in Doctoral learning denotes the identification of a potentially 'green field' site for educational researchers (ABRC, 1996; J. A. Armstrong, 1994; Burnard, 2001; Kiley & Mullins, 2002). This openness is an opportunity to advance not only our picture of adult higher order cognitive processes, but also to cast a light onto the very nature of research, reason and thinking itself. As we have argued Doctoral education sits at the apex of the University model, where the institutional learning construct is pared down to its most fundamental components – content, learner, guide and assessment. In this context students are required to learn about and solve the problem of their study. This process requires a student to anticipate and plan a solution that meets a set of dynamic criteria and constraints. In essence, research is the expression of a contextually sensitive process of testing and refining predictions, choices, and actions [343].

Returning to Schoenfeld's arenas and the previously identified idea of research depth, the methodological reasons for selecting Doctoral study as the site for analysis are four fold: firstly, there is an explicit social component to the Doctoral process (i.e. between student and supervisor/s, between the student and the discipline, etc.) that allows for multiple perspectives on events; secondly, the Doctoral process involves an extended period of problem solving (and learning) around a specific goal and discipline, and as such offers a

[343] This of course should not be seen as exclusively the remit of 'academic' activity – instead we need to adopt a broader notion of practice and action (Sternberg et al., 2000) in which this process of choice, action and selection are endemic to the behaviour of intelligent agents in the world.

series of reflective opportunities; thirdly, there is a broad expectation that some form of observable (and assessable) transformation and/or mastery will occur as part of this process and therefore it would seem to be a likely site for seeing actions and or transformations in knowledge and cognition; and fourthly, this activity affords us an opportunity to interrogate our intuitions about the relationships between mind, cognition and brain. In particular there are two key components of pivotal concern – the process of supervision, and the production of a significant and original contribution to knowledge (in the form of a thesis – usually written).

14.4 Concluding comments

A programmatic approach allows us not only to scope the nature of the problem in its totality, but also to articulate the potential and the necessary interdependences of the work. While the volume of educational theorising in total continues to grow apace there has been only a modest growth in synthetic and integrative work that speaks to the discipline of education writ large. Instead we find separate domains of activity, working in parallel if not duplicate on issues often with inadequate awareness of similar efforts. The fragmentation of specialisation has to a degree restricted the effectiveness of foundational research strategies – such as the comprehensive review of published material – when there is work of merit but outside the discipline or sub discipline of the project. In addition to this challenge there is the sheer growth in information and knowledge available. Access to published materials and presentations (both current and past) has never been as simple.

The issue is not merely a need for more work. Instead we need more coordinated activity and efforts to drawn this material into a meta-theoretical positions (Dervin, 1999; Mahoney, 1988). It will remain for future research to further to refine and operationalize the solution to this beyond the directions suggested here. At this point, however, some general implications of this set of circumstances are apparent.

Firstly that if educational research or science is to be made more relevant to issues of knowing, priority must be placed on obtaining this information from a broad range of disciplines and specialities and making it available to educational researchers/practitioners. We must more fully understand the context or ecology of the phenomena we are interested in. For example, in the case of Doctoral cognition we must look at the context in which the Doctorate takes place and the experiences of those involved. This flow of information must be a two-way connection; research needs to link back into the space of the Doctorate and help shape the experiences of students and supervisors.[344]

Here Thomas and Tymon (1982) can assist us with their helpful set of properties of relevant research. In particular, their writing examines how research can and should be mindful of its end use. They outline five priorities for increasing research relevance:

1. **Descriptive relevance**: the degree of accuracy of research findings in capturing the phenomena encountered by practitioners (in this case high education academics).
2. **Goal relevance**: the degree of correspondence of the outcome (or dependent) variables in a theory to the things the practitioner is seeking to influence.
3. **Operational validity**: the ability of the practitioner to implement a theory by manipulating its causal (or independent) variables.
4. **Non obviousness**: the degree to which a theory matches or exceeds the complexity of the common sense theory already in use by a practitioner.
5. **Timeliness**: that a theory be made available to practitioners in time so they can use it to deal with problems.

Although Thomas and Tymon's priorities are expressed primarily in terms of empirical research they can be used to considered theoretical research as well. As Kelly (1991b) and Lewin (1951) have both expressed in their own ways, the power of good theory lies in its ability to generate ideas and to be useful.

Secondly, that education research needs to adopt a *credulous* approach to both empirical and theoretical frameworks. There has to be a general willingness to look at alternate constructions for the problem. This includes an awareness that part of the *answer* to one component of a program of work may well be located in a separate but related field. In this work we have seen that efforts in the field of biology, neurology, systems engineering, cybernetics and reasoning are trying to speak to the same if not similar issues that have occupied educational thinkers. There is much to be potentially gained by trying to develop a common language between these efforts and educational theory and research.

Third and finally, that the current circumstances of research practice suit the kind of programmatic and collaborative effort the Schoenfeld calls for. There are a range of communication and information sharing channels, platforms, and environments, which would support large-scale research efforts. Educational research would not have to be bound by institutional, geographic, discipline or even theoretical borders. Moreover by

[344] Although research by its nature makes connections with the practice domain, it must be acknowledged that this would benefit from improvement.

seeking to push this work onto a larger stage we can open up new contexts in which to trial are conjectures and gather data.

In closing it is important to observe that the call to programmatic action made in this chapter is not a dismissal of what is currently being achieved, but rather an observation that we are capable of more. In fact, we will benefit from different constructs and understandings of education, learning, knowing and inquiry; and that this benefit has real world effects if we look to apply this to educational institutions and practices. By trying to understand what it means to be Doctoral, and trying and catch the activity of Doctoral cognition, we have illuminated an unabashed alternative to the instrumental description of the Doctorate. In doing this we offer the possibility of an alternate story about Doctoral education.

AUTOBIOGRAPHY OF A THESIS

Others have observed during the course of my work on this thesis that there is a paradox in a *Doctorate about Doctorates*. While I have often made glib replies about this being an amusing observation, I now have an opportunity as part of this writing to reflect on this situation and its meaning. I have felt, to use Kelly's (1979a) words, a need to describe "the happenings out of which, in some accountable way, the theory has sought to make sense" (p. 46). For this work has tried *to make sense of the Doctoral experience*, for both others and myself. So I want to devote a small amount space, now the other work is done, to identify some of the psychological experiences that have shaped my thinking.

The importance of inquiry and experimentation

During the first year of my university degree I encountered a range of educational theorists. There was something about the ideas of Piaget and Vygotsky that made a strong impression on me. Not only could I see the mechanism they described in the *real world*, but they also seemed to be deeply concerned with such a very wide range of issues. This gave me a feeling that Education could be open knowledge from range of disciplines, and that it was not just teachers who could think and speak thoughtfully about education. Furthermore, that science and experimentation could be applied to such a messy business as teaching was a new idea to me.

Then as part of my reading for an assignment I came across Dewey and saw a companion to Piaget and Vygotsky in his notion of *inquiry*. Again here was a model of a thinker and educator, who looked deeply at schooling, education and the mind. It was here I began to consider the importance of grand theories and large-scale narratives as they applied to education. I also began to consider in detail what I saw to be a lack of contemporary voices speaking in the same way. This theme became the basis of my first piece of independent scholarship – where I asked the question of who were the educational philosophers of today?

Constructing meaning

After the completion of my undergraduate study, I was working casually as a research assistant when I attended a talk on personal construct psychology. At this presentation I heard a way of describing how people made sense of the world; and it made sense to me. It resonated not only with my own experience, but also with a large amount of the data I was collecting for different research projects. While I was attracted to personal construct psychology, I was also sceptical of the precision of its axioms. I was concerned that it was too prescriptive or technical for my tastes. Thus began a long course of reading, reflecting, testing and thinking about how much sense this theory really made to me.

Supervision: cooperation, collaboration or just a lot of work?

After several years working as a casual instructor I had the opportunity to work with students as a research supervisor. As with many opportunities in higher education, this one was more of circumstance than careful planning. With little practical support and no real training beyond my work and study history, I commenced working with students to help them refine and carry out their research projects.

This allowed me for the first time to genuinely experience (because perhaps *understanding* is too bold a claim) how other people were trying to make sense of research. It showed me that many of the things I thought of as basic *facts* were not so for others. It also revealed that my way of thinking about content, and of identifying issues and problems, was not explained neatly by my folk expert-novice paradigm. At times it was almost as if we had different horizons and that we were literally seeing two different projects. My concern was I was not always sure which was the right horizon to be working within – mine or the student. Did my view automatically 'trump' the concerns of a beginning researcher? Is this what a supervisor really did?

Being supervised: cooperation, collaboration or just a lot of work?

My own experience of supervision, prior to my own Doctorate was varied. There was a strange mix of detachment and monitoring that characterised this experience. I was unsure what I expected from supervision but at times I struggled to make sense of my projects; and the concerns of my supervisor seemed removed from the deeply epistemic and even ontological struggle I was having. I was having coming to terms with what my project meant and its value. The direction I was provided by my supervisor did not appear to me to speak to my struggle. But perhaps this was not the role of the supervisor, perhaps this was what doing research was *really* meant to be like. I felt I was learning about research and supervision by osmosis. Trying to self-define my role through referencing the behaviour and ideas of others.

The Naturalistic turn

As I began to explore more closely the work of the neuro and cognitive sciences I began to consider what made human cognition distinct. Having already been motivated to consider the species level boundaries as part of some philosophy course I had completed via distance education I also saw the significant challenge posed by the question of consciousness and mind. Konrad Lorenz's work was of particular import in making me reconsider the mind as a natural process. I also returned to the writing of Piaget and Vygotsky, which in turn lead me to consider a range of non-English theorists. In particular I was drawn to the work of Luria, von Uexkull, Leont'ev, Lewin and Bernstein. From these I worked to the phenomenologist school and from there into the embodied cognition work of Andy Clark, Brooks, and others. The next step of this conceptual journey challenged me to consider: can it all be understood as part of the brain? Is there anything more?

Becoming Doctoral

As my professional career progressed I encountered an eclectic range of roles that saw me teaching and researching across a very wide group subjects and methodologies. I taught both within and outside of my discipline area. I began to work with others who were concerned with education and training but did not come from an educational background. I was surprised at what they did not know about research in education – especially given their oft-cited expertise. I was also surprised at what I did not know about education in contexts other than schooling.

In this milieu of unplanned multidiscplinarity I had the opportunity to undertake a Doctorate. I was committed to the idea that this work would transcend what I still saw to be the enforced limitations of my previous scholarship and perhaps bring me resolution to what it meant to have a Doctorate.

I had come, over the course of my thinking about learning and education, to the view that foundational processes were instrumental to building effective models of higher education learning. Now I was presented with the opportunity to do a Doctorate in this area. I felt that problem solving was something important – as either a skill or a circumstance. I also thought knowledge had a role to play. The research process was something I had a lot of practical and theoretical experience with. How was I to put this together into a project that could be done?

My initial discussion with my supervisors did not bring me much in the way of increased clarity. I was struggling with how to frame the necessary requirements of the study with my own ideas of what the Doctorate should be for. These two normative frames did not seem to sit comfortably together.

Again I was encountering a range of views on this – from fellow students (I just want the piece of paper!), colleagues (I could never do that) and supervisors (lets make sure we get something that is doable). Combined with the forms, information sheets and seminars on being a postgraduate student I soon found that had a lot of information but no real practical understanding of a course of action. I decided that it was time to go back to basics. What was the Doctorate about and why was I doing it?

The outcome

This brief account, emulating Kelly's 'autobiography of a theory', has been intended to describe some of the key psychological experiences, as best I can recall them now, which lead to the development of my view on Doctoral cognition and the Doctoral process. In addition to these experiences I have immersed myself in a range of published literature, conference presentation and workshops. As I have tried to make sense of these experiences and the literature I have come to a meta theoretical position on Doctoral education as a constructive process. Doctoral cognition is a natural process that extends the basic mechanism of intelligent agents to the domain of research. While I have expounded this idea through my thesis, some of the central constructs of this idea also owe something to these experiences. "What I have done, therefore, is to tell you how this theory happened. Or perhaps it would be more accurate to say that this is how, in retrospect, I think it happened" (G. A. Kelly, 1979a, p. 65).

APPENDICES

Appendix I

STUDENT INTERVIEW PROTOCOL INTERVIEW

A. Tape Identification and recording check

Recorded verbally onto audiotape and sound check for quality. ID number and date recorded on Tape

- Date and time of interview
- Location
- Subject ID code
- Interviewer name

B. Introductory statement and explanation of interview protocol

To be read by the interviewer:
Before we formally start the interview I would like to explain a broad outline of the goals of this interview and the protocol we will be using during the process.

I would firstly like to thankyou for your willingness to participate. I would also like to remind you that you are able to pause, stop and/or withdraw from this interview at any time. If you are unsure of any of the questions please ask for clarification. Please take as much time to consider your response as needed. We will pause the tape if necessary. Most importantly we are after “your responses” and there are no expectations, other than the general direction of each question, as to the specific nature of this response.

Are there any questions before I move on to describe the specific structure today’s interview?

Today’s interview will be broken into three components – firstly I want to briefly to discuss with you your previous educational experience and how you feel this has influenced you current approach to your studies and thinking about your discipline. The second section will make use of a “critical incident” format to try and explore thew ways in which you engage with and solve “thinking tasks” in your study. By critical incident I mean asking you to recall an event, or series of events, that had significant impact on your actions and thinking. Third and finally we will turn to a series of general questions about your perspective of knowledge and thinking within your discipline.

Do you have any questions before we proceed?

C. Questions – outline academic background and experiences

1. Could your please briefly describe you academic background – focusing in particular on how your research activity has brought you to this point.

2. Could you please describe and characterise your personal supervision history.

3. How well equipped did you feel your "background" (family, schooling, work) made you for this type of study? Could you explain why?

4. What would you characterise as the "key" elements of an academic or research disposition?
   - How did you come to hold your point of view in relation to this statement?
   - On what do you base this point of view?
   - How is it possible that people have different points of view about this statement?

5. What would you see as the overall purpose or goal of PhD study?

6. What is the biggest challenge you have faced in completing your study?

D. Critical Incident

To be read by the interviewer:

A "critical incident" or telling moment is a defining moment in your experiences. It is an event or series of events that you associate with a significant change or shift in practices, insights or attitude. At times this can be as simple as a passing conversation through to a chain of experiences. In relation to the following questions we are focused primarily on your "academic" experiences, and in specific your interaction with your supervisor, your personal research activities and more generally the process of Doctoral study. This provides the context but it does not preclude the inclusion of influences, experiences or events that occur outside of this milieu.

1. Describe a critical incident in which you felt you made a significant "breakthrough" in your thinking about your project

- What factors contributed to this change?
- How did this influence your thinking/actions from this point?
- What was the role of your supervisor in this process
- Did you struggle with this? Why/Why not?

2. Describe a critical incident in which you felt you where "stuck" in relation to your thinking about your project?

- How did you know you were stuck?
- What strategies did you use, in any, to try and move beyond this situation
- What was the role of your supervisor in this process
- How did this influence your thinking/actions from this point?

3. Please respond to the following statement

"PhD study is not about mastering a discipline, it is about developing an attitude or style of thinking"

- How did you come to hold your point of view in relation to this statement?
- On what do you base this point of view?
- How is it possible that people have different points of view about this statement?

4. What are the changes you perceive in your perspective, in relation to your area of interest, as a post grad student to those that you held as an undergraduate student?

5. How do you/did you know when you had come across information that was important to your study?

- Please characterise the strategies you have used
- Have these strategies changed over time? Why/Why not? In what ways?

6. What changes, in any, do you perceive as having occurred in your "thinking/understanding" as a result of the PhD/Supervision process

Appendix II

SUPERVISOR INTERVIEW PROTOCOL

A. Tape Identification and recording check
Recorded verbally onto audiotape and sound check for quality. ID number and date recorded on Tape

- Date and time of interview
- Location
- Subject ID code
- Interviewer name

B. Introductory statement and explanation of interview protocol
To be read by the interviewer:

Before we formally start the interview I would like to explain a broad outline of the goals of this interview and the protocol we will be using during the process.

I would firstly like to thankyou for your willingness to participate. I would also like to remind you that you are able to pause, stop and/or withdraw from this interview at any time. If you are unsure of any of the questions please ask for clarification. Please take as much time to consider your response as needed. We will pause the tape if necessary. Most importantly we are after "your responses" and there are no expectations, other than the general direction of each question, as to the specific nature of this response.

Are there any questions before I move on to describe the specific structure today's interview?

Today's interview will be broken into two components – firstly I want to briefly to discuss with you your previous educational experience and how you feel this has influenced you current approach to your supervision and thinking about your discipline. The second section will make use of a "critical incident" format to try and explore thew ways in which you engage with and solve "thinking tasks" in your study. By critical incident I mean asking you to recall an event, or series of events, that had significant impact on your actions and thinking.

Do you have any questions before we proceed?

B. Supervision experience and Academic background

1. Could you please briefly describe your academic background – focusing in particular on how your research activity has brought you to this point?

2. Could you please describe and characterise your personal supervision history – from honours through to PhD (where appropriate).

3. Do you believe that your personal supervision experience shaped the way in which you supervise your own students? Why/Why?

4. What would you characterise as the "key" elements of good research?

- How did you come to hold your point of view in relation to this statement?
- On what do you base this point of view?
- How is it possible that people have different points of view about this statement?

5. Please characterise what you perceive to be the differences, if any, between the "thinking" of post grad student and undergraduate students?

6. What would you see as the overall purpose or goal of PhD study?

- For the student?
- For the supervisor

C. Critical Incident

To be read by the interviewer:

> *A "critical incident" or "telling moment" is a defining moment in your experiences. It is an event or series of events that you associate with a significant change or shift in practices, insights or attitude for your student. At times this can be as simple as a passing conversation through to a chain of experiences. In relation to the following questions we are focused primarily on your "academic" experiences, and in specific your interaction with your student, their research activities and more generally the process of Doctoral study. This provides the context but it does not preclude the inclusion of influences, experiences or events that occur outside of the milieu of supervision.*

1. How do you know when your student is/has made substantial progress in their thinking about their project? What are indicators that you look for?

2. Describe a critical incident where you could "see" you student making significant "breakthrough" their thinking about their project.

- What factors contributed to this breakthrough
- How do you believe this influenced your students actions/thinking from this point
- What role did you play in this process

3. Describe a critical incident where you could "see" your need to move beyond their current "understanding or thinking" in relation to their project.

- How did you know they were "stuck"?
- What factors contributed to this difficulty
- What strategies, if any, did you employ to assist them?
- Why did you select these strategies?
- What role did your supervisor play in this process?

4. Please respond to the following statement
"PhD study is not about mastering a discipline, it is about developing an attitude or style of thinking"

- How did you come to hold your point of view in relation to this statement?
- On what do you base this point of view?
- How is it possible that people have different points of view about this statement?

5. Over the course of you supervision what differences/changes have you observed your students "thinking"?

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