PATTERN RECOGNITION IS A CLINICAL REASONING PROCESS IN MUSCULOSKELETAL PHYSIOTHERAPY

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STATEMENT OF ORIGINALITY

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 this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying subject to the provisions of the Copyright Act 1968.

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Date _____

Signed _____

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ABSTRACT

Pattern recognition is a non-analytical clinical reasoning process which has been reported in the medical and allied health literature for some time. At a time when clinical problem solving was largely considered to consist of the analytical process of hypothetico-deductive reasoning, pattern recognition was introduced in the literature with observations of greater efficiency and accuracy. The research that followed these apparent opposing models of clinical reasoning resulted in significant growth in the understanding of problem solving in healthcare. On commencing this thesis the knowledge surrounding pattern recognition in physiotherapy was insufficient for its inclusion in educational design. Consequently the aims of the study described in this thesis were to clearly identify pattern recognition using high fidelity case methods and observe its relationship with accuracy and efficiency.

The study utilised a single case study with multiple participants. A real clinical case with a diagnosis of high grade lumbar spine spondylolisthesis was simulated using a trained actor. This provided a high fidelity case study method allowing the observation of more realistic problem solving practices as compared with the common low fidelity paper case approach.

Two participant groups were included in the study to investigate the common belief that pattern recognition is an experience based reasoning process. The expert group comprised ten titled musculoskeletal physiotherapists with a minimum of ten years overall clinical experience and greater than two years experience following the completion of postgraduate study. The novice group included nine physiotherapists in their first year of clinical practice following completion of an undergraduate degree.

Qualitative data collection methods included observation of the participant taking a patient history of the simulated client and a stimulated retrospective recall interview with the participant. The mixed method analysis used in the

study provided methodological triangulation of the results and supported the presence of pattern recognition in musculoskeletal physiotherapy. The quantitative research findings indicated that pattern recognition was significantly more likely to produce an accurate diagnostic outcome than analytical reasoning strategies during a physiotherapy history. However its use was not a guarantee of success with only three of the four experts using pattern recognition identifying the correct diagnosis. Although four experts utilised pattern recognition as compared with only one novice, no significant overall differences were found in the use of pattern recognition between the expert and novice participant groups. The findings relating to time data found that expert participants took longer to conduct the client history than novices. Similarly those participants identified using pattern recognition also required more time which seemingly contradicts the view of pattern recognition being an efficient clinical reasoning process. This finding was limited by the incomplete nature of the study which did not include a physical examination or any client management.

ABBREVIATIONS

APA	Australian Physiotherapy Association
E	Expert
HDR	Hypothetico-deductive reasoning
LBP	Low back pain
MPA	Musculoskeletal Physiotherapy Australia
N	Novice
PR	Pattern recognition
SIJ	Sacro-iliac joint

CHAPTER 1. INTRODUCTION

Clinical reasoning is a vital skill in physiotherapy. It requires critical thought, needs to be practiced with reflection and is adapted to each unique situation. The clinical reasoning process is the problem solving that occurs during clinical encounters which integrate client specific information with individual practitioner knowledge.

The clinical reasoning literature describes a few core models of reasoning from the medical research and several other models based on qualitative physiotherapy research over the past decade (Edwards & Jones, 2007). These models complement each other and provide an overall view of problem solving that adapts to the requirements of decision-making in everyday clinical practice. The original reasoning models are associated primarily with diagnostic reasoning and are commonly known as forwards and backwards process models (Edwards & Jones, 2007; Higgs & Jones, 2000). Forwards and backwards refers to directional movement of the data collection during a clinical encounter. The most common forwards and backwards models are pattern recognition (PR) and hypothetico-deductive reasoning (HDR) respectively.

The educational implications for PR as a forwards reasoning process model in physiotherapy were initially considered as a topic of research. However a review of the relevant literature found the level of understanding of PR in musculoskeletal physiotherapy to be insufficient to enable such educational research. PR as a phenomenon needed to be better understood first.

1.1 RATIONALE OF THE STUDY

The clinical reasoning model of PR and its attributes form the basis for the research study reported in this thesis. Its existence as a diagnostic reasoning model has acceptable evidence in medicine based on profession specific research and psychology foundations (Norman et al, 2007). The research in

both of these domains underpins its current understanding in physiotherapy, however questions relating to its existence and advantages remain within the profession (Jones & Rivett, 2004).

PR has great potential as an efficient reasoning strategy (Arocha et al, 1993; Higgs & Jones, 2000; Ridderkhoff, 1989). The modern healthcare climate has increased scrutiny on the value of all services and challenged time efficiency in physiotherapy clinical practice. The medical profession has also provided a view that experts are able to generate accurate clinical outcomes via PR (Coderre et al, 2003). Efficiency and accuracy are unquestionably desirable in relation to clinical reasoning in modern healthcare.

Pressures for cost effectiveness in physiotherapy practice also have the possibility to enforce potentially time saving clinical reasoning processes upon clinicians without sufficient knowledge or experience. The consequence of inappropriate use of PR in physiotherapy is increased risk of clinical reasoning error (Jones, 1992). In particular, its use by novices without sufficient knowledge or experience is commonly agreed to have negative effects on clinical outcomes (Coderre et al, 2003; Norman et al, 2000; Norman, 2005).

Despite the large amount of literature relating to PR, insufficient research is available to provide sound conclusions regarding the value of PR as a diagnostic reasoning process in physiotherapy. It is currently a commonly used term in the physiotherapy literature without being well understood.

1.2 STUDY AIMS

This explorative study aimed to provide greater insight into PR use in musculoskeletal physiotherapy practice. It utilised a high fidelity case study to answer questions in relation to the existence and consequences of PR as a reasoning strategy. The project specifically aimed to:

1. Determine whether PR is utilised by expert and novice clinical physiotherapists in the musculoskeletal field
2. Relate the use of PR to efficiency within a physiotherapy assessment
3. Relate the use of PR to accuracy within a physiotherapy assessment

1.3 THESIS OUTLINE

This thesis is divided into 6 chapters including this introduction. Chapter 2 summarises the existing clinical reasoning literature in relation to PR as a clinical reasoning process. It also provides the background in relation to methodologies and findings of similar studies in the literature. The method of the study is described in Chapter 3 with respect to the research questions. Chapter 4 provides the results of the study including the supporting qualitative data. The findings of the study are discussed in Chapter 5 and the overall conclusions of the study form Chapter 6.

CHAPTER 2. REVIEW OF THE LITERATURE

2.1 BACKGROUND

Clinical reasoning is a problem solving process undertaken in healthcare. It refers to a process that integrates cognition and knowledge in clinical practice resulting in decision-making with a client (Higgs & Jones, 2000) for the purpose of achieving realistic and meaningful goals. Clinical reasoning research commenced in the medical profession more than 30 years ago and has resulted in the development of various models that attempt to explain the process (Norman, 2005). These empirical models have been adapted and further developed in other health professions, whilst further models have more recently been developed in the interpretive research paradigm (Higgs & Jones, 2000). Clinical reasoning is undoubtedly complex and multifaceted in nature and can be considered somewhat specific to each individual health profession. The terms clinical reasoning and problem solving are interchangeable terms and will be used as such within this thesis. Decision-making is also used synonymously with clinical reasoning in the literature, however this term has been differentiated from clinical reasoning, as indicated in Figure 2.1.

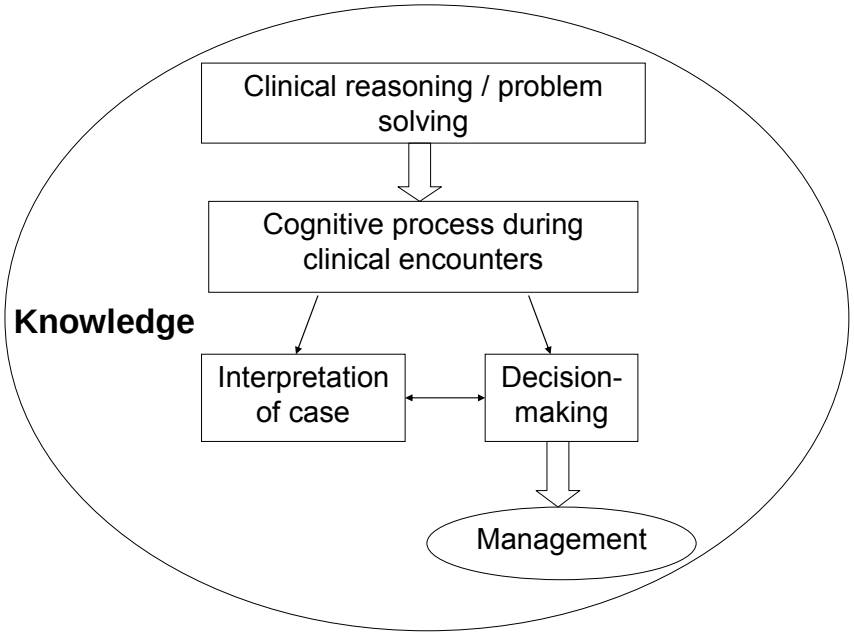

Figure 2.1 Relationship of clinical reasoning to decision-making

2.1.1 Literature search strategy

For the purpose of this literature review, searches were conducted in several databases to maximise the capture of information relevant to the topic. Medline, CINAHL, PsycINFO and AMED databases were searched using both MeSH headings (if available) and key words. The MeSH headings utilised included problem solving, decision-making and diagnosis (differential). Key words searched in isolation and combination included: clinical reasoning, pattern recognition, hypothetico-deductive reasoning, cognition, metacognition, knowledge, expert / expertise, experience and physiotherapy. These databases were searched for English papers only throughout all available years. The 'find citing articles' command contained in individual databases was used to search for more recent relevant articles. Each paper's reference list was scrutinised to identify further articles not located in prior searches. Searches were repeated during the entire period of the study to ensure that recently published papers were included.

2.1.2 Problem solving in physiotherapy clinical practice

The physiotherapy health profession has several proposed models that describe and interpret the clinical reasoning process. These have developed over several decades and across empirical and interpretive research paradigms. The empirical research basis of physiotherapy clinical reasoning lies predominantly within the medical literature, which has progressed through the domains of hypothesis generation, memory performance and knowledge organisation (Norman, 2005). Physiotherapy problem solving research initially followed the medical profession within the empirical paradigm, concluding that no single model or type of reasoning can be stated as preferable. It was subsequently influenced by the interpretive paradigm towards a complex expansion of reasoning models. All models of physiotherapy clinical reasoning are now viewed as more closely related

based on observations of concurrent use within a clinical decision-making process (Edwards & Jones, 2007).

2.1.3 Integration of paradigms

Jones and associates (Jones, 1995; Jones et al, 2000) describe a collaborative hypothesis oriented model of clinical reasoning which is centred on achieving diagnostic understanding and optimal decision-making in collaboration with the client. Developed within the empirico-analytical paradigm, the collaborative hypothesis oriented model has subsequently been challenged by the interpretive research paradigm. It has been argued that important elements of continual collaborative and interactive involvement with the client during the problem solving process, and additional strategies such as ethical, predictive and narrative reasoning (Edwards et al, 2004; Higgs & Jones, 2000) provide a better overall understanding of physiotherapy problem solving across the sub-disciplines.

The generation of a diagnostic understanding in musculoskeletal physiotherapy, similar to medical reasoning, is an important element of clinical practice and education. However clinical reasoning is known to involve more than just diagnosis (Edwards et al, 2004). The complexity of clinical reasoning has led to the expansion of models within the interpretive research paradigm in an attempt to further understand clinical reasoning based on phenomenology (Higgs & Titchen, 2000). Humanistic research has allowed physiotherapy clinical reasoning to be understood via interpretive models, such as collaborative, narrative, interactive, predictive and ethical reasoning (Edwards et al 2004; Edwards et al, 2005; Higgs & Jones, 2000). These models have provided a clearer picture of what occurs in physiotherapy problem solving and also highlighted that although diagnostic reasoning is an important component of problem solving, its role is limited within the more complex clinical cases presenting to physiotherapists.

Integrating research paradigms is useful in providing a better understanding of clinical reasoning. Edwards and Jones (2007) have comfortably integrated both empirico-analytical and interpretive paradigms into their understanding of clinical reasoning but without requiring a process model as previously developed. In particular, they describe the use of interpretive reasoning skills with more complex clinical encounters where management without diagnosis is commonplace. The empirico-analytical reasoning models are comparatively described in relation to more characteristic clinical presentations with recognisable management strategies.

The development of reasoning strategies in the interpretive paradigm can be viewed as observations from clinical practice. The interpretive paradigm does not specifically look at the outcome resulting from the reasoning pathway or process but rather a whole phenomenon in a real context (Higgs & Titchen, 2000). Interpretive reasoning strategies (Table 2.1) have been understood in the physiotherapy profession via qualitative multiple case study research (Edwards et al, 2004; Jensen et al, 2000). These strategies have been observed to simultaneously exist in physiotherapy practice and are not isolated strategies to facilitate decision-making. Additionally, these interpretive strategies can co-exist alongside empirical reasoning models such as those associated with diagnostic reasoning (Edwards & Jones, 2007).

Table 2.1 Interpretive reasoning strategies

(Edwards et al, 2005; Edwards & Jones, 2007; Higgs & Jones, 2000)

Reasoning strategy	**Brief description**
Collaborative	Cooperative goal setting and decision-making regarding management
Ethical	Consideration of ethical dilemmas within decision-making and management
Interactive	Social interaction as a means of developing rapport with client and enhanced understanding of their perspective
Narrative	Interprets the complexity of the client's personal perspective of their problems via story telling
Predictive	Predicting implications of management options within decision-making
Procedural	Relating to treatment / management procedures
Teaching	Client education towards further understanding of the person and their problems

The empirico-analytical hypothesis models are based on process or pathway throughout a clinical encounter and are particularly suited to diagnostic reasoning. The collaborative hypothesis oriented model (Jones, 1995; Jones et al, 2000) integrates backwards (deductive) reasoning and forwards (inductive) reasoning and entwines knowledge and cognitive skills throughout the process. Specific clinical reasoning models relating to backwards and forwards reasoning types include HDR and PR respectively which are also described alongside diagnostic reasoning. A basic view of the different reasoning types commonly used in diagnosis and management has been provided in Figure 2.2. This view is not to limit the scope of any single

reasoning type but rather to introduce PR and HDR as primarily diagnostic reasoning strategies.

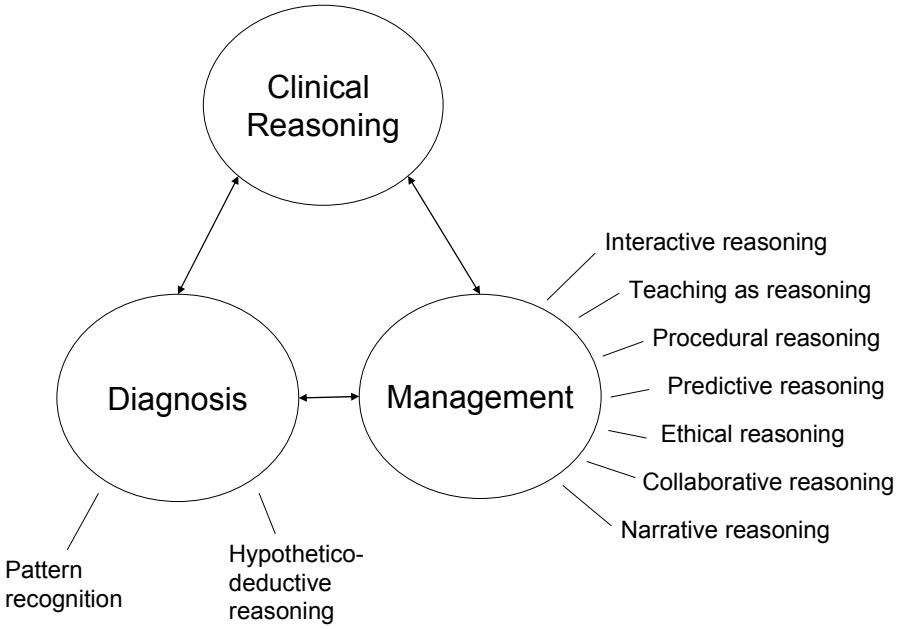

Figure 2.2 Reasoning strategies within diagnosis and management (based on Edwards & Jones, 2007)

HDR refers to the generation and testing of hypotheses based on clinical information obtained during an entire patient assessment (Higgs & Jones, 2000). It moves in both forwards and backwards directions with several hypotheses until sufficient evidence is gained to support a predominant hypothesis. PR is a purely forwards reasoning process and refers to the generation of a single hypothesis based on instant recognition of significant case features (Coderre et al 2003; Ridderkhoff, 1991). The empirico-analytical models of HDR (Section 2.4) and PR (Section 2.5) will be examined in further detail with respect to the physiotherapy and medical literature. Hypothesis generation and testing will also be explored as the basis of both reasoning models.

More recently the terms analytical and non-analytical models of clinical reasoning have been used to encompass HDR and PR respectively (Norman et al, 2007). The term non-analytical reasoning has in essence been used as another name for PR. It seeks to separate experience based models from methodical problem solving processes associated with unfamiliar circumstances. The present chapter has primarily made reference to the original terms of HDR and PR, whereas Chapters 4 and 5 have also used the more contemporary terms of analytical and non-analytical reasoning.

2.2 CLINICAL REASONING RESEARCH METHODS

An important pre-requisite to critique any study is an understanding of the relevant research methods. This section provides a summary of the methods suited to clinical reasoning research. Following this section, the clinical reasoning literature on PR will be interpreted.

Pre-eminent among the plethora of qualitative research approaches is case study methodology which may investigate one or more cases within a given setting (Creswell, 2007). A case study is uniquely able to provide a view of a specific situation in an authentic setting. Yin (2003) describes the single case study as a useful means towards testing existing theory. This type of method has been extensively used in medical problem solving research over the past 20 years and continues to be a popular choice amongst physiotherapy researchers (Doody & McAteer, 2002; Edwards et al, 2004; Jensen et al, 2000; Noll et al, 2001; Smart & Doody, 2006).

2.2.1 Single case study design

A case study design is a suitable method to investigate clinical decision-making and problem solving. A single case study is appropriate when the phenomenon under investigation is known and a single ‘critical case’ allows it to be further examined (Yin, 2003). A single case study in clinical reasoning

research can include a variety of methods from real to paper cases, with each offering their own benefits.

2.2.2 Simulated case design

Case methodology in decision-making and problem solving research allows for a more thorough understanding of a health professional's thought processes and actions. Case studies have the opportunity to be wide-ranging in design to accommodate the needs of the researcher. The design may incorporate the use of consistently reproducible and low cost paper or electronic text cases (Arocha et al, 1993; Coderre et al, 2003; Coughlin & Patel, 1987; Grant & Marsden, 1987, 1988; Hasnain et al, 2004; Joseph & Patel, 1990; King & Bithell, 1998; Patel & Groen, 1986; Patel et al, 1990; Patel et al, 1993; Ridderikhoff 1985), however these limit the uniqueness of a clinician's data collection search and offer no visual data during the process. Video sources of client data (Rivett & Higgs, 1997) allow for visual information to be incorporated into problem solving but also lack the interaction necessary to effectively transfer results to everyday clinical practice. At the opposite end of case methodology is the use of real client cases (Doody & McAteer, 2002; Edwards et al, 2004; Embrey et al, 1996; Gale & Marsden, 1982; Jensen et al, 2000; Noll et al, 2001; Payton, 1985) which enable a mostly natural flowing process but are limited in their reproducibility. A mid-point between the two ends of the spectrum is case methodology involving simulated clients. Simulating a situation that can be assessed in a real person allows for unique case data exploration but is reproducible to allow for direct comparison. Such methods have been employed in health based problem solving research (Elstein et al, 1978; Ladyshewsky, 2002, 2004; Nendaz et al, 2004; Norman et al, 1985; Ridderikhoff, 1991).

2.2.3 Simulated client assessments

Utilising simulated patients is quite common in education and research. A simulated patient refers to a person who portrays the role of a patient for specific educational or research purposes. They allow for more realistic interaction with clinical reasoning tasks, including the integrated search for data and cognitive processing during problem solving. The use of real or simulated patients in clinical reasoning research has been referred to as high fidelity methods, as compared with the low fidelity methods of paper or electronic based cases (Doody & McAteer, 2002; Ladyshewsky et al, 2000). High fidelity research methods are comparatively more costly and time consuming however allow for more realistic and richer data.

Clinical reasoning research has extensively used low fidelity methods, providing results that underpin the theoretical base of problem solving including its inherent complexity. However these studies are largely contrived in nature and lack face validity for understanding all aspects of clinical reasoning in everyday clinical practice.

Further investigation of the use of PR within physiotherapy clinical reasoning requires a valid method that enables all information to be immediately available for a clinician. This enables independent choice of the pathway through the data available. It is for this reason that low fidelity methods lack the ability to clearly differentiate the use of PR from the more widely used HDR strategy (Coderre et al 2003; Elstein et al, 1978). Section 2.5.1 discusses this in further detail.

A reported limitation of simulated client research relates to how accurately a situation can be repeatedly portrayed. However the ability of a simulated patient to provide consistent information in a physiotherapy context has been investigated by Ladyshewsky et al (2000) who concluded that “researchers interested in evaluating … the clinical reasoning process can use simulated

patient technology as a means of introducing much needed experimental control in their studies" (p.24).

2.2.4 Verbal reported data

High fidelity methods examining clinical reasoning are reliant on verbal reported data. Verbal reporting is a means of accessing the participant's thoughts when engaged in a cognitive task. Two methods utilised to obtain this cognitive information in health based problem solving research are simultaneous recall and retrospective recall (Patel & Arocha, 2000). Simultaneous or immediate recall occurs during the collection of clinical information, whereas retrospective recall follows and consequently does not influence the normal process of clinical assessment.

Simultaneous recall occurs most commonly via 'think-aloud' protocols, which require the participant to make explicit their understanding of a case either verbally or in writing at the time of thinking. Ladyshewsky (2004) reports these are "assumed to be direct representations of what is stored in short-term memory" (p.18). Simultaneous think-aloud methods are considered an excellent means of obtaining actual cognitive processes from the time of an event, resulting in high correlation between data obtained and actual thought processes. However think-aloud methodology also has the potential to facilitate metacognition and create forced reflection-in-action within participants which could significantly alter the behaviour of participants compared with routine clinical practice. A clinician who is skilled may not be influenced by this method, however it is likely to substantially alter the behaviour of those not so competent.

Retrospective recall involves the verbalisation of thoughts after a cognitive task, which has been reported as an appropriate method to obtain the participant's actual thoughts from the time of a cognitive event (Ladyshewsky, 2004) but without influencing the clinical assessment process.

A particular method of retrospective recall involves a stimulus to trigger prior cognitive thoughts (Elstein et al, 1978; Ladyshewsky, 2004). Observing a video replay of an assessment is considered an ideal stimulus for recall and has been utilised in several studies investigating clinical reasoning (Embrey et al, 1996; Gale & Marsden, 1982; Jensen et al, 2000; Noll et al, 2001). It is important that during the video replay the subject actually verbalises their thoughts from the cognitive event without 'theorizing' at the time of recall (Patel & Arocha, 2000). Timing of recall is important to ensure optimal accuracy of verbal reporting. Although delayed thoughts are reported to utilise a subject's short and long term memory, the data obtained is considered sufficiently similar to the thoughts during the actual event (Ladyshewsky, 2004). Immediate review of the cognitive event allows for a high level of accuracy of data obtained via stimulated recall. Any increase in time delay following the event reduces the accuracy of recalled thoughts (Barrows, 2000; Ladyshewsky, 2004; Patel & Arocha, 2000).

Verbal reported data has been criticised by some authors based on the potential for participants to adapt to the study and report what they think the researcher wants to hear (Elstein et al, 1990; Elstein & Schwartz, 2000). The alternative research methods enabling investigation of clinical reasoning have been those utilised in conventional psychology research which emphasise the relationship between the observed responses to each stimulus rather than participant's verbalisations (Elstein et al, 1990; Elstein & Schwartz, 2000). This study method also has its limitations, particularly with respect to face validity when generalising results to real life clinical reasoning. Collectively, the use of these different research methods should in fact provide a better overall understanding of clinical reasoning.

2.2.5 Retrospective interview

A participant interview stimulated by video replay immediately following the cognitive event provides a valuable source of verbal reported data. The use of interviews to obtain research information is well recognised in many

professional fields (Britten, 1995) with those following an event referred to as retrospective. Clinical reasoning research in physiotherapy has commonly incorporated retrospective interviews with high fidelity studies (Doody & McAteer, 2002; Edwards et al, 2004; Embrey et al, 1996; Jensen et al, 2000; Noll et al, 2001). Careful consideration of interview method and structure is necessary to obtain the required information that will answer the research question.

Qualitative interviews can take a more or less structured form dependent on the research aims. At one end of the spectrum ‘structured interviews’ are based on standardised questionnaires which offer little flexibility to explore the topic being considered. ‘Semi-structured interviews’ however allow for more broad discussion via open ended questions configured to direct the conversation yet allow the participant the liberty to converse freely (Britten, 1995). At the opposing end of the spectrum ‘in depth interviews’ have little structure allowing the participant even more freedom in dialogue. These are more appropriate to a grounded approach and suited to developing rather than testing theory.

Skilled interview technique is imperative to obtain quality data and meaningful research outcomes (Britten, 1995; Barrows, 2000). Regardless of whether or not the interviewer is the researcher, rapport must be built with the participant and an atmosphere of trust developed. This includes an explanation of the purpose of the interview and clear instructions that there are not right or wrong responses. Any verbal or non-verbal response should not be perceived by the participant as judgmental or critical. The interviewer’s verbal inquiry and listening skills should give control to the participant. Most importantly it is recognised that a researcher conducting interviews should not bring their own beliefs to a topic and should strive to keep an open mind to new possibilities.

An interview must direct data collection towards useful information relative to the research question. Interviews designed to validate physiotherapy clinical

reasoning theory require careful design of a semi-structured interview to minimise reflection during stimulated recall but encourage recollection of thought processes from the actual event. Audio or video technology captures all information from an interview and allows for critical appraisal of interview technique to ensure maximum value from the data.

2.2.6 Observational data

Observation of a participant's behaviour is another data source that is valuable in decision-making research. It is insufficient alone to provide a good understanding of the cognitive actions of a health professional during clinical practice but offers additional information that can support other data sources such as verbal transcripts. Observations are a rich data source that allow for behaviour to be observed in context. Videorecording during a therapist assessment has a minimal effect on behaviour and allows for subsequent qualitative or quantitative analysis.

2.2.7 Mixed Methods

Mixed method research refers to merging the desired aspects of qualitative and quantitative research in single or multiple studies. Particularly within a single study the use of both qualitative and quantitative data sources is becoming more accepted as an approach to conducting research. Although it has been previously reported as a means of achieving triangulation (Patton, 1990), the recent development of mixed method research as a stand alone methodology recognises the value of integrating the traditionally separate methods to provide greater strength in certain areas of research (Barbour, 2008; Creswell & Plano Clark, 2007). This type of methodology provides great value in circumstances where either source of traditional data alone is unable to provide a satisfactory understanding of the topic being investigated.

The identification of diagnostic reasoning process models requires careful exploration of a clinician's thoughts. To obtain such information requires a

study to utilise qualitative data sources such as observation or verbal reporting, as has been extensively and appropriately used to date. However, two commonly reported mixed method approaches suited to research in clinical reasoning include embedded and triangulated designs (Creswell & Plano Clark, 2007).

Embedded Design

The embedded design type generates either qualitative or quantitative data from within the other. In clinical reasoning research the quantitative data is generally obtained from within the qualitative sources and adds weight to the overall interpretation (Figure 2.3). This type of embedding is similar to that described by Yin (2003) where multiple levels or 'subunits' of qualitative data are embedded within an overall single case study.

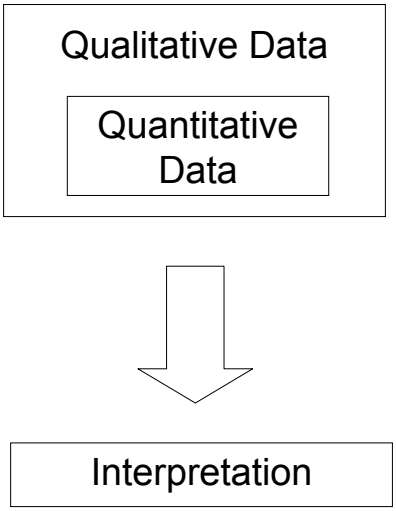

Figure 2.3 Embedded design (Creswell & Plano Clark, 2007)

Qualitative data sources common in problem solving research include verbally reported and observational data. The qualitative component usually outweighs the quantitative element which provides a supporting role in the overall interpretation (Cresswell & Plano Clark, 2007). Quantitative analysis

can vary from simple number counts to more complex statistical analysis depending on the data generated. Embedded designs are useful in providing greater strength to research studies of existing theory.

Triangulation

Triangulation is a well documented method of validation in qualitative research, referring to the use of multiple perspectives on the same research question within a single study (Patton, 1990; Richards & Morse, 2007). Although most commonly recognised in pure qualitative research, the use of both qualitative and quantitative data sources to achieve triangulation is reported as a mixed method approach (Creswell & Plano-Clark, 2007).

Integrating data sets allows for a more detailed understanding of the entity under investigation. A second data set in parallel with an embedded design allows for a triangulation design (Cresswell & Plano Clark, 2007) as indicated in Figure 2.4. This is reported as a type of methodological triangulation (Sim & Wright, 2000) which may involve differing data sources within mixed method research. Other types of pure qualitative research triangulation are beyond the scope of this thesis.

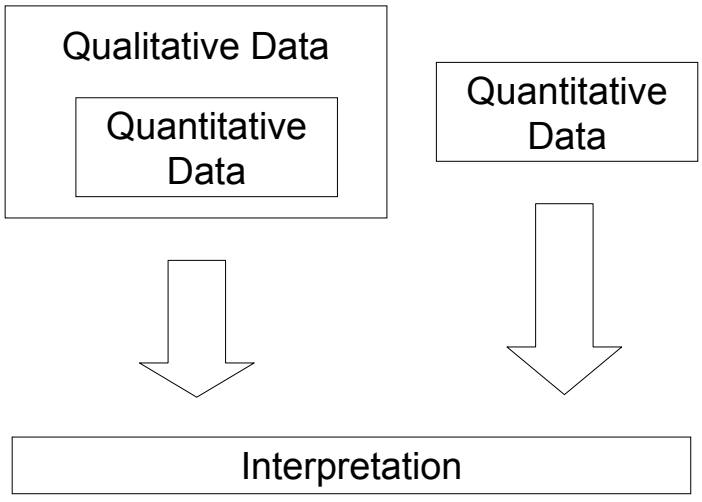

Figure 2.4 Triangulation design (Creswell & Plano Clark, 2007)

2.3 HYPOTHESIS GENERATION

Physiotherapy clinical reasoning results in the generation of hypotheses. Musculoskeletal physiotherapy in particular relies on an initial assessment to gain a hypothetical understanding of each client's case and continual reassessment of this hypothesis. Previous research has shown that musculoskeletal physiotherapists do generate hypotheses during patient assessments (Payton, 1985; Rivett & Higgs, 1997). The study conducted by Rivett and Higgs (1997) involved a video-taped patient history of a lumbar disorder. They found all nineteen physiotherapists, with varied levels of experience, generated hypotheses. The development of hypotheses is considered essential to interpret and manage the considerable amount of data available in a clinical encounter.

The nature of a hypothesis should be considered when interpreting previous problem solving research. A hypothesis in clinical reasoning should be regarded as the understanding or interpretation of the presenting information at any stage of the process (Rivett & Higgs, 1997). There may be a single hypothesis or several competing hypotheses whilst undertaking clinical reasoning. Groen and Patel (1985, p. 95) define a hypothesis as "a verbal statement about a situation that may either be true or false". It is essential that a clinician undertakes an assessment to interpret and understand the presenting problems. A clinician's understanding can be represented as a working hypothesis that can be tested to confirm or negate its accuracy. In other words, the hypothesis becomes the basis for further reasoning and testing (Anderson, 1989).

The use of the term hypothesis in clinical reasoning should be separated somewhat from that utilised in scientific research. Ridderkhoff (1991) discusses the less precise use of the term 'hypothesis' in clinical problem solving as compared with the specific meaning of the word in scientific research. In clinical practice, testing via questioning or physical examination

may provide information that rejects the primary hypothesis, however the clinician rarely sets out to disprove their hypothesis (or prove the null hypothesis) which is often the case in experimental research. It has been suggested by prominent researchers in medical clinical reasoning that confirmation strategies are more often utilised in clinical problem solving than those that negate a hypothesis (Arocha, Patel & Patel, 1993). Physiotherapy clinical reasoning includes testing that may confirm or reject a clinical hypothesis, however it is unknown if either is more commonly utilised.

The complexity of a patient encounter requires hypothesis formation to manage and organise the presenting information throughout the entire process. Hypothesis generation has been stated as a "psychological necessity" due to the potential complexity of a clinical case (Elstein, Shulman & Sprafka, 1990, p. 9). The information available from any patient often outweighs the capacity of the working memory and requires 'chunking' groups of information. One possible means of separation or chunking of clinical data involves using groups of hypotheses known as categories.

2.3.1 Hypothesis categories

Clinical hypotheses may be developed under the guise of various categories. Several versions of hypothesis categories have been reported in the medical (Barrows & Feltovich, 1987) and physiotherapy literature (Jones, 1992; Jones & Rivett, 2004; Payton, 1985; Rivett & Higgs, 1997). Categorising hypothesis types is beneficial from a research and educational viewpoint. These divisions in thought processing have evolved alongside the progressive models of healthcare, such as the mature organism model (Gifford, 1998; Jones & Rivett, 2004). Jones and Rivett (2004) have detailed several categories (Table 2.2) that are suited to hypothesis generation in current musculoskeletal physiotherapy practice and are influenced by progressive healthcare models such as Gifford's mature organism model (1998). These categories allow for an overall clinical understanding within health and

disability models that provide a more holistic view of a person and their problem rather than merely the pathology.

The hypothesis categories in Table 2.2 allow for a broad array of possible clinical descriptions within the same clinical case. The utilisation of some of the individual categories as reported by Jones and Rivett (2004) has not been investigated in current clinical practice and as such the relative frequency of their use remains somewhat unknown. Only a few studies of physiotherapy clinical reasoning have recorded frequency of use in differing hypothesis category classifications (Payton, 1985; Rivett & Higgs, 1997). Payton (1985) utilised the following categories (observed occasions in parentheses): pathological (3), pathokinesiological (18), pathophysiological (8), and psychosocial (5). Rivett and Higgs (1997) reported on an earlier version of those presented in Table 2.2, including: source of the symptoms and / or dysfunction, contributing factors, precautions for and contraindications to physical examination and treatment, management, prognosis, mechanisms of signs and symptoms, and reassessment. Consideration of hypothesis categories is useful reflection in preventing a narrow view of musculoskeletal physiotherapy clinical reasoning, or in other words expanding on basic impairment / structural problem solving.

Table 2.2 Hypothesis categories (Jones & Rivett, 2004, pp.13-20)

Category	Definition
Activity and participation	Concerns the capabilities or restrictions of an individual during a specific activity or being involved in a life situation.
Patient's perspective / psychosocial factors	An individual person's perspective may be considered in terms of their understanding, feelings or beliefs related to the presenting problems. The patient's perspective may be a contributing factor or a consequence of the pain or restriction in activity / participation, but either way may be relevant in the recovery process.
Pathobiological mechanisms	Consideration of tissue healing and pain mechanisms allows for reasoning related to initial onset or maintenance of signs and symptoms by the nervous system. Normal tissue healing can be a basis for hypothetical understanding of a patient's presentation. Pain mechanisms can help in understanding the activity or participation levels, patient's perspectives and physical impairments. These refer to the input mechanism of pain, the central nervous system processing of the input, and the output mechanisms that may result in distorted movement patterns and motor activity.
Physical impairments & associated structure / tissue sources	Impairments identified in the physical examination are atypical findings in the neuromusculoskeletal system. Associated pathological sources are the structures or tissues hypothesised to be related to the client's symptoms and signs. This category alone is insufficient to understand a problem, its effect on a patient or the reason for management.
Contributing factors	A causative factor may be "environmental, psychosocial, behavioural, physical / biomechanical, and even hereditary" (p. 17). This category refers to any aspect of a client's case that may contribute towards or is associated with the onset or maintenance of the presenting problem(s).
Precautions & contraindications	Hypotheses regarding precautions and contraindications to examination and / or treatment. The type of pathology / disorder, stage of healing, severity / irritability, and patient's perspectives must all be considered when hypothesising in this category. Precautions and contraindications can be viewed simply as safety related hypotheses.
Management & treatment	Any intervention to assist a patient towards recovery or achieving their stated goals, including specific treatment techniques, is considered a hypothesis in management or treatment.
Prognosis	Predicting a possible response to treatment intervention or an outcome for a particular problem / pathology is a prognostic hypothesis. Features of a case that may influence the outcome in a positive or negative way can be labelled as prognostic features.

2.3.2 Diagnostic hypotheses

A clinical diagnosis can be considered as the final hypothesis of a case that is most probable following examination and testing. Diagnostic reasoning in physiotherapy has been referred to as the process undertaken whilst forming a diagnosis within certain categories (Edwards & Jones, 2007), as listed in Table 2.2. Edwards and Jones (2007) state a diagnosis relates primarily to hypotheses of activity / participation and associated physical impairments and structure / tissue sources. It should also consider the pathobiological mechanisms and potential contributing factors. In other words, a physiotherapy diagnosis is typically limited to four of the eight hypothesis categories reported by Jones and Rivett (2004). Hypotheses relating to management, prognosis and precautions / contraindications should be considered equally important within problem solving although may not contribute to diagnostic reasoning. The patient's perspective / psychosocial factors category is noted as an essential consideration in any clinical encounter due to its impact on overall outcomes but this area is also arguably outside the scope of usual diagnosis within physiotherapy.

A diagnostic hypothesis within clinical reasoning refers to a statement that interprets a case (Joseph & Patel, 1990). Clinical reasoning research often enters into the experimental domain of accuracy which relies on a participant's diagnostic statement for comparison with a known outcome. This comparison is not without its own complications given the array of different descriptions for any given case study.

The range of hypothesis categories makes it possible that the same interpretation of a case could be labelled in several ways with respect to a final hypothesis. An example of a hypothesis combining several categories would be 'the patient is unable to climb stairs (activity restriction) with the mechanical limitation and pain resulting from excessive inflammation (pathobiological mechanism) within the synovial joint capsule of the knee

(structure / source)'. Alternatively a diagnostic hypothesis may lie within only one of the categories. Figure 2.5 displays the use of different hypothesis categories to explain the variations in stated final hypotheses despite a similar understanding of a case. This has implications for designing studies in diagnostic accuracy.

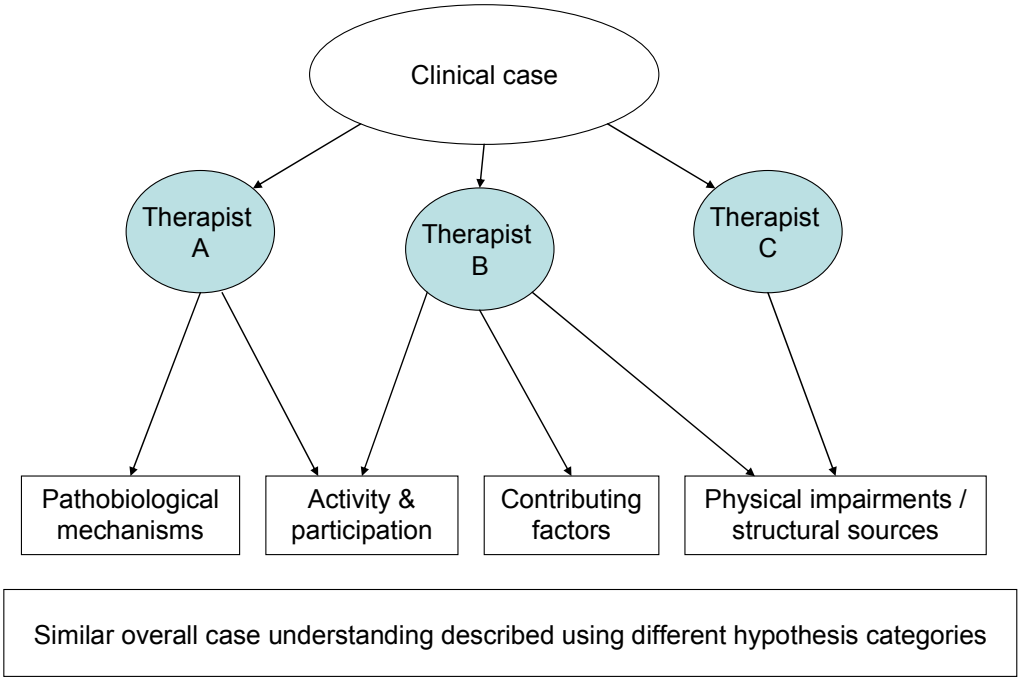

Figure 2.5 Example of diagnostic hypothesis variations based on the range of categories

2.3.3 Basis for empirico-analytical reasoning models

Hypothesis generation is the basis for empirico-analytical process models of clinical reasoning. Studies conducted by Elstein et al (1990) concluded that subjects generated hypotheses whether instructed to or not and also did so when specifically instructed not to. This clearly supports the view that hypothesis generation is central to clinical reasoning. Hypothesis generation is specifically a requirement for PR to be identified and is included as a stage of HDR.

2.4 HYPOTHETICO-DEDUCTIVE REASONING

HDR was initially developed as a general model of the clinical reasoning process. It allowed for the generation and evaluation of competing hypotheses as a result of collecting and interpreting clinical data. It provided an early understanding of clinical reasoning as a process or hypothesis generating pathway through a clinical encounter.

2.4.1 Defining hypothetico-deductive reasoning

The HDR model was first developed as a general problem solving strategy by Elstein and associates in the medical profession (Elstein, Shulman & Sprafka, 1978). It provided a sequence of problem solving stages that could be associated with any clinical encounter. As implied in the term, the deductive process refers to a search for findings to support or validate a limited number of previously generated hypotheses (Elstein & Schwartz, 2000). It has been the base of much clinical reasoning research and debate over the last three decades.

HDR commences with the ‘acquisition of cues’, which refers to collecting or gathering data from the many available sources throughout an organised clinical assessment (Elstein, Shulman & Sprafka, 1978). This search aims to identify cues that are relevant and meaningful to the clinician allowing for subsequent ‘generation of hypotheses’.

The second stage of ‘generation of hypotheses’ based on the relevant data acquired is necessary for problem solving in clinical practice (Elstein, Shulman & Sprafka, 1978). Hypotheses form a framework to consider a problem and guide further data collection. As previously discussed in section 2.3, this is a necessity when confronted with a substantial amount of clinical information.

The third stage relates to the evaluation of cues relevant to each hypothesis generated. ‘Cue interpretation’ requires awareness and knowledge of the various data sources to understand the value of each cue in supporting the hypotheses (Elstein, Shulman & Sprafka, 1978). The validity and reliability of each question in the history or specific test during a physical assessment must be considered fundamental for accurate cue interpretation.

The final stage of HDR is ‘hypothesis evaluation’ or judgement of competing hypotheses (Elstein, Shulman & Sprafka, 1978). This stage of the process attempts to achieve a final understanding of the case but can also trigger continued deductive stages. Although stated in four stages, these are not strictly linear in nature and overlap exists. The process undoubtedly starts with acquiring data and ends with evaluating competing hypotheses, however hypothesis generation and cue interpretation could occur concurrently in an experienced clinician. Data collection then continues throughout the entire process but it becomes more targeted in the later stages of the process. The development of HDR was an important step in understanding the intrinsic nature of medical problem solving.

2.4.2 Hypothetico-deductive reasoning in physiotherapy

The origins of clinical reasoning in physiotherapy relied heavily on the work of medical problem solving research. The identification of both hypothesis generation and HDR as a model of problem solving was initially found in musculoskeletal physiotherapy. An early physiotherapy study replicated that of Elstein and associates, which included physician assessment of simulated patients followed by video stimulated retrospective recall methodology (Elstein, Shulman & Sprafka, 1978). Payton (1985) investigated 10 physiotherapists assessing real patients and identified the application of all four stages of the HDR process. He concluded that similar clinical reasoning

was used by physicians and musculoskeletal physiotherapists (Payton, 1985).

The belief that HDR existed in musculoskeletal physiotherapy was further supported by Rivett and Higgs (1997) who utilised observation of a prior recorded video case in a problem solving study. This research involved both expert and novice physiotherapists who all generated hypotheses during problem solving, consequently providing further evidence that HDR was utilised in physiotherapy practice.

HDR has been incorporated in undergraduate and postgraduate physiotherapy programs as a structural basis for clinical reasoning (Higgs, 1993). However given that HDR cannot adequately explain all problem solving practices, its inclusion in teaching encouraged reflection on the analytical thought processes occurring during physiotherapy clinical reasoning. Professional education subsequently incorporated a profession specific model based on HDR (Jones, 1995; Jones et al, 2000) with the understanding that it is a process utilised within diagnostic reasoning, especially that of novices (Edwards & Jones, 2007).

2.4.3 Characteristics of hypothetico-deductive reasoning

HDR is known to be a slow but thorough analytic process that when utilised by a skilled clinician leads to effective management of more complex and / or unfamiliar situations. It is a process recognised in physiotherapy to continue beyond management strategies. Encouraging critical reflection on response to treatment interventions enables further evaluation and refinement of the final hypothesis.

An early criticism of the HDR model related to its generality, which refers to its applicability to all problem solving situations. All analytical problem solving models like HDR have generality limitations when attempting to understand clinical reasoning. The problem solving approach varies depending on the

case and the clinician's knowledge in the particular domain (Elstein et al, 1990; Groen & Patel,1985; Norman, 2005). The original misconception that HDR is the sole explanation for clinical reasoning should not reduce the value it has provided in understanding part of the problem solving process within medicine and physiotherapy.

HDR has also been criticised for being a strategy utilised predominantly when knowledge and experience is insufficient. Groen and Patel (1985) refer to the cognitive psychology literature on differences between novice and expert, and note that HDR is characteristic of novices. Expertise research in medicine supports this view via a lack of association between HDR processing and expert practice (Norman, 2005). This leaves us with the view that an expert operating in their domain does not generally use HDR processing, but novices who are attempting to develop a structured knowledge base across many areas of practice do rely on analytical and backwards problem solving strategies such as HDR.

The backwards nature of HDR and its relative use in less familiar situations is thought to result in overall inefficiency when compared with other forwards reasoning strategies. The formation and testing of several competing hypotheses during a deductive assessment process is slowed particularly by the need to gain information that supports or negates each hypothesis. HDR has been reported as a slow process when compared with inductive type processes or what is actually observed in experts within familiar situations (Arocha et al, 1993; Higgs & Jones, 2000; Jones & Rivett, 2004; Patel & Groen, 1986). Although relatively inefficient, HDR remains commonly utilised by novices and a 'fall back' strategy for experienced clinicians encountering complex or unfamiliar cases requiring a diagnostic approach.

2.4.4 Summary of hypothetico-deductive reasoning

HDR is a problem solving strategy utilised by physiotherapists (Payton, 1985; Rivett & Higgs, 1997), however it is limited in providing a full understanding of clinical reasoning (Norman, 2005). It provides a good structural basis to analytical problem solving within clinical practice but falls short of explaining all observations of clinical reasoning. HDR is considered applicable in situations where experience and knowledge isn't readily available with respect to the case at hand.

Diagnostic reasoning in physiotherapy practice should not be considered as either a backwards or a forwards process but rather an integration of process models. An integrated view of HDR and PR may provide a better understanding of diagnostic reasoning.

2.5 PATTERN RECOGNITION

Clinical reasoning in physiotherapy can at times be observed as recognition based on previous experience. This refers to patterns derived from experience with similar patients / conditions which form a prototype in a clinician's non-propositional knowledge base. The pattern is triggered when similar case features are confronted and a hypothesis relating to the presenting case is consequently formed. Like HDR, PR is a diagnostic reasoning strategy (Edwards & Jones, 2007) that can be employed at an appropriate time within problem solving. It has been associated with the terms inductive and forwards reasoning (Higgs & Jones, 2000) which refer to the movement from cues to hypothesis. In contrast, backwards or deductive reasoning moves from hypotheses back to clinical data for further testing of each hypothesis. Induction from cues and deduction from hypotheses (Arocha et al, 1993; Coughlin & Patel, 1987) creates a simple separation of forwards and backwards movement during clinical reasoning.

PR is notably only one type of several inductive models of clinical reasoning. Ridderkhoff (1989) also describes inductive-heuristic and inductive-algorithm, alongside PR, as inductive reasoning models. However it is PR that almost exclusively exists as a forwards reasoning model in the physiotherapy literature.

2.5.1 Defining pattern recognition

A barrier to understanding PR as an interpretation of the clinical reasoning process lies with its varied descriptions in the literature. There is a clear need for consistent terminology amongst researchers of clinical reasoning (Barrows & Feltovich, 1987), however the term ‘pattern recognition’ has been used with varied meanings (Gale & Marsden, 1983), a situation that continues at present. Despite the lack of a universal definition of PR, common elements have been identified from a review of the literature in medicine and allied health. Table 2.3 identifies the common elements of PR reported in the literature.

Table 2.3 Common elements of pattern recognition described in the literature

Element	Description	Research articles	Commentary
Timing	Immediate / almost instantaneous	Arocha et al, 1993 Coderre et al, 2003 Doody & McAteer, 2002 Groves et al, 2002	Caputo & Mior, 1998 Higgs & Jones, 2000
Result	Hypothesis formation	Coderre et al, 2003 Doody & McAteer, 2002 Noll et al, 2001	Round, 2000
Reliance	Organised knowledge from prior experience	Gale & Marsden, 1982 Ridderikhoff, 1985	Edwards & Jones, 2007 Norman et al, 2007 Rivett & Higgs, 1995
Utilises	Significant case features	Coderre et al, 2003 Groves et al, 2002 Noll et al, 2001	Caputo & Mior, 1998
Basis	Highly organised knowledge Prototypes of single patient or abstract model (several patients combined)	Ridderikhoff, 1985 Roberts, 1996	Caputo & Mior, 1998 Jones & Rivett, 2004
Direction	Forwards reasoning strategy	Coughlin & Patel, 1987 Noll et al, 2001 Patel & Groen, 1986 Patel et al, 1990	Edwards & Jones, 2007

The synthesis of these common elements found in the literature leads to an overall understanding of PR as a process within clinical reasoning:

> PR involves immediate hypothesis formation based on a pattern of highly significant features / cues recognised in a case that are matched with similar instances from prior experience. It is deemed to have occurred when a single hypothesis is formed based on a prototype from a similar case and context.

Single hypothesis

The stand out feature that clearly separates PR from other hypothesis generating models is the single dominant hypothesis. A recent study undertaken by Coderre et al (2003) attempted to determine the diagnostic reasoning strategy used by novices and experts in medicine. They labelled PR as one strategy and identified its use via “a single diagnosis with only perfunctory attention to the alternatives” (Coderre et al, 2003, p.703). Ridderkhoff (1989, 1991) also identified PR as a type of inductive reasoning with a single hypothesis.

It has been argued however that more than one hypothesis can be considered as a result of PR. Arocha et al (1993) refer to different data sources (cues) triggering different hypotheses within a forwards reasoning process. Although this is probably valid, it becomes increasingly difficult to separate PR from hypothesis generation within a HDR process when more than one unrelated hypothesis is present throughout a clinical assessment.

Significant case features

The utilisation of significant case features to move forwards within reasoning is also a key component of PR. The cues or features of the case utilised for hypothesis generation have been shown to influence the forwards reasoning

process. Patel et al (1990) demonstrated that comparison of irrelevant cues / features against the primary hypothesis disrupted the forwards reasoning process. On this basis, pure PR should be evident by the use of predominant significant case features that relate directly to the primary hypothesis. Contrary to this, following the generation of an initial hypothesis, any unrelated data collection may indicate a backwards process.

Information availability

A research design consideration has been reported in relation to identifying PR. Elstein et al (1978) contend HDR can only be utilised if all the clinical information is not initially present. This raises a technical issue whereby identifying PR using low fidelity methods (section 2.2.3) requires immediate availability of all case data. A recent study of diagnostic reasoning strategy utilised clinical case vignettes that had all the necessary information available to the participants (Coderre et al, 2003). However the use of such case vignettes with essential information available at the outset has also been criticised as having "problems of temporal unfolding" (Barrows & Feltovich, 1987, p.89). It is clear that clinical practice involves progressive data acquisition and a 'temporal unfolding' of information. These research design issues are best avoided by using high fidelity methods such as real or simulated clients.

A single hypothesis generated via PR can occur at any time throughout an assessment. Noll et al (2001) demonstrated that recognition of similar cases can occur during either the history or physical components of a physiotherapy examination. This finding is again important with respect to study design and would suggest PR research requires high fidelity methods.

In musculoskeletal physiotherapy a large number of visual cues such as non-verbal communication, body type, posture, and functional movement are quickly obtained via initial patient observation. Auditory data acquired by verbal communication are obtained sequentially. Tactile data along with the

observations of specific movements do not usually add to the assessment until a thorough understanding of the problem has already been formed (i.e. after reaching the initial hypothesis). Norman et al (1992) highlighted in radiology that a visual cue alone can trigger a diagnostic hypothesis. Figure 2.6 illustrates the range of cues within a physiotherapy assessment. This suggests that PR is more likely to relate to visual or verbal cues during the early stage of a clinical encounter but may possibly occur at any stage during an assessment.

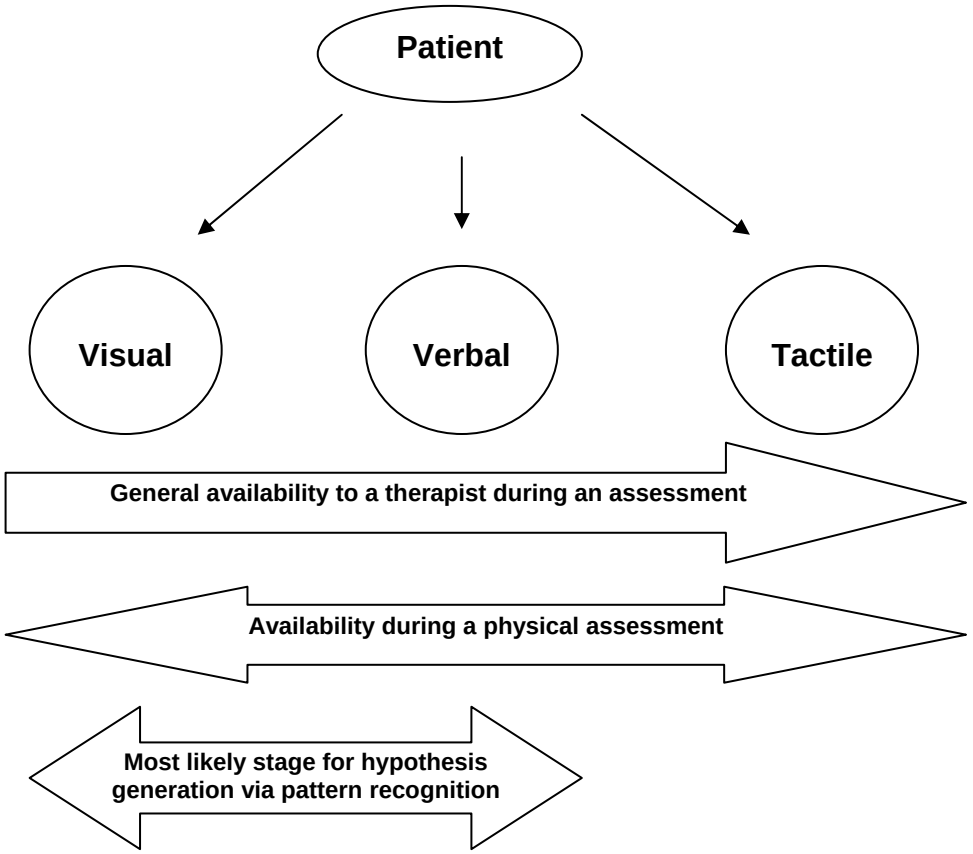

Figure 2.6 Available cues / data for developing hypotheses using PR

2.5.2 Pattern recognition in physiotherapy

Qualitative research in musculoskeletal physiotherapy has identified PR (Doody & McAteer, 2002; King & Bithell, 1998; Noll et al, 2001). However

varied definitions of PR create discord amongst the findings of these studies. Doody and McAteer (2002) described PR only by movement from hypothesis generation to evaluation and bypassing the appraisal of data relative to the hypothesis. Hypothesis evaluation in this study referred to assessing each hypothesis for best fit with the case. Noll et al (2001) reported PR as a qualitative code, labelled as a pattern of data (signs and symptoms) recognisable from prior experience and used to develop a working hypothesis. King and Bithell (1998) used only reported similarity to previous clinical experience, during a retrospective interview, as identification of PR. These studies provide some support for PR based on each researcher's understanding of the model, however the evidence supporting PR as a diagnostic strategy in physiotherapy lacks strength.

2.5.3 Characteristics of pattern recognition

The synthesis of PR definitions from the literature may provide some clarity in describing its elements as a model. Further insight can be provided with respect to knowledge, categorisation, efficiency and accuracy. These characteristics relate to or underpin PR as previously described and offer potential benefits within musculoskeletal physiotherapy research.

Knowledge

Knowledge is undoubtedly a factor when considering PR or inductive reasoning. The recognition of a unique clinical pattern is dependent upon an individual's propositional and non-propositional knowledge. A highly organised knowledge structure is reported as a basis for PR (Edwards et al, 2004; Jones, 1992). Clinical patterns rely on an elaborate network of clinical and biomedical / biopsychosocial knowledge structures. In other words, the clinical case is recognised by certain features but linked with a complex integrated understanding of the presentation. PR facilitates this knowledge link between clinical patterns and their underlying (knowledge) structures.

Categorisation

The theory of categorisation has been utilised when dissecting PR. Several authors advocate categorisation, which refers to the grouping of objects or events, as a means of understanding PR (Brooks et al 1991; Hayes & Adams, 2000), while others believe categorisation and PR utilise similar concepts in achieving a diagnosis (Elstein & Shwartz, 2000 & 2002). Categorisation specifically refers to the comparison of "two or more distinguishable cases, objects or events" (Hayes & Adams, 2000, p. 45). The recognition of a clinical pattern relies on finding a similarity between separate but similar cases and could therefore be considered as a type of categorisation.

Models of categorisation identified in the cognitive psychology literature are able to provide further insight into clinical reasoning. Hayes and Adams (2000) provide a summary of two models of categorisation relevant to medical clinical reasoning. First, the prototype model has features such as characteristic signs and symptoms of a condition, which have been abstracted and stored as a summary. The prototypes develop over time as a result of clinical exposure to similar cases. Cognitive psychology research has provided considerable support for the prototype model of categorisation (Hampton, 1998). Second, exemplar-based processing models involve each individual instance being memorised. The exemplar-based models have also been referred to as instance-based recognition where "a new instance is classified by resemblance to memory of a past case" (Elstein & Shwartz, 2000). A pattern may therefore be viewed as a single case from experience (i.e. exemplar) or more commonly one that is formed over time with multiple clinical experiences and associated integration of knowledge (i.e. prototype).

Categorisation clearly resembles PR at a superficial level, depending on the definitions applied. However one opposing view is that categorisation theory should be regarded not just by the recognition of patterns but rather as the grouping of knowledge structures with underlying meanings and associated

actions (Hayes & Adams, 2000). This view ultimately depends on the depth of understanding of PR.

A pattern can be simplistic in nature like the recognition of an acromio-clavicular joint injury from the description of a fall onto the point of the shoulder and the observation of a joint deformity on visual inspection. Even this simple pattern would likely have a knowledge base involving a network of Patho physiological, anatomical, prognostic and management features that are all enabled on recognition. At the other end of the spectrum, more elaborate and intricate networks of knowledge can allow recognition of more complex conditions such as cervicogenic headaches. These may be triggered by a known pattern using a few features of the case and then confirmed with further data collection. Regardless of the level of complexity, the clinical patterns of a reflective practitioner will have an underlying basis that is similar to that described in categorisation.

Efficiency

Efficiency in clinical practice has become a feature of modern healthcare provision. Considerable external pressure is placed on clinicians from various sources, including business management within both public and private sector practice. The government currently demands evidence of value for money in public sector health. Similarly the private sector has the internal pressure of maintaining financial viability in an economic environment that is becoming more client / user funded (Higgs & Jones, 2000). Clinical reasoning remains a complex and potentially imprecise part of healthcare, however some authors have argued that forwards reasoning strategies such as PR are more efficient (Arocha et al, 1993; Higgs & Jones, 2000; Ridderkhoff, 1989) and potentially cost effective than backwards reasoning models such as HDR. These claims are apparently based on plausible theory but as yet are not supported by research evidence within physiotherapy.

Early research in medical reasoning found that experts generate a diagnostic hypothesis earlier than novices during a patient's history (Joseph & Patel, 1990). More recent qualitative studies of physiotherapy clinical reasoning have also found differences in timing between novices and experts (King & Bithell, 1998; Doody & McAteer, 2002). The experts in these studies were however reported to spend more time taking a patient history and longer to express their initial hypothesis. This view supports earlier cognitive psychology research findings that experts are often slower during the initial phases of problem solving but are faster overall (Glaser & Chi, 1988). Doody and McAteer (2002) conducted an assessment of a real patient and compared the time taken for all parts of each management session. The experts spent less time on the physical examination, although this was not a statistically significant finding. Review of the small amount of data available relating to timing and efficiency does not produce any conclusive finding. Nevertheless, Doody and McAteer (2002) contend that experts have refined a more definitive hypothesis by the end of the patient history and use more specific confirmation testing during the physical examination, thus requiring less overall time compared with novices.

PR may indeed be associated with efficiency in clinical practice but only in those familiar cases associated with a well developed structure of knowledge. Any relationship between efficiency and PR is therefore reliant on familiarity and knowledge of the case at hand. PR may be an efficient process when used accurately by an expert in a given domain, however this possibility at present lacks empirical evidence.

Accuracy

The ability of an expert clinician to develop an accurate diagnostic hypothesis has been previously proposed to be influenced by the direction of reasoning. Early research in medicine has found associations between forwards reasoning and the accuracy of diagnostic performance (Patel & Groen, 1986). More recently, Coderre et al (2003) found similar results in that PR

had the greatest likelihood of producing an accurate diagnosis during their study. These studies notably included the use of low fidelity methods involving diagnosis of a written / paper case.

In professions such as radiology and dermatology that are largely based on visual perception, diagnostic accuracy has been associated with case feature recognition from previous cases (Norman et al, 1992). This provides some support for visual cues facilitating accuracy in PR, but is not the same as the more complex and multi-faceted interaction required in a physiotherapy assessment.

These medical studies generally support the contention that forwards reasoning strategies may be more accurate with experts, but all notably have utilised either visual cues or low fidelity paper case methods. Indeed, no studies have looked at diagnostic accuracy with high fidelity methods such as real or simulated patients.

Accuracy can only be assessed by comparison of a clinician's understanding of a case with the actual case diagnosis. Diagnostic hypotheses have been criticised by Gale and Marsden (1982, p.26) who believe that a diagnostic hypothesis focus may "overshadow equally important prior stages in the clinical problem solving process". This is true if the participant's focus is to produce a diagnosis, however a carefully designed study should be able to observe the reasoning processes undertaken and the evolving understanding of a case. This may result in a final diagnostic understanding in the form of a hypothesis without impacting on the processes utilised along the way.

There is only one study in the physiotherapy literature that sheds any light on the accuracy of the clinical reasoning process. King and Bithell (1998) conducted a study involving a segmentally reviewed paper case integrated with a structured interview. All five participants in the 'physiotherapy

specialist' group provided an accurate diagnosis compared with only one of five in the 'generalist' group. This study concluded that there is an association between diagnostic accuracy and reported recognition of previous cases. No studies investigating accuracy with respect to clinical reasoning process have been found which use high fidelity methods such as real or simulated patients.

Opposing views exist in the literature relating to the potential of PR to result in errors. Indeed the use of this form of reasoning by novices has potentially negative consequences due to the lack of consolidated clinical experience and a sound knowledge base (Coderre et al, 2003; Norman et al, 2000; Norman, 2005). Jones (1992) in particular has raised caution regarding the use of PR within physiotherapy assessment due to the increased risk of errors, referring to limited flexibility within hypothesis generation leading to errors in problem solving. Jones (1992, p.882) specifically warns that "anything that has any resemblance to a standard pattern will be seen as that pattern". This is more likely with respect to the clinician who is not a master of their domain.

The association between PR and accurate outcomes in diagnostic reasoning is not fully understood at present. The potential link between these problem solving variables is undoubtedly complex and dependent on knowledge structures and experience. No conclusive research evidence is currently available in physiotherapy that demonstrates PR is more accurate or alternatively leads to errors. The possibility that PR leads to more accurate outcomes in expert clinicians is worthy of further exploration.

2.5.4 Summary of pattern recognition

The diagnostic reasoning strategy of PR has been primarily reported in the medical and physiotherapy literature. Despite the inconsistencies relating to

its interpretation, PR is commonly reported as a forwards reasoning process model. The majority of research evidence relating to PR lies in medicine and this has predominantly used low fidelity methodology.

The recognition of a pattern may be simplistic in nature but the understanding of patterns that lead to efficient and accurate outcomes is of greater complexity. Consideration of PR requires an understanding of what actually constitutes a pattern, which necessitates consideration of the knowledge literature. A review of the integration of forwards and backwards models within diagnostic reasoning is also important to better understand the clinical reasoning process.

2.6 INTEGRATION OF DIAGNOSTIC REASONING MODELS

The clinical reasoning literature suggests that neither PR nor HDR alone are sufficient to understand clinical problem solving. Elstein and Shwartz (2000) refer to the difficulty of a specific case and the experience of the clinician as predictors of the problem solving strategy utilised in any given clinical situation. On this basis any single strategy on its own cannot be simply considered as superior (Norman & Eva, 2003). Grant and Marsden (1987) give support to the view that no single best way of thinking exists when determining a medical diagnosis and that varied pathways (and thus models of clinical reasoning) can exist to reach similar conclusions. In a study identifying case interpretations and forceful (clinical) features, they demonstrated that experts did not use the same thought processes nor did they utilise the same important case features to reach their interpretations (Grant & Marsden, 1987). Diagnostic reasoning can therefore be described as complex and ever changing and include both the forwards and backwards models of PR and HDR respectively.

Physiotherapy clinical reasoning has been explained using a model allowing both forwards and backwards movement during problem solving (section 2.1.3). This collaborative clinical reasoning model (Jones et al, 2000) places

more emphasis on the backwards-reasoning loops and multiple hypotheses in the clinical reasoning process, however also allows for forwards reasoning or PR to occur with confirmation testing of a single hypothesis.

2.6.1 Further exploration of forwards reasoning

It is widely believed that forwards reasoning strategies are utilised within clinical reasoning, however there is a paucity of evidence within the physiotherapy literature supporting this presumption. The existence of PR as a model of forwards reasoning has been observed in expert physiotherapists (Noll et al, 2001; Doody & McAteer, 2002), but our understanding surrounding these observations is limited. Despite the existing beliefs regarding both the medical and physiotherapy professions, a full understanding of PR as a model of forwards reasoning requires further exploration. This understanding must lead further down the path of any potential associated benefits. In particular, the diagnostic accuracy and time efficiency should be investigated to help determine the overall benefit of PR to clinicians of varying levels of experience.

Notably, the assessment of accuracy with respect to the direction of reasoning has not been undertaken with high fidelity methods in physiotherapy research. If a particular process alone or a specific combination of processes were found to be consistently more accurate in diagnosis, this could provide evidence to support these clinical reasoning processes being utilised by clinicians.

2.6.2 Separating forwards from backwards reasoning

It is generally believed that both forwards and backwards reasoning will be utilised during physiotherapy clinical practice. Unfamiliar or more complex cases are believed to require a backwards approach alone (Jones, 1992;

Rivett & Higgs, 1997), whilst pure forwards reasoning is likely only in familiar cases with little variance in differential diagnosis (Figure 2.7). It is plausible that an integration of both directions of reasoning may well occur in many of the semi complex cases presenting to clinicians.

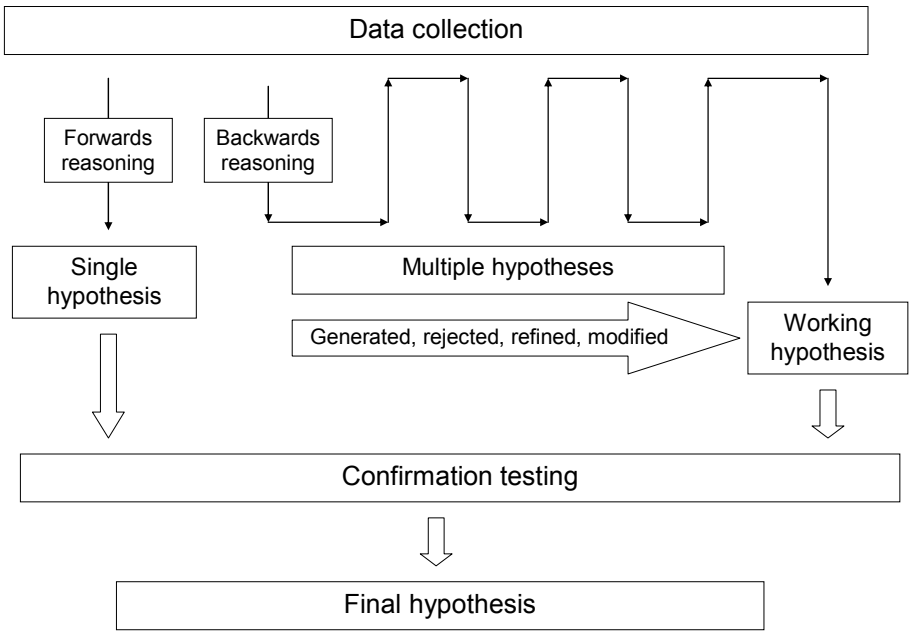

Figure 2.7 A separate view of forwards and backwards reasoning models

Several integrated combinations of forwards and backwards processes are probable within physiotherapy assessment. A condition may be sufficiently recognised from highly significant case features using prior experience and lead directly to confirmation testing. This may then confirm the understanding or alternatively initiate a backwards process. Figure 2.8 depicts confirmation testing following PR not supporting the hypothesis and therefore initiating a deductive process. Alternatively, a clinical assessment may commence with a hypothesis based deductive search of the clinical data and then be followed by the recognition of a component of the condition, which in turn triggers a forwards reasoning confirmation process (Figure 2.9).

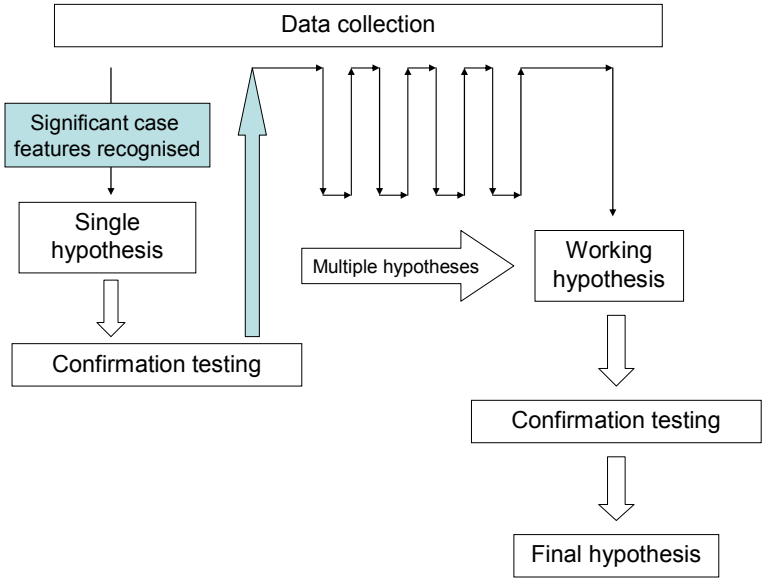

Figure 2.8 Deductive strategies following incorrect pattern recognition

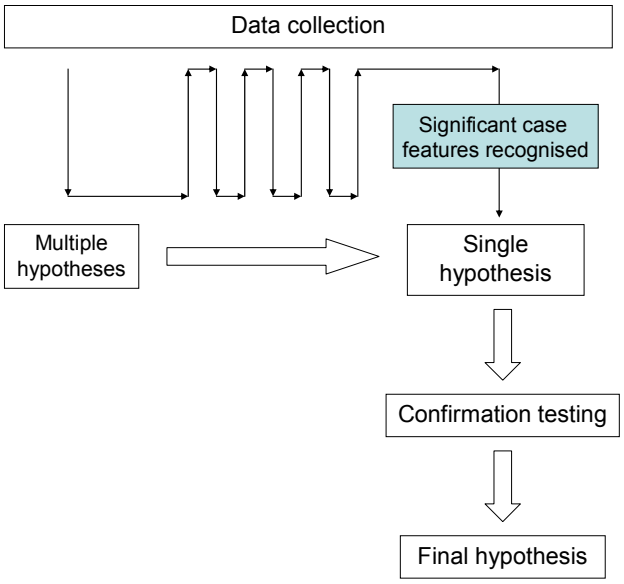

Figure 2.9 Pattern recognition following deductive strategies

The possible integration of reasoning processes presented in Figures 2.8 and 2.9 highlight the complexity of clinical reasoning research. For example, the identification of a PR process resulting in a single hypothesis midway through a backwards search for understanding in a clinical case becomes increasingly difficult to separate from HDR. This is especially so if the single

hypothesis was already one of the multiple hypotheses previously generated. This means that some episodes of PR use could be difficult to detect within deductive problem solving strategies if recognition occurred later during a clinical assessment and after a deductive data collection process had commenced.

2.6.3 Context specificity

A high probability exists that both HDR and PR reasoning strategies contribute to the understanding and decisions made in a large number of clinical encounters (Eva, 2004). Indeed, Norman and Eva (2003) state that various strategies are likely to be used by experts and novices when solving problems. One of the key features relating to the type of reasoning utilised is the case at hand. ‘Case specificity’ has long been identified as having a significant impact on the clinical reasoning process (Elstein et al, 1978). The clinician’s experience and organised knowledge base referred to as ‘content specificity’, also significantly influences the clinical reasoning process (Elstein et al, 1978; Eva et al, 1998). Thus there are multiple variables likely to influence the type of strategy used in clinical reasoning at any stage of the process. The context of clinical reasoning includes the clinical environment, the case at hand, and the knowledge and experience of the therapist with respect to a case (Eva, 2004). All of these contextual factors will have an impact on the direction of reasoning utilised by clinicians, both experts and novices alike.

2.7 KNOWLEDGE IN CLINICAL REASONING

Clinical reasoning research has taken several directions in the past three decades. Research involving the exploration of memory followed the failure of single process models to fully explain how a clinician problem solves. Based on memory recall research with chess experts / masters, research in medical reasoning investigated memory recall of experts but was unable to find a clear association between expertise and memory performance (Ericsson, 2004). This led to a belief that the structuring of knowledge leads to improved performance in medical reasoning (Norman, 2005). A full discourse on the complexity of knowledge is beyond the scope of this literature review but an overview has been provided to facilitate an understanding of the clinical reasoning process, particularly in respect to methodology within problem solving research.

2.7.1 Types of knowledge

Knowledge refers to specific information or understanding on a subject, unique to an individual or group of people (Wilkes & Krebs, 1989). It can be considered from an individual or personal perspective, where what is known by a person comprises their knowledge. However this type of knowledge may not be valid to the next person. Higgs and Titchen (2000, p.24) refer to "public validation" of knowledge to highlight that overall knowledge about a topic at any point in time may rightly or wrongly differ from an individual's knowledge on a topic. Public or common knowledge on a topic is usually based on the evidence provided by specific research in the area in combination with expert views. Personal and public knowledge can be likened to non-propositional and propositional knowledge types.

Several types of knowledge should be considered when attempting to understand physiotherapy clinical reasoning. Propositional knowledge refers

to theories and concepts or objective views based on sound research (e.g. biopsychosocial knowledge) (Higgs & Titchen, 2000), whilst non-propositional knowledge includes experiential, personal and practical types of knowledge (Higgs, 1992). Experiential knowledge encompasses the learning from both personal and practical experience, whilst practical knowledge in particular refers to that developed from professional practice in a specific domain. Practical knowledge has also been labelled 'professional craft knowledge' within the physiotherapy literature (Higgs, 2004).

Consideration of the different types of knowledge is important when relating clinical reasoning process back to expertise. No single type of knowledge is sufficient when dealing with the complexities of everyday clinical practice, which instead relies on a problem solving process that likely integrates all of the various knowledge types at appropriate times.

2.7.2 Structured knowledge

Structuring knowledge has been considered by way of the theory of 'encapsulation'. This refers to knowing a clinical case via associated knowledge concepts that provide a greater depth of understanding. The integration of knowledge concepts attached to any clinical case are unique to each clinician. A mind map or concept map is a tool utilised to depict the development of an integrated knowledge base. Figure 2.10 provides an example of a concept map portraying encapsulation. The case may be known by a clinician at a number of levels, for example from management and prognosis to the underlying pathophysiology of normal tissue healing. Boshuizen and Schmidt (1992) provided support for the encapsulation of concepts into clinical knowledge during a think-aloud problem solving study. They found that family medical physicians with four years experience utilised far greater pathophysiological knowledge underlying the case when

compared with medical students. Encapsulation is a means to understand organised knowledge structures which in turn relates to expertise.

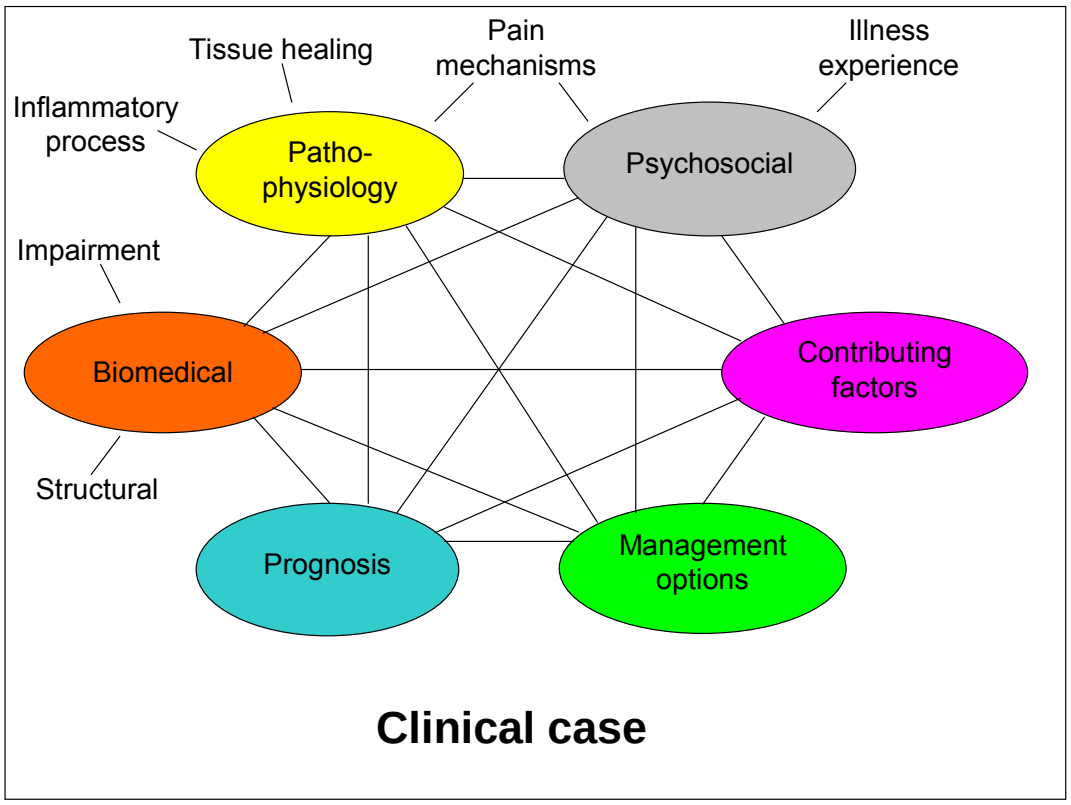

Figure 2.10 Example of encapsulated concepts (utilising some hypothesis categories reported by Jones & Rivett, 2004)

PR incorporates the use of experiential knowledge (Gale & Marsden, 1982; Ridderikhoff, 1985; Rivett & Higgs, 1995) and the presence of an organised knowledge base (Gale & Marsden, 1982; Ridderikhoff, 1985; Jones, 1992; Rivett & Higgs, 1995). Some patterns may be simple and utilise only professional craft or experiential knowledge, however an expert's pattern will have superior knowledge structure with integrated knowledge types. The model of PR presumably relies on far more than a single type of knowledge.

2.7.3 The role of knowledge

Knowledge is undoubtedly important to clinical performance. Some evidence does exist for enhanced clinical diagnostic skill based on greater use of basic science knowledge in novices (Woods et al, 2005). However knowledge related research in the field of medical reasoning has concluded that no distinct type of knowledge is alone able to explain expertise (Bordage & Lemieux, 1991; Norman, 2005). Additionally, despite the belief that an expert is likely to have more knowledge than a novice, the overall amount of knowledge is not a sole predictor of expertise (Norman, 2005).

The development of a structured knowledge base is without doubt a requirement for attaining expert status. The research literature supports the understanding that a structured and refined individual knowledge base is required for expertise in healthcare (Boshuizen & Schmidt, 1992; Gale & Marsden, 1982; Ridderikhoff, 1985; Rivett & Higgs, 1995). With respect to clinical reasoning, it is also likely that a sound structured knowledge base is essential for superior clinical performance. The type of diagnostic reasoning pathway employed will be partly based on a therapist's knowledge related to that particular case.

Despite the findings that clinical reasoning process and knowledge alone are not fully able to explain expertise, both remain important elements of problem solving in clinical practice. The interaction of many factors, including problem solving skill and knowledge, is likely to be central to the development of expert status.

2.8 EXPERTISE

Expert clinical practice is a sought after goal for any motivated physiotherapist with a desire to provide the best possible care. Expertise refers to extensive skill or knowledge in a particular field (King & Bithell,

1998; Wilkes & Krebs, 1989). The study of expertise crosses many professional fields, including and beyond healthcare. A view of expert characteristics based on cognitive psychology research includes:

- Efficient ability to solve problems in a specific domain with few errors
- Greater short and long term memory capacity
- Enhanced visual representation of a problem's structure using concepts and principles rather than superficial features
- Increased perceptual ability to see meaningful patterns
- Better ability to build a mental representation of a problem to enhance understanding and further problem solving
- Exceptional ability to monitor self-performance during problem solving (Glaser & Chi, 1988).

Most of Glaser and Chi's (1988) findings on experts relate in part to a greater and more structured knowledge base. These findings can be utilised to assist with understanding expertise in modern healthcare.

2.8.1 Common attributes of an expert physiotherapist

The physiotherapy profession has developed a broad template to understand the qualities and strengths displayed by an expert. Jensen et al (2000) qualitatively assessed and described the observed qualities of physiotherapy experts across several domains. These authors developed a theoretical model outlining an expert's common attributes, including:

- Have a patient centred knowledge base that evolves through reflection
- Skilled collaborative problem solving (clinical reasoning) with the patient
- Focus on the assessment of movement in relation to patient function
- Display caring and committed virtues towards clients

(Jensen et al, 2000).

The two primary expert attributes of interest to this thesis relate to knowledge and clinical reasoning skill. Both are essentially linked when considering a reasoning pathway such as PR and the associated underlying knowledge structures. Knowledge has been discussed with respect to expertise in section 2.7, whilst the clinical reasoning skill of experts will now be further considered.

2.8.2 Clinical reasoning skill

Clinical reasoning skill includes the effective integration of diagnostic and interpretive reasoning types reported in section 2.1.3. Clinical reasoning is without doubt a critical component of expertise (Higgs & Jones, 2000; Jensen et al, 2000) but its varied nature adds complexity when relating these topics. A clearer view of expert clinical reasoning skill can be found when looking at diagnostic reasoning alone.

There is general agreement that no single problem solving pathway allows for the attainment of expertise. Nor does knowledge represent the sole attribute of an expert. Skilled clinical reasoning should not be considered as a single type or model of reasoning, but rather an adaptive approach dependent on case complexity and familiarity. The most evident aspect of expert clinical reasoning rests with an approach that involves the client in problem solving and adopts a reasoning approach specific to a situation. As per Glaser and Chi's (1988) views, expert reasoning in physiotherapy is likely to include recognition of familiar cases via prior categorised patterns.

The direction of diagnostic reasoning (forwards versus backwards) is believed to be associated with expertise. The general understanding in the literature is that forwards reasoning is utilised more commonly by experts, whereas novices rely heavily on backwards reasoning (Norman et al 2000). Importantly, Patel et al (1990) noted that the basis of this view was in

psychology research, which essentially only had a theoretical basis due to the lack of strength of the original empirical studies. However several authors have since demonstrated that medical expert problem solving does vary from that of novices (Doody & McAteer, 2002, King & Bithell, 1998; Coughlin & Patel, 1987; Joseph & Patel, 1990). In recalling a normally structured problem, experts were significantly better able to recognise and interpret cases than novices (Coughlin & Patel, 1987). The experts recognised patterns of familiar problems via significant case features or critical cues.

Support for PR as a forwards reasoning strategy in physiotherapy has also drawn on differences between expert and novice clinicians. Investigations into clinical reasoning differences between experts and novices have shown an association between expertise and the use of PR (Doody & McAteer, 2002; King & Bithell, 1998). Retrospective think-aloud verbal protocols were utilised by Doody and McAteer (2002) following the assessment and treatment of a real patient to investigate clinical reasoning in practice and determine differences between novices and experts. They concluded that novices and experts both utilised HDR, but only the experts demonstrated use of PR.

2.8.3 Significant case features

Clinical problem solving involves the generation of hypotheses following the collection of relevant case information. A significant case feature refers to any part of a clinical case that is important in interpretation or problem solving. It may be data from the history, an observation of posture or other visual information, or information obtained from a specific physical test or combination of tests. Significant case features have also been labelled as critical cues or forceful features (May & Dennis, 1991). Each clinician is likely to have their own unique critical cues that assist them in their interpretation and decision-making.

Just as knowledge and experience are unique to an individual, the features of the case deemed important are also expected to vary amongst expert clinicians. Grant and Marsden (1987) found that significantly different forceful features were utilised to arrive at the same end point by experts whilst solving paper based clinical cases. However despite the differences in type of case features utilised, expert clinicians more effectively identify and use significant features in a case as compared with novices.

Clinical reasoning can be partly viewed via the use of significant case features to promote the recognition of specific clinical patterns (May & Dennis, 1991). As previously highlighted, this characterises a forwards process which likely enhances efficiency, and one that is primarily observed in experts.

2.9 REASONING IMPACT ON CURRENT HEALTHCARE

The global economy has highlighted the importance of cost effectiveness in health service delivery. The cost effectiveness of a healthcare service can be influenced by the efficiency of which an accurate understanding of the case is obtained. Less time spent developing a working understanding of the client as a person with associated problems, should in turn lead to improved outcomes based on client goals and arguably less overall cost. Accuracy and efficiency are therefore key elements for cost effective healthcare.

Cost effectiveness may also be considered indirectly. Firstly, overall healthcare costs may be reduced by early and appropriate intervention. A more accurate initial assessment of a problem may decrease the overall cost via early provision of necessary healthcare services and a potential reduction in unnecessary medical costs such as imaging services. A second indirect view of cost effectiveness relates to lost work time. Employee time away from work is one factor that has a considerable financial effect on individual

business and the overall economy (National Occupational Health & Safety Commission, 2004). More effective and efficient health service provision theoretically may reduce lost work time and enhance economic gain. Overall better healthcare should have a positive effect on an economy in many ways.

2.9.1 Errors in clinical reasoning

Clinical reasoning is a complex skill in the best of circumstances. Problem solving may be misdirected from its path at numerous stages. Scott (2000) outlines three main causes of error during problem solving: poor elicitation of key case features from data; incomplete knowledge; and not applying relevant knowledge to a specific problem. An error in clinical reasoning will most likely result in misdirected diagnosis and management strategies, which in turn influences outcome and cost-effectiveness of care. Table 2.4 outlines five common types of clinical reasoning error in physiotherapy (Rivett & Jones, 2004).

Table 2.4 Clinical reasoning errors in physiotherapy (Rivett & Jones, 2004, p.409)

Component	**Example**
Information collection	Neglecting or misinterpreting relevant information Premature decision-making Not recognising data inconsistencies
Hypothesis formation	Confirmation bias – overemphasis on supporting features and neglecting negating features of a hypothesis Limited hypothesis category use Not testing hypotheses
Identifying flags	Missing data indicative of red (serious pathology) or yellow (psychosocial barriers) flags
Diagnosis	Presumption that a relationship between symptoms confirms cause and effect and thus diagnosis
Treatment	Use of recipe treatments and not clinically reasoned management strategies Lack of involvement of client in decision-making

Certain process models have been linked with greater possibility of errors in problem solving. As discussed in section 2.5.3, PR is possibly more prone to error than backwards reasoning models, especially with novice clinicians. Jones and Rivett (2004, p.8) go as far as stating, “pattern recognition … represents perhaps the greatest source of errors in our thinking”. However these authors also highlight that critical reflection on clinical patterns may reduce inaccuracy in reasoning. This may occur over time as more experience is gained. Errors from PR should be reduced by continual refinement and development of each pattern through reflective practice.

The time available to a clinician during an encounter with a client can impact on the clinical reasoning process and thus affect hypothesis accuracy. When healthcare is placed under financial pressure from a governing body, it has greater potential for inaccurate outcomes (Rivett & Jones, 2004). Clinical

reasoning errors may then directly impact on the effectiveness of management, which will indirectly impact on efficiency in achieving outcomes or client goals.

Little conclusive research has been conducted into clinical reasoning error. There is no single process that has been clearly associated with greater error in physiotherapy clinical practice. The causes of error outlined above indicate that incomplete or inappropriate use of knowledge is linked to inaccurate reasoning. Knowledge is a core element of any model or process of clinical reasoning and thus could be theoretically identified as a primary associate to error in clinical practice.

Current support for enhanced cost effectiveness related to experienced or expert clinicians comes from the physiotherapy professional association. Australian physiotherapy service provision is moving towards a specialisation framework that relates service cost to the clinician's level of expertise. The service provider descriptors developed by the Australian Physiotherapy Association (2001) support the notion that an expert clinician achieves more efficient benefits and better outcomes compared with those of less experience.

2.9.2 Possible impact of accurate clinical patterns

Modern healthcare needs to be cost effective to be sustainable. The clinician is placed under pressure from various financial and management sources. This pressure will influence the time available to assess and treat a client and undoubtedly impact on the type of assessment and reasoning strategies employed. The recognition of clinical patterns using accurate underlying knowledge structures may offer value in improving the efficiency of the assessment process, but is limited in its application with inexperienced physiotherapists. Experts seemingly utilise forwards reasoning with positive results, but when does a clinician have enough experience to be considered

an expert? In other words, at what stage during a physiotherapist's career development does accuracy outweigh inaccuracy when utilising PR or other efficient forwards reasoning strategies? The answer to this question is undoubtedly complex and currently unknown.

2.9.3 Reasoning skill as a cost effective variable

The current healthcare climate will continue to drive physiotherapy services to be more efficient in achieving better outcomes. The profession should therefore closely consider the many variables associated with cost effectiveness. Achieving accurate and efficient clinical outcomes relies on effective clinical reasoning skills integrated with an extensive knowledge base in the relevant domain. The use of the ever growing knowledge base within evidence based practice relies on the operator to effectively reason and integrate the available evidence with the case at hand. Clinical reasoning skill is arguably the ground substance beneath the surface of cost-effectiveness and should be further explored in the field of musculoskeletal physiotherapy.

2.10 SUMMARY

Expert status is regarded highly within the physiotherapy profession. An expert must have extensive knowledge and be skilled in clinical reasoning (Jensen et al, 2000). Clinical reasoning is therefore a desirable skill for physiotherapy clinicians and an important area to consider in educational curricula design. This should include all reasoning types, including but not limited to process models of diagnostic reasoning.

The area of interest in this thesis is the diagnostic reasoning models that relate to the pathway a clinician takes in current physiotherapy practice. The present review of the literature provides a background and basis to the most

common forwards and backwards diagnostic reasoning models and the potential impact of these process models on healthcare.

The empirico-analytical strategies of HDR and PR have been observed in musculoskeletal physiotherapy practice but require further investigation. The term PR continues to be utilised in professional education, yet it lacks a comprehensive research basis to its use. Research into the frequency, efficiency and accuracy of PR in physiotherapy practice potentially offers great benefit for professional education in problem solving.

This literature review highlights a general lack of knowledge surrounding accuracy in physiotherapy clinical reasoning. Empirical support for the various problem solving and decision-making strategies lies within the medical field and is not evident to the same degree in other health professions such as physiotherapy. Forwards reasoning in particular has limited available evidence in both the medical and allied health literature. This thesis therefore seeks to determine the use and potential benefit of PR in physiotherapy. The study aims were to:

1. Determine whether PR is utilised by expert and novice clinical physiotherapists in the musculoskeletal field
2. Relate the use of PR to efficiency within a physiotherapy assessment
3. Relate the use of PR to accuracy within a physiotherapy assessment.

The current study is based on a pragmatic world view combining both deductive and inductive processes (Cresswell & Plano Clark, 2007). Inductive analysis in qualitative research refers to the discovery of categories as they surface from the data, whereas a deductive process can involve an existing theoretical model as a category that is deductively tested during analysis (Pope et al, 2000). The primary research question involves deductive analysis to test an existing theoretical model of PR.

CHAPTER 3. METHODS

3.1 INTRODUCTION

This chapter describes a case study used in a mixed method research design to gain insight into the clinical reasoning model of PR in physiotherapy. Section 2.2 provides support for the mixed method design based on the research aims and prior case study research in the literature. Albeit a non-traditional research approach, both qualitative and quantitative methods have been commonly used in combination in similar research. The aims of the study outlined in sections 1.2 and 2.10, required a mixed method approach to ensure successful deductive testing of PR.

The study used a carefully chosen single critical case to provide research data relating to the phenomenon of PR. The case was a real life clinical situation portrayed by a trained actor. Details of the case study and its simulation are provided in section 3.2. The single case study was repeatedly assessed by research participants made up of expert and novice physiotherapy clinicians with varied clinical experience and qualifications. The chosen study sample and rationale for their inclusion is outlined in section 3.3. Qualitative observation and interview data collection methods form the foundation of the study (section 3.4) with subsequent analysis incorporating qualitative (section 3.5) and quantitative (sections 3.6 & 3.7) methods. The result of mixed method analysis provided a comparative view of the clinical reasoning process employed by participants and inherent relationships. The overall study design and chapter outline are depicted in Figure 3.1.

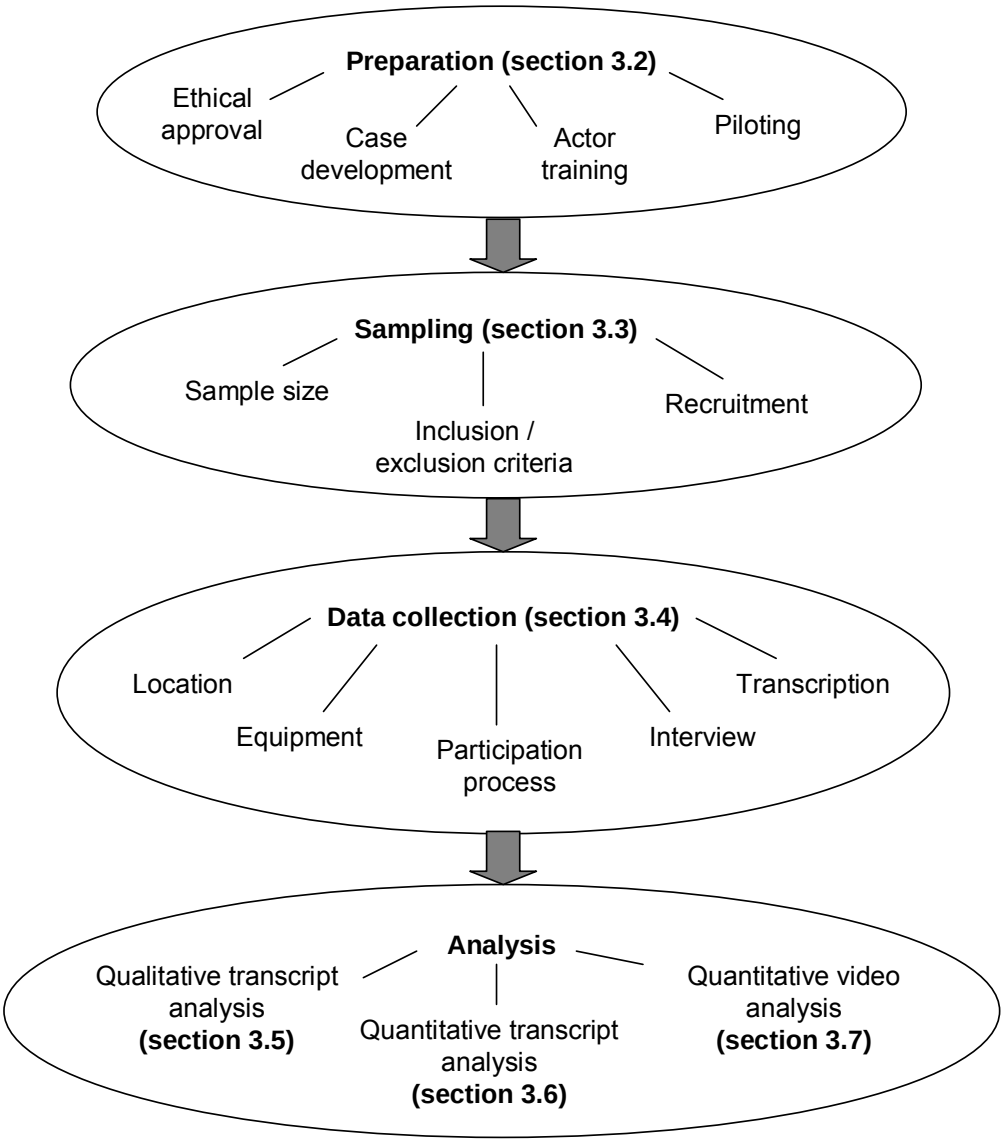

Figure 3.1 Study method and chapter outline

3.2 PREPARATION

3.2.1 Ethical approval

Prior to commencing recruitment or data collection the study was granted approval from the Human Research Ethics Committee of The University of Newcastle. The approval letter has been attached as Appendix 1 with approval number H-149-1105.

3.2.2 Case development

A key element of any research study involving a simulated client is the actual case itself. Developing a case study is complex and demands careful consideration (Creswell, 2007). In this study, a suitable case was sought to facilitate exploration of the primary research question. Firstly, the identification of PR requires a clinical presentation that is known or familiar to the therapist. Secondly, a real life case that was taken from a single physiotherapy clinical experience was deemed appropriate as it allows for a documented outcome including clear diagnosis of the primary pathology and problem identification. This is necessary to ascertain the accuracy associated with PR.

The case utilised for the study involved a 20 year old female presenting to a physiotherapist for the first time with lower back pain (LBP). It is known that LBP is frequent in the community and a regular presenting problem to musculoskeletal physiotherapists. A high percentage (85%) of LBP cases are labelled non-specific as they cannot be sufficiently diagnosed from a patho-anatomical perspective with available radiological and other investigations (O'Sullivan, 2005; Waddell & van Tulder, 2004). The remaining 15% of specific LBP cases are generally still common in presentation to physiotherapy clinicians working in the musculoskeletal field. One such specific condition is spondylolisthesis of the lower lumbar spine with established diagnostic criteria via X-ray imaging. Spondylolisthesis refers to the forwards movement of one vertebral body relative to the vertebra below. It is a type of mechanical

instability of the spine and most commonly occurs due to a bilateral pars interarticularis defect or spondylolysis (Floman, 2000; Herman & Pizzutillo, 2005; Rossi & Dragoni, 2001).

The incidence of spondylolisthesis is reported as between two and six percent of the general population (Herman & Pizzutillo, 2005; McNeely et al, 2003; Stanitski, 2006; Treble et al, 2005). The distribution of spondylolisthesis between males and females is two to one, however the frequency of this condition presenting as symptomatic LBP is greater in females reportedly due to activity predisposition (Earl, 2002). Supporting this observation, a study of twenty-one consecutive clients presenting with high grade spondylolistheses over a fifteen year period found that more than 60% were females (DeWald et al, 2005). The Meyerding classification is a widely utilised grading system for the extent of vertebral translation and labels a spondylolisthesis from grade 1 to grade 5. 'High grade' refers to the grades 3 or above which relates to an anterolisthesis or forwards movement of greater than 50% of the vertebral body below (DeWald et al, 2005; Haun & Kettner, 2005; Lim et al, 2004; Rossi & Dragoni, 2001).

Higher grade spondylolisthetic conditions are commonly symptomatic. The symptoms associated with higher grade spondylolistheses include bilateral lower lumbar pain spreading to the gluteal regions and posterior thighs (Hensinger & Michegan, 1989; Herman & Pizzutillo, 2005; McNeely et al, 2003; Stanitski, 2006; Treble et al, 2005). Mechanical activity tends to provoke the symptoms and rest or reduced activity levels will ease the reported symptoms (Hensinger & Michegan, 1989; Lim et al, 2004). Extension motion of the lumbar spine is consistently reported as provocative of pain (Lim et al, 2004; McNeely et al, 2003; Stanitski, 2006; Treble et al, 2005).

The level most commonly observed with an anterolisthesis deformity is the 5^{th} lumbar segment (Beutler et al, 2003; Earl, 2002; Haun & Kettner, 2005; Lim et al, 2004; Rossi & Dragoni, 2001; Stanitski, 2006; Treble et al, 2005). Although the history of spondylolisthesis can involve insidious symptomatic onset,

Hensinger and Michegan (1989, p.1098) state that a “history of minor trauma is common … and an episode of trauma often initiates the onset of symptoms”.

Given that clients with spondylolisthesis are more likely to have LBP than the general population and that LBP is one of the most common problems presenting to a musculoskeletal healthcare professional, the prevalence of such conditions will likely be greater in a healthcare setting than in the general population (Treble et al, 2005). Thus an experienced clinician should be familiar with this condition enabling recognition and use of forwards reasoning strategies. The details of the case utilised in this study are found in Appendix 2. The case was found to be consistent with the reported presentations in the literature.

The real life case chosen for the study was considered from the perspective of the hypothesis categories (Jones & Rivett, 2004, p.13-20) as summarised in Table 2.2. This provided an actual case outcome for comparison with hypotheses formulated by participants. The primary management of the case included X-ray imaging undertaken after the first physiotherapy assessment and demonstrated a grade 3 spondylolisthesis of the 5^{th} lumbar on the first sacral vertebra (Figure 3.2). An evidence based specific stabilisation exercise approach to management was commenced (O'Sullivan, Twomey & Allison, 1997). Short term follow up demonstrated a reduction in symptom levels via two main treatment interventions; activity modification and specific exercise. The pain mechanism involved in reported symptoms was primarily mechanical without any clear neuropathic or ongoing inflammatory components. Leg symptoms were attributed to somatic referral from the lower lumbar spine (i.e., non-radicular pain). Precautions and contraindications identified for the case included extension based manual therapy techniques or exercises, and spinal manipulation of the unstable segment. No clear psycho-social features were deemed relevant to the outcome or recovery of the client. Medical management involved an orthopaedic specialist monitoring the degree of anterolisthesis movement over a 12 month period. Evidence of continued vertebral translation resulted in surgical fusion of the unstable segment.

Activity / participation restrictions continued beyond the post-operative rehabilitation period however a return to full functional capacity was achieved with respect to completion of studies, subsequent employment and sports participation. With conservative management alone the prognosis towards achieving full function in this case was predictably poor, however with surgical intervention the prognosis can be stated in hindsight as very good.

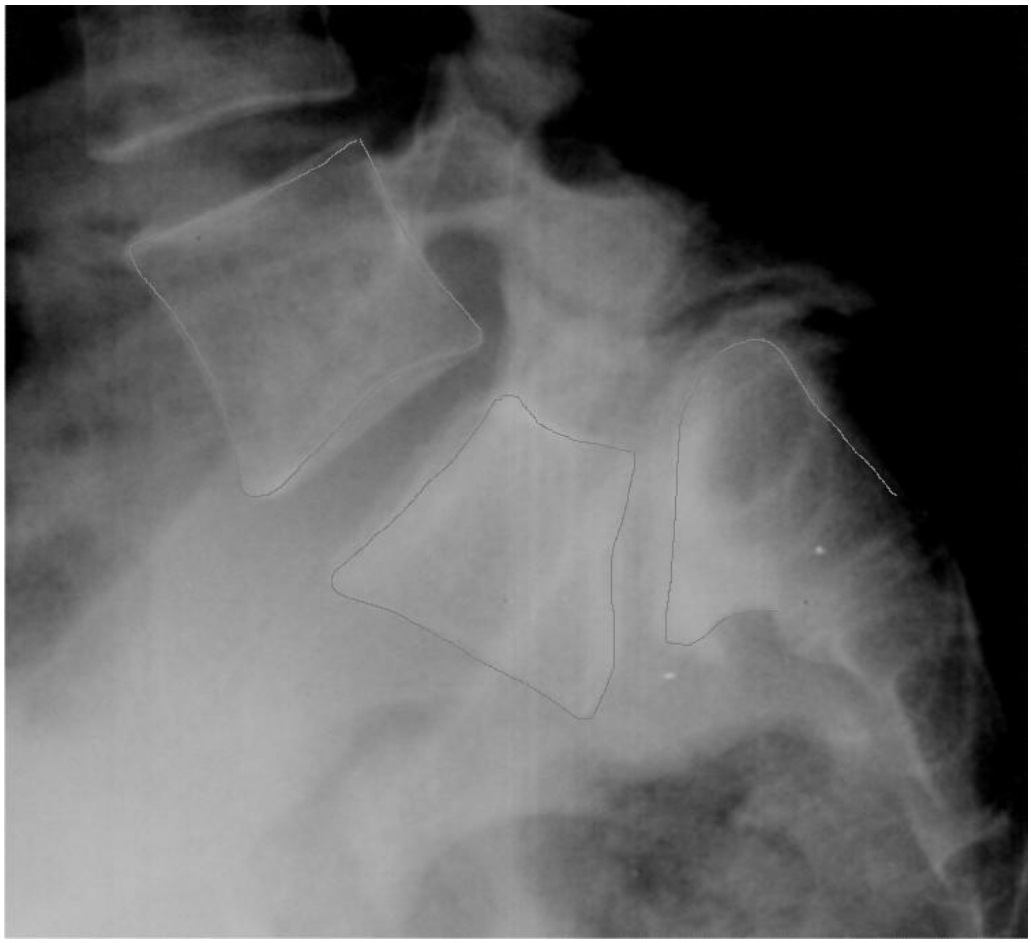

Figure 3.2 X-ray image of the grade 3 spondylolisthesis case

3.2.3 Training of case actor

Preparing the actor for the role as a simulated patient involved a three part process. Firstly, the case was converted to lay format (Appendix 3) and presented to the actor who simultaneously took their own notes during discussion to complement their understanding. Each aspect of the case was individually discussed without offering the actor more than a lay understanding

of the data. Following a period of independent review of the case information, a second training session was undertaken involving the researcher questioning the actor on the case details and providing feedback regarding responses. Questioning was undertaken as per a routine physiotherapy assessment but was completed in sections allowing for feedback and further note taking by the actor. A third phase of training involved a second researcher conducting an uninterrupted videotaped subjective assessment (history) with the actor as the simulated client. The second researcher provided feedback regarding the realism and accuracy of the case and the videotape was then viewed by both the actor and primary researcher. The final phase of training was incorporated into a pilot trial as described in section 3.2.4. Once more the actor was provided with feedback regarding accuracy and performance.

Consistent with previous research involving the training of simulated patients, the total time spent training the actor was six hours without including the actor's independent study time. The training was predominantly associated with the portrayal of subjective examination case information given that a physical examination was not required. Training related to physical aspects of the case was limited to basic observations of client entry to the assessment location and sitting postures during the assessment. This was also monitored during training and participation via the videorecorded assessments. To ensure ongoing accuracy of the actor's portrayal of the case, the simulated client assessments were reviewed by the researcher throughout the data collection phase of the study. Evaluation of the accuracy of case simulation was undertaken during subsequent review of videorecorded assessments via a simulated client response checklist (Appendix 4) that was transferred to nominal data for each participant. Areas of inaccuracy could therefore be identified immediately and feedback provided to the actor. Overall statistical analysis of simulated client accuracy across all participant assessments could then be calculated as discussed in section 3.7.

3.2.4 Pilot trial of method

A single participant with more than 10 years of clinical experience and a postgraduate qualification in musculoskeletal physiotherapy from the United Kingdom volunteered to participate in a pilot trial of the study design / method. This participant was provided with an information statement and signed a study consent form. Data collection was then undertaken including subsequent transcription of the interview and coding process. Following this trial no changes in study procedure were deemed necessary.

3.3 SAMPLING

Experienced musculoskeletal physiotherapists were chosen as the group of interest due to their proposed use of PR strategies during problem solving and probable previous exposure to spondylolisthesis as a condition. To help ensure the findings could be related to experience / expertise a second group of registered but novice physiotherapists were included in the study. Systematic non-probabilistic sampling (Mays & Pope, 1995) was therefore used with two specific groups that were predicted to have differing cognitive skill relevant to the clinical reasoning process. The inclusion criteria for the expert and novice sample populations have been detailed in sections 3.3.2 and 3.3.3 respectively, and the supporting physiotherapy and medical clinical reasoning literature cited.

3.3.1 Sample size

On commencement of the study, it was anticipated that ten expert and ten novice physiotherapists were required for data collection. These numbers were based on previous comparable published research projects in physiotherapy (Doody & McAteer, 2002; Rivett & Higgs, 1997) and predicted saturation rates. Qualitative research refers to saturation when further data collection does not reveal any new themes than previously identified.

3.3.2 Expert inclusion criteria

The physiotherapy and allied health literature has generally failed to agree on consistent criteria for expertise. Problem solving research involving medical experts has largely been based on specialisation groups as defined by the various registration bodies (Grant & Marsden, 1987; Joseph & Patel, 1990; Patel et al, 1990). At the time of designing the methodology of the study, the process of attaining the title of 'specialist musculoskeletal physiotherapist' was a work in progress by the Australian Physiotherapy Association (APA) (Australian Physiotherapy Association, 2008). During the period of recruitment for the study, the number of musculoskeletal physiotherapists in Australia, who had attained the title of 'specialist' remained insufficient for the study sample.

Physiotherapy experts within the clinical reasoning literature have been defined in different ways, from academic qualifications and positions (King & Bithell, 1998) to peer nomination (Jensen et al, 2000). The criteria for this study have been adapted from prior physiotherapy clinical reasoning research (Doody & McAteer, 2002; Edwards et al, 2004; King & Bithell, 1998; Rivett & Higgs, 1997) involving participants with a measurable level of experience and knowledge to meet the requirements of an expert.

The amount of time in clinical practice alone is insufficient to define an expert. It must be combined with domain specific knowledge and critical reflection. Knowledge has traditionally been described as an essential requirement for expertise (Simon, 1980), however medical research conducted regarding the organisation and accessibility of knowledge within problem solving highlights that knowledge alone is also insufficient for expertise (Norman, 2005). Thus expertise in this study was based on both measured duration of clinical experience and also extent of knowledge in the musculoskeletal domain.

When considering experience, a minimum of ten years exposure in any given domain has been reported as being necessary to achieve expertise (Simon, 1980). This is supported in the physiotherapy clinical reasoning literature by King and Bithell (1998) who utilised ten years experience as a minimum timeframe in their research to predict the presence of expert clinical patterns. It was deemed necessary in the present study that expert physiotherapists remained currently practising due to the association between relevant and accessible clinical experience and the use of forwards reasoning strategies such as PR.

Identifying clinicians deemed more knowledgeable and worthy of recognition as an expert was based on a recognised postgraduate degree in manipulative / musculoskeletal physiotherapy. Such qualifications require comparable standards to be met of both academic and professional bodies and involve written and practical examinations to assess levels of knowledge and clinical skills. The physiotherapy profession in Australia identifies titled 'Musculoskeletal Physiotherapists' as those who have completed recognised postgraduate study and have extensive musculoskeletal physiotherapy clinical experience (Australian Physiotherapy Association, 2005). Titled Musculoskeletal Physiotherapy Australia (MPA, a sub-group of the APA) members can therefore be considered to have a greater and more organised propositional knowledge base. When integrated with experiential knowledge resulting from continued clinical practice, it was considered that this should result in critically refined clinical patterns.

The current study identified an expert musculoskeletal physiotherapy clinician by the following inclusion criteria:

1. Titled membership of MPA based on completion of a recognised postgraduate qualification in manual / manipulative therapy;
2. Greater than two years experience following postgraduate qualification enabling titled membership;

3. More than ten years overall clinical experience in musculoskeletal physiotherapy;
4. Currently involved in clinical practice.

3.3.3 Novice inclusion criteria

Given that PR has been strongly linked with clinical experience and domain specific knowledge it is unlikely that a novice will display this strategy. This view has been supported by previous research however the novice groups investigated have often been undergraduate students without complete education in their particular professions (Arocha et al, 1993; Doody & McAteer, 2002; Gale & Marsden, 1982; Grant & Marsden, 1987; Grant & Marsden, 1988; Groves et al, 2003). Alternate research designs have used 'sub-experts' for the comparison group, who are experts in their own domain but not with that of the case type presented (Joseph & Patel 1990; Patel et al 1990) or generalists who have considerable overall clinical experience but no specific postgraduate qualifications (King & Bithell, 1998). The 'sub-expert' comparison group is fraught with potential difficulties of the intermediate effect in which participants with less domain specific knowledge or experience may outperform experts in their domain (Patel & Arocha, 2000).

A more robust approach towards answering the research question and exploring whether PR is a strategy of more experienced clinicians requires a comparable group with minimal experience. Undergraduate physiotherapy students were considered underdeveloped in their ability to conduct an assessment and problem solve during the reasoning process. However recently graduated physiotherapists in their first year of clinical practice, generally having undertaken a musculoskeletal rotation (usually a minimum of three months), were considered a more representative group but without sufficient clinical experience to have developed clinical patterns to any great degree.

The novice physiotherapy participants included in the study were classified by the following inclusion criteria:

1. Completed a recognised physiotherapy qualification and be registered with the NSW Physiotherapists Registration Board;
2. Less than one year of clinical experience as a physiotherapist;
3. Currently involved in clinical practice.

Any formal postgraduate study in physiotherapy excluded participation in the novice group.

3.3.4 Recruitment process

Registered physiotherapists from the Hunter region of New South Wales, Australia formed the source of potential participants. Expert physiotherapists were identified via the Directory of APA Musculoskeletal Physiotherapists (Australian Physiotherapy Association, 2005). Every MPA titled physiotherapist located within a 90 minute radius of the research venue was sent an invitation letter to participate (Appendix 5). If no response was received following initial invitation, the follow-up procedure involved a single reminder letter (Appendix 5) after a two-week period of time followed by a single phone call to ensure the letters of invitation had been received. New graduate physiotherapists (novice physiotherapists) were recruited via advertisement (Appendix 6) in the Australian Physiotherapy Association Hunter Regional Group newsletter.

A written information sheet and consent form (Appendix 7) was provided for further consideration once potential subjects contacted the researcher. Following an opportunity to ask additional questions and sign the consent form, participants were included in the study and scheduled a time that suited their work commitments. The first ten physiotherapists meeting the inclusion criteria and consenting to participate formed each group.

3.4 DATA COLLECTION

Several aspects of data collection required careful consideration to minimise influencing participant behaviour and to help ensure a realistic client assessment. Similarly, accurate recollection of thought processes from the actual client assessment relied on a skilled interview. The location for participation and the equipment used in the study are two key elements that will be discussed in this section, along with the participation process including client assessment and stimulated recall interview. Lastly details regarding interview transcribing are provided.

3.4.1 Location

The project's data collection phase took place within the School of Health Sciences Research Laboratory at The University of Newcastle. The assessment was conducted at a small table with both the participant and simulated patient seated on facing chairs. A room adjacent to the Research Laboratory allowed for the setup of the notebook computer recording the video to be out of participant view during the client assessment. The retrospective interview was undertaken at the same table in the Research Laboratory with the notebook computer located on the table. The videorecorded client assessment was replayed on the notebook computer as the stimulus for retrospective recall. The adjacent room was not required during the interview process.

The location of the study became a barrier to recruitment of expert participants during data collection. This resulted in an ethics variation regarding this aspect of the method being submitted to the Human Research Ethics Committee of The University of Newcastle (Appendix 8), providing approval for data collection to be conducted at the workplace of some expert participants. This required the simulated patient actor and the researcher to travel to the expert's practice location to complete data collection. A similar setup was utilised at the

alternate location except the notebook computer was located in the same room.

3.4.2 Equipment

Conducting the data collection sessions required specific equipment to allow for the audio / videorecorded client assessment. A standard one square metre flat desk and two chairs were utilised for both the simulated client assessment and interview. The participant and actor portraying the simulated client were seated for the majority of the assessment but were free to move as required. Similarly, the researcher and participant were seated for the entirety of the subsequent interview. A microcassette audio tape recorder was located on the desk during both client assessment and interview. Additionally the camcorder utilising mini digital video cassettes was situated on a tripod two metres from the desk with an external microphone placed one metre from the desk (Figure 3.3).

Figure 3.3 Research location and recording equipment

The notebook computer requisites included video recording software and a serial data transfer protocol for high bandwidth applications (IEEE 1394 port) for direct downloading from the camcorder. This equipment was located in an adjacent room whilst recording the client assessment (Figure 3.4). A fire wire cable connected the camcorder to the laptop for simultaneous downloading

during the simulated client assessment and retrospective downloading of the interview data. The notebook computer was relocated to the interview table in the Research Laboratory for the participant interview.

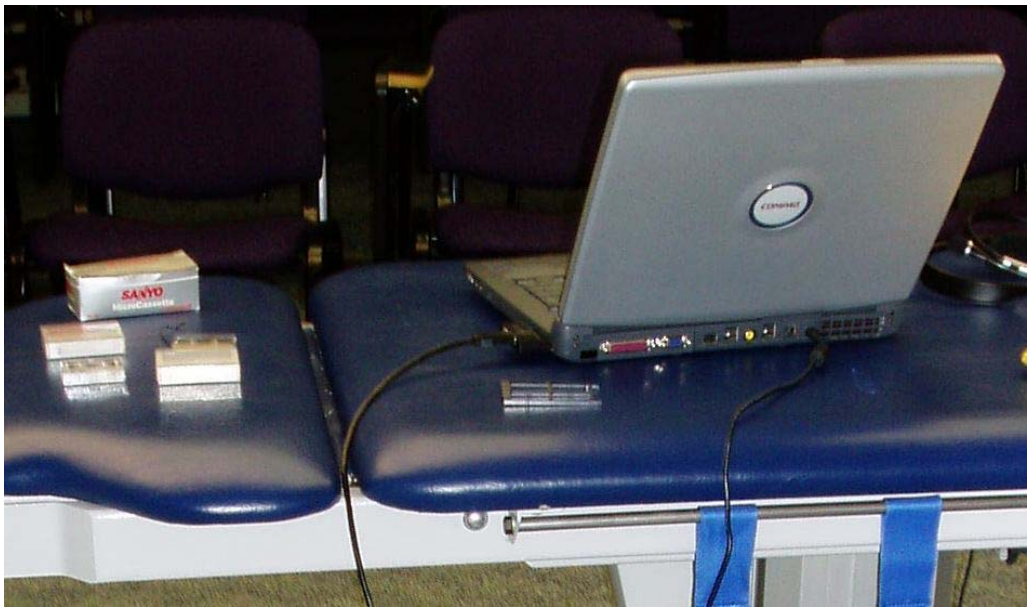

Figure 3.4 Notebook computer recording setup in adjacent room

The transcription data included the dialogue between participant and researcher during observation of the simulated client assessment. To avoid transcribing the replay of the client assessment, two headsets were utilised to remove this auditory source during recording of the interview.

The client assessment and participant interview were recorded from two sources to ensure a backup source of data. The separate sources included the microcassette audio tape recorder and mini digital video cassette camcorder. A full list of setup procedures and equipment utilised for data collection is documented in Appendix 9. The study investigated only the subjective examination (history) information of a physiotherapy assessment, which reduced the complexity and extensiveness of equipment required, recording methods and overall space required.

3.4.3 Participation process

On completion and return of the consent form a session time was scheduled for the study. The study equipment was setup in advance (Appendix 9). On arrival the participant was provided with an 'orientation to the patient assessment' information sheet (Appendix 10). This did not state the client to be simulated however the participant was made aware via the research project information statement (Appendix 7) that the client was an actor simulating a real clinical case. After reading the orientation sheet the audio and video equipment commenced recording / downloading and the simulated patient was introduced to the participant. The researcher was not present in the room for the entirety of the assessment with the participant instructed to let the simulated client know when the assessment was complete.

During the preparation for the stimulated interview, the participant was provided with an 'orientation to the interview' information sheet (Appendix 10). The interview was then commenced and conducted in the same location.

3.4.4 Semi-structured interview technique

The purpose of the retrospective interview was to obtain information relating to the clinician's problem solving strategies, in particularly the use of case data and subsequent generation of hypotheses. A semi-structured interview design (Appendix 11) utilising a combination of open-ended questions and more directed questions was developed by the researchers. This type of interview design is appropriate when the topic is sufficiently understood but the responses to questioning are not (Richards & Morse, 2007). The interview was divided into two parts.

The first group of questions were asked throughout the video-replayed portion of the interview. These were open-ended enquiring questions allowing the participant to discuss their problem solving from the client assessment without

creating bias or reflection in the participant's responses. The timing of the video stops throughout the interview was either following each group of similar clinical questions or if the participant sought to comment on their thoughts from that part of the assessment. A few examples of groups of clinical questions commonly leading to video stops include location of symptoms, description or severity of symptoms, current or past history, or investigation questions. Due to the varied nature of individual physiotherapy assessments the questioning and subsequently the time stops were never the same between participants.

The second more specific group of interview questions followed the completion of the video replay. At this point the participant had described their choice of pathway through the data, provided reasons for their chosen methods and described their understanding of the case along the way. Once the video replay had finished all the data was available for use in discussing the final hypothesis. This second group of questions were designed to ensure the necessary information had been gathered from the interview to address the research questions. These related to the first and final hypotheses developed, the physical examination plan, and the influence of the study method on participants. If the information had already been obtained for any question it was not repeated.

3.4.5 Transcription

The participant retrospective interviews were transcribed from the audio recorded source of data. The transcript was reviewed for completeness in comparison to the secondary source of interview data. This backup data was obtained from the video recordings. Any erroneous or incomplete words or section of a transcript was completed from the video data to ensure accurate and complete coding and analysis.

3.5 QUALITATIVE TRANSCRIPT ANALYSIS

The predominant data source in the study was the verbal interview transcripts. Qualitative analysis of these transcripts was similar to that described by Creswell and Plano Clark (2007). Preparation of data for analysis first involved the professional transcription of interview data from audio tape recordings. Corrections were then made where required to complete the transcripts (section 3.4.5). The participant interview transcripts were then imported into NVivo 7 (QSR International, n.d.), a qualitative software program (section 3.5.2).

A broad review of transcripts enabled the completion of a codebook and note taking regarding overall content and researcher thoughts. Finally, detailed analysis of the data involving coding and categorisation allowed for an overall qualitative understanding to be formed and comparison between groups.

3.5.1 Code development

Coding is a process that allows for data to be organised and categorised. Grouping common ideas that develop during data analysis allows for easier association and comparison. The development of codes prior to commencing analysis facilitates the identification of the categories required to test existing theory, however it is recognised that this can limit the depth of understanding outside the walls of the phenomena being studied (Creswell, 2007). A thorough review of the literature pertaining to PR has been detailed in Chapter 2. The common elements of PR outlined in Table 2.2 and the resultant definition enabled the development of an initial coding schema. The early codebook was subsequently refined following initial data collection to ensure completeness of the pre-determined codes.

To ensure agreement amongst researchers regarding the identification of pre-determined codes, a process was undertaken to review these codes and their definitions. This was not dissimilar to the process described by Creswell

(2007). The first two participant transcripts of each group were independently coded by all three researchers. Following complete coding of each transcript, the researchers met to discuss and reach consensus on coding data. This process was repeated for all four transcripts following which the researchers had a consistent understanding regarding the allocation of codes to the textual data. At this coding agreement stage only the 'hypothesis' sub-codes were reviewed.

The three researchers involved in the coding agreement process included the student researcher who was currently practising in musculoskeletal physiotherapy and had completed post-graduate study in clinical reasoning. The other two researchers have a track record in clinical reasoning research and related publications. All three researchers each had more than ten years of physiotherapy clinical experience.

To minimise the potential limiting effect of a pre-determined codebook, additional codes were added throughout the analysis (Creswell, 2007). These new codes were placed separate to the prior developed codes but easily compared and associated at subsequent stages by the qualitative software program NVivo 7 (QSR International, n.d.).

3.5.2 Qualitative data analysis software

The computer software program NVivo 7 was used throughout data analysis. Qualitative data analysis software has recently become commonplace amongst academic research of a qualitative nature (Davidson & Jacobs, 2008). NVivo software is produced by QSR International Pty Ltd, originating with NVivo 1 in 2001 and releasing NVivo 7 in February 2006 (QSR International, n.d.).

The primary benefits of qualitative data analysis software in the study included the organisation of files, notes, memos, codes and their descriptions. The program allowed for efficient data retrieval and enhanced ability to compare or

relate transcript sections or themes. The transcripts from novice and expert participants were placed in individual NVivo 7 files to allow for separate thematic analysis and easier comparison.

The pre-determined coding schema was entered into the NVivo 7 software as tree nodes, which were able to be organised in a hierarchical fashion with sub-codes. A node is referred to as the location for a compilation of references identified by the same code. The new codes identified during transcript analysis were labelled as free nodes and documented with an associated description. These free nodes contain codes that don't necessarily relate to others in a clear structure. The stand alone information in the free nodes was useful for identifying potential emerging themes throughout the analysis.

3.5.3 Data analysis process

The qualitative analysis process involved a series of steps to allow for inductive development of new ideas and deductive testing of the primary research question. The steps have been outlined in Table 3.1 with further detail provided in this section.

Table 3.1 Qualitative analysis process

Steps:
1. Initial reading of transcripts whilst making memo notes
2. Coding from pre-existing codebook (tree nodes) and identifying new codes (free nodes)
3. Checking for coding accuracy and reliability
4. Creating categories or themes from codes and memo notes
5. Comparing themes across groups

Overview reading

An inductive review of each transcript was undertaken by the student researcher to gain an overall feel for its content and noting potential new codes and concepts. Subsequent coding from the existing codebook was then able to be completed without limiting the analysis to existing theory. During this stage a memo was created for each participant and notes from the overview reading were taken. Any new code identified during the overview reading was entered into NVivo 7 as a free node.

Coding

Each transcript was analysed in detail to identify data fitting the pre-determined (tree) codes. The tree codes have been detailed in Table 3.2. Researcher notes were made during this coding process and any specific notes relating to each participant or code were recorded as memos. Any new codes revealed from raw transcript data during this phase were labelled as free nodes.

Sub-coding the hypothesis codes based on previously reported hypothesis categories was undertaken during the initial coding process as this sub-level had been previously developed. Each section of text coded with a hypothesis was simultaneously sub-coded into one of nine hypothesis categories. The first eight of these had been sourced from Jones and Rivett (2004) with one additional sub-code (non-specific) being added following the review of the codebook. The hypothesis code and sub-codes, including descriptions and examples, are provided in the final codebook (Appendix 12). A similar process was undertaken for data collection and planning codes. Examples for each pre-determined code and sub-code have been included in Appendix 12.

Sub-coding for knowledge and self-awareness codes was undertaken as separate processes during the analysis stage following initial coding. All coded data in each of these nodes were reviewed and divided into sub-groups with meaning based on data collected and knowledge relating to the specific code.

The sub-coding of knowledge and self awareness and associated descriptions have been outlined in section 4.3.1.

Table 3.2 Tree codes: predetermined code schema

Code	**Description**
Data collection	Therapist reports collecting information in a routine manner without the data relating to a hypothesis.
Hypothesis related	Therapist states an understanding of the case in any of the hypothesis categories. This may be several competing possibilities or a single clear hypothesis. Any lay level of response, where no interpretation has occurred, was not coded as a hypothesis.
Knowledge	Participant refers to their knowledge in an attempt to apply it to the problem at hand.
Planning	Therapist verbalises their use of data during the history to plan physical examination or treatment procedures.
Self awareness	Therapist verbalises awareness of their own thinking. These reflections may relate to data, process, hypotheses, decisions or knowledge.
Significant case feature	Therapist highlights the relevance / significance of data obtained to case at hand.

Any new code identified during coding was reviewed for content and assigned a description. These were assigned a free node with associated description. If a free node was identified mid-way through transcript coding, each prior coded transcript was re-read specifically for the identification of the newly developed free node. This was a cyclical process until no further free nodes were identified. Free nodes developed during analysis have been listed in section 4.3.3 of this thesis.

Coding accuracy and reliability

Of concern during coding was the possibility that inconsistent or inaccurate grouping of text segments may occur and impact on analysis. To ensure minimal effect on the overall results, coding accuracy and reliability were further considered after the development and review of the codebook by all researchers.

Accuracy during the coding process was ensured by node content review. Each tree or free node and associated sub-nodes were opened and contents reviewed relative to the description. Editing at this stage involved un-coding or re-coding any data found to be inappropriately labelled. The description of each node was also reconsidered with respect to its contents.

Following the coding review process involving all three researchers, the remainder of the study involved the student researcher coding alone. Given the sole coding nature of the study an intra-rater reliability evaluation was undertaken. This involved the first two transcripts of each group being repeat coded at a later stage following complete coding of all transcripts. This occurred after more than a three month period after the initial coding of each transcript to reduce the likelihood of memory recall during repeat coding. Intra-rater reliability was undertaken only for tree nodes and analysed via percentage agreement and kappa reliability coefficient (Domholdt, 2005).

3.5.4 Theme analysis

The reduction of data into themes occurred throughout the coding process. Themes are patterns repeated throughout the transcripts. Notes and memos relating to any aspect of a developing theme were documented by the researcher during coding. These notes were then compared alongside the codebook and coded data to further develop and encapsulate themes. The final element of analysis involved displaying the data and themes allowing for

visual representation of the research findings. This included the comparison between the novice and expert groups.

3.5.5 Interpretation

Qualitative analysis gradually develops over a prolonged period of continuous analysis (Barbour, 2008). It requires a systematic and thorough approach to cover the available data without losing track of the study goals. Throughout the qualitative interpretation within this study it was imperative the student researcher remained open to new possibilities to ensure comprehensive qualitative results. The qualitative process outlined has been undertaken to gather the necessary data and subsequently allow quantitative analysis to follow. Generating an overall qualitative understanding of the primary research question via themes and categories and also enabling a subsequent quantitative interpretation, arguably provides greater strength to the study findings. In addition, the qualitative process ensures that any new themes will be identified in relation to the clinical reasoning process of physiotherapists.

3.6 QUANTITATIVE TRANSCRIPT ANALYSIS

Quantitative analysis of verbal transcripts involved reviewing the tree nodes for coded portions of the transcripts that related to the identification of PR and type of hypothesis category used. Completion of this aspect of analysis was undertaken following the qualitative coding and thematic analysis and thus did not influence the qualitative conclusions.

3.6.1 Identification of pattern recognition

Identifying PR within a clinical encounter is partly dependent on the complexity of the case. In more complex clinical encounters differentiating PR from a deductive reasoning process is likely to be difficult. For example, simply having a participant refer to prior experience alone does not provide conclusive evidence of PR use.

The formation of a synthesised understanding of PR from the prior literature has been outlined in section 2.5.1. Based on this interpretation the features of PR were refined and detailed to provide a consistent structure when reviewing transcript data (Table 3.3). An associated identification tool for each interview time stop and an overall scoring tool (Appendix 13) for each participant were developed and utilised in conjunction with the features of PR. The application of the identification and scoring tools to the coded transcript data provided a structured method of identifying PR from each participant's clinical encounter.

Table 3.3 Identification features of pattern recognition

Component	**Description**
Central hypothesis	A central hypothesis was developed at a distinct point in time and maintained as a predominant understanding throughout the assessment.
Significant case features	Case features that were considered significant or important to the central hypothesis are described.
Professional knowledge	Professional knowledge relevant to the central hypothesis was stated at any point in time during the retrospective interview.
Clinical experience	Prior clinical experience was referred to by the participant in reference to the current case and the central hypothesis.
Management plan	A plan for management was evident and relevant to the stated central hypothesis formed at the distinct point in time. The plan doesn't need to be stated at the same distinct point in time but rather relates to the hypothesis of this time.

Identifying PR relies on more than just using the word 'pattern' or stating that this case had been recognised. In the current study, the identification of PR required a central hypothesis to be stated at a distinct time related to the client

assessment. As discussed in section 2.5.1, separating PR from HDR requires the hypothesis to be immediately formed and not developed gradually.

Further support for PR can subsequently be provided by identifying significant case features described during the interview that were relevant to the central hypothesis. Identifying professional knowledge and direct clinical experience related to the central hypothesis were also included based on the commonly agreed elements of PR in the literature. These provide additional support for the presence of PR.

The final feature included in identifying PR was management. This component provided insight into the presence of a central hypothesis and the diagnostic reasoning process utilised.

Efficiency was not included as a feature in identifying PR but is rather a consequence of its use. The commonly reported feature of immediacy when forming a hypothesis through PR was separated from efficiency due to inconsistencies in the literature (see section 2.5.3). However the timing data obtained for the formation of a central hypothesis generated from an existing pattern could provide some insight into efficiency as an outcome of PR.

The ‘time stop identification tool’ was applied to each participant transcript and involved reviewing all coded text from each point in time where the client assessment was paused to obtain the participant’s thought processes. This involved transferring hypothesis coded text transcripts into the ‘Hypothesis formed’ column and subsequently indicating the hypothesis category identified. The primary benefit of this process was to observe the presenting case hypothesis in sequential order throughout the assessment. Additional tree codes were then reviewed for significant case features, knowledge, experience and management. These were directly compared with the central hypothesis if present. Relevant transcript text supporting the positive identification of any of these codes was documented in the ‘comments / quotes’ column.

The data was then summarised from the ‘time stop identification tool’ into the ‘overall pattern recognition scoring tool’. This provided a score from 0 to 5 for each participant relating to PR use. A central hypothesis was necessary throughout the assessment for overall identification of PR. Higher overall scores provided greater support for utilisation of PR.

3.6.2 Expert and novice group differences in pattern recognition use

The comparison between expert and novice use of PR followed its investigation across all participants using the scoring tool (Appendix 13). Comparison between groups was via simple number counts following transfer of data to categorical form where 0 = not identified and 1 = identified.

3.6.3 Accuracy of pattern recognition

The stated final hypothesis for each participant was listed in summarised form for comparison with identified PR. Subsequent participant numbers per group utilising the PR strategy and the respective case accuracy relative to the known case diagnosis was presented in a 2x2 format for visual comparison.

3.6.4 Hypothesis category utilisation

The literature indicates that hypothesis generation clearly occurs throughout physiotherapy problem solving. Section 2.3.1 highlights one classification of the various types of hypotheses that can be formed as reported by Jones and Rivett (2004). The use of various hypothesis categories during a clinical encounter is predictably unique to each therapist, however it is arguable that an expert would have a greater depth of understanding of a case and that this may be represented in the extent of hypothesis category use. In other words, a higher level of integrated thought process should relate to a greater number of interrelated hypothesis categories. However this has not been reported or investigated in the literature to date.

Hypothesis sub-codes stored within NVivo 7 software allowed for simple review of data relating to the range of categories used by each participant and the percentage use of each category by the expert and novices groups. Following this quantitative process the integration of various categories into one overall case understanding can be reviewed qualitatively to add more depth to the findings.

3.7 QUANTITATIVE VIDEO DATA ANALYSIS

The final stage of data analysis involved obtaining quantitative data from the simulated client assessments. The videorecorded client assessments provided observational data which included:

- Order of participant questions to the simulated client
- Timing data during the client assessment
- Simulated client response accuracy.

The participant questions to the simulated client were manually transcribed then grouped into traditional categories of similar question types, such as area of symptoms or past history questions. This allows for more detailed investigation of the order of questioning undertaken by each participant and has potential to shed more light on the pathway undertaken and possible use of forwards reasoning strategies. Subsequently a comparison of pathways taken between participants can be analysed for similarities and differences.

A second area of quantitative analysis involved obtaining and analysing the total amount of time per client history, along with the time taken to develop any central hypothesis that was immediately formed via PR. This time data was not a key component of identifying PR given that physiotherapy experts who are more likely to use PR have been noted to spend more time taking a client history (Doody & McAteer, 2002; King & Bithell, 1998). However the reported efficiency of PR (Arocha et al, 1993; Higgs & Jones, 2000; Ridderkhoff, 1989) required observation of time during the client assessment component of the

study. The analysis of time data took place following identification of reasoning processes.

The intra-coder and simulated client reliability were also analysed quantitatively to evaluate the consistency of the methodology of the study. The accuracy of the simulated client actor was obtained via video observation data. The data obtained from the simulated client response checklist (Appendix 4) were transferred to nominal categories for every group of similar questions for each participant. This provided an indication of accuracy via calculating proportions of correct responses for each question group and overall. Validity was also evaluated using comments from participants on the realism of the actor playing the simulated client. Training towards achieving consistent accuracy of the simulated client across all participants has been discussed in section 3.2.3.

3.8 TRIANGULATION

The current study incorporated triangulation involving a mixed methods approach combining qualitative and quantitative data from participant transcripts, in addition to a third source of video observation data. The embedded and triangulation designs introduced in Figures 2.3 and 2.4 have been further detailed in Figure 3.5 to assist understanding of their application in this study.

The two forms of triangulation utilised in the current study include data triangulation and methodological triangulation (Patton, 1990). Data triangulation involves the use of more than one type of data to understand a phenomenon, whilst methodological triangulation can refer to the inclusion of mixed methods. The present research design has included a combination of data and method triangulation to enhance the validity of the findings. This triangulated design has been depicted in Figure 3.6.

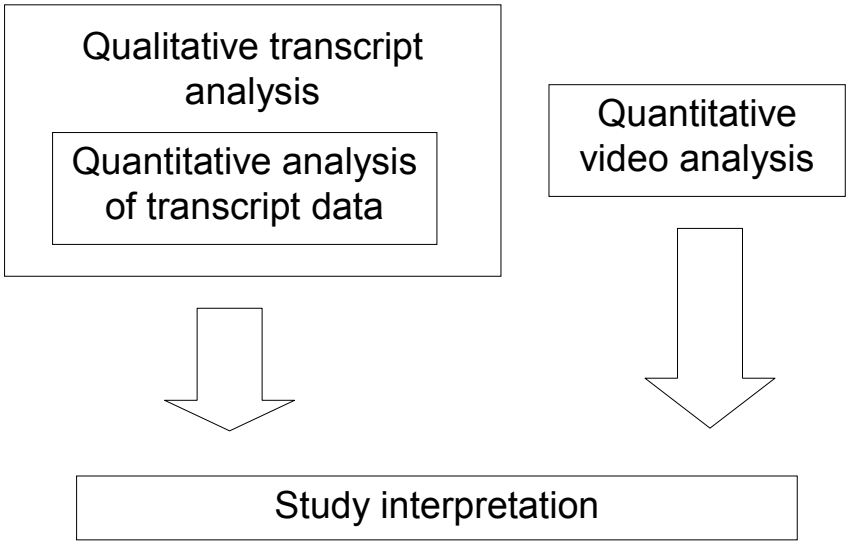

Figure 3.5 Embedded method design

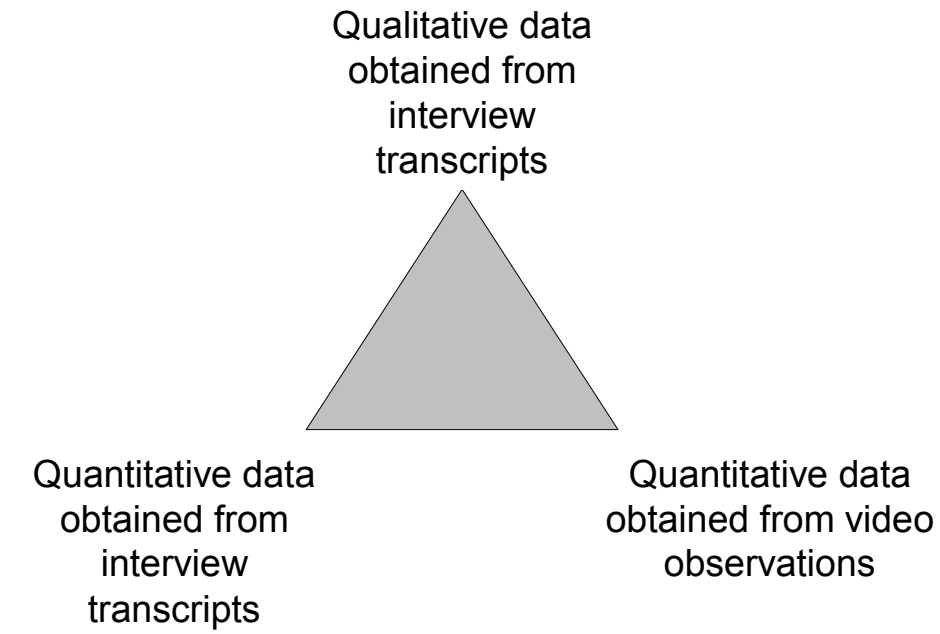

Figure 3.6 Triangulated design

3.9 SUMMARY OF METHODOLOGY

This chapter details the inclusion of a mixed methods research approach with a single case study design to investigate PR employed during clinical reasoning. The use of multiple sources of data is aimed at enhancing the overall quality of the findings and to allow more confidence in the results. Integrating quantitative and qualitative sources of data is an increasingly utilised method (Creswell & Plano-Clark, 2007) that can enhance the interpretation of the evidence within clinical reasoning research.

The method outlined in Chapter 3 is considered the most suitable to investigate PR as a forwards pathway during clinical reasoning. Physiotherapy experts are predicted to utilise these strategies to a greater degree than clinical novices. This carefully chosen methodology is aimed at providing a better understanding of this clinical reasoning strategy in musculoskeletal physiotherapy.

CHAPTER 4. RESULTS

4.1 INTRODUCTION TO FINDINGS

The clinical reasoning process represents an important component of physiotherapy problem solving in practice. The two groups of participants recruited for the present study have been chosen to provide more insight into the problem solving process or pathways undertaken and particularly the use of PR as a forwards reasoning pathway. The key study findings can be found in section 4.4, including the identification of PR and its relationship with diagnostic accuracy and efficiency.

This chapter commences with the details relating to participant recruitment (section 4.2). Examples of coded data and the thematic analysis are then presented in section 4.3, along with intra-coder reliability results. The outcome of the thematic analysis relative to the reasoning process is provided in section 4.5. These findings present a qualitative view of the reasoning processes observed during the study and provide the researcher's view of clinical pattern use amongst participants.

Participant use of the hypothesis categories (section 2.3.1) during problem solving has been detailed with respect to expert and novice differences in section 4.6. This analysis has been separated into categories identified from the final participant hypotheses (section 4.6.1) and those observed to be used by participants 'overall' or at any stage during the interview (section 4.6.2).

The new codes labelled as free nodes in NVivo 7 (section 4.3.3) and subsequent themes identified (section 4.3.4) were condensed into five additional topics of interest. These have been reported as 'additional findings' in section 4.7, which provide some interesting qualitative observations related to clinical reasoning. Lastly, analysis of study location, case simulation and

study equipment influences on participant behaviour are presented in section 4.8.

4.1.1 Examples of coded text provided as results

The presentation of specific examples of participant transcript text will be included in subsequent results sections. As with the majority of qualitative studies, only those statements that help give the reader an understanding of the basis to the study findings will be presented rather than an exhaustive list of quotations. Every attempt has been made to openly and thoroughly present sufficient transcript examples that relate to the results. The aim was to provide meaningful transcript quotations that allow the reader to develop their own opinion of the presented material and be able to critically review the study findings.

The transcript data includes the interviewer questions at points where it allows for a more complete understanding of the responses. Throughout this chapter, any reported text including the researcher's questions or comments have been labelled with the letter R and participant responses with the letter P. If no label exists in association with transcript data it includes only those responses of participants.

4.2 PARTICIPANT RECUITMENT

In all nineteen physiotherapists participated in the study. The targeted number of ten experts was recruited over a one year period. The nine novices were also recruited over one year with completion of data collection occurring due to unavailability of the simulated patient actor. There was overlap between data collection and data analysis of experts and novices. The total timeframe for data collection was approximately fourteen months.

Throughout data collection each participant was labelled with either the letter E for expert or N for novice followed by a consecutive number associated

with recruitment (e.g. E4, N6, E9, N2). In line with confidentiality requirements of the ethics approval, the participants were randomly assigned a letter which replaced the number. The expert participants were randomly assigned one of the first ten letters of the alphabet and the novice participants the next nine letters, for example ‘Expert G’ or ‘Novice P’. This format will be used to identify a participant in the results and discussion chapters of this thesis.

4.3 CODING AND THEMATIC ANALYSIS

Complete transcript coding and subsequent analysis of results was undertaken by the student researcher. The study limitations associated with sole coding were considered and managed by the coding review process (section 3.5.1), an intra-coder reliability evaluation, and most importantly by general agreement between all researchers on the key study findings.

The pre-determined (tree) codes listed in Table 3.2 have been included in this section to offer real participant examples of each code to the reader. The pre-determined codes of knowledge and self awareness were sub-coded following completion of participant recruitment and transcript coding. This subsequent process attempted to provide more depth to the understanding of the clinical reasoning pathway and possible identification of PR. The free nodes developed throughout the process of coding have been similarly introduced, described and examples provided.

The overall results of thematic analysis are presented in section 4.3.4. Subsequent sections then detail the process of grouping relevant qualitative transcript data into each meaningful theme.

4.3.1 Tree codes

Throughout the coding process transcript data was not limited to any single code within the pre-determined coding schema. Overlap between codes and

within the hypothesis categories did occur and was important for accurate storage and easy retrieval of data during analysis.

Data collection

'Data collection' coding occurred when a participant reported routine data collection during the assessment without relating the clinical information to any hypothesis of the case. 'Data collection' was included within coding due to its negative impact on determining whether forwards reasoning was evident. 'Data collection' unrelated to a hypothesis tended to suggest that forwards reasoning or PR was not being utilised.

The 'data collection' code also highlighted that an element of routine always existed during the client assessment, regardless of the reasoning process utilised. For example:

Expert F: **R:** So were there any unexpected findings out of all the general health questions?
P: No, no that was all fine. I always go through those with them.

Expert A: **R:** Are these fairly standard questions that you would normally ask at the end of an assessment?
P: Yeah I ask every one there.

During the early stages of each participant interview, data collection was often prompted by the student researcher / interviewer to initiate discussion and facilitate more open dialogue relating to the thought process during the client assessment. Any 'data collection' coded text that was prompted by the researcher was noted for subsequent review.

Examples of prompted 'data collection' text:

Novice R: **R:** Does that information lead where you go next, or do you just continue on with data collection, routine data collection?
P: Um, from there I sort of thought that early information didn't really delve too deeply into it at that stage -- And sort of when back to another routine run through.

Expert I: **R:** At this stage were you more collecting data or were you actually forming an understanding that you –
P: No still at this stage collecting data.

Examples of unprompted 'data collection' coded text:

Novice P: Um just the filling out the body chart, trying to get a bit of an idea of the location of, of the location of her symptoms and the quality of her symptoms, which ah the moment probably just probably not even thinking too much about, about what's going on with her and just trying to gather as much information at this point in time. You know just sort of gathering information

Expert D: Just routine questions that I would a ordinarily ask, yeah, you know occasionally someone would say oh yeah I've got rheumatoid arthritis and well you'd be thinking OK so I just, I always ask them, I'm sort of on autopilot going through that just to make sure that I've covered all of those specific things

Hypothesis related

Hypothesis was coded when a participant stated an understanding of the case in any of the hypothesis categories (Jones & Rivett, 2004). Any lay level of response, where no interpretation was evident was not coded as a hypothesis. For example, descriptive comments such as "the pain was fairly strong" weren't coded. Simultaneous sub-coding of hypotheses occurred into the relevant category.

Category 1: Activity & participation

Any hypothesis relating to the capabilities or restrictions of the client during a specific activity or life situation was sub-coded into this category. Examples included:

Expert F: it didn't ever stop her playing netball. So it couldn't have been, like it wasn't a severe -- thing that interfered with the lifestyle.

Novice N: She hasn't lost any time off work although she's stopped playing sport and it does hamper her ability to perform the normal things that she needs to do.

Category 2: Patient's perspective and psychosocial factors

Hypotheses relating to the client's perspective in terms of their understanding, feelings or beliefs related to the presenting problems was placed within hypothesis category 2. The patient's perspective may be a contributing factor to or a consequence of the pain or restriction in activity / participation, but in either case may be relevant to the recovery process. This category directly relates to the illness experience that is unique to each individual person. For example:

Expert G: looking at a goal of hers that you know she's worried she's got another clinical placement.

Expert D: we know she's got a poor understanding of what her problem is. It just gives me a little bit more of a picture of who she is. What she's about. I'm thinking at that point in time she said I'm a little bit worried about how this is going to affect me in the future. I'm really looking for how it's affecting her from a psychological or emotional perspective. Because that will impact on how she responds to any treatment or intervention that I might give her

Category 3: Pathobiological mechanisms

Hypotheses in this category may include stage of tissue healing and / or pain mechanisms that relate to initial onset or maintenance of signs and symptoms by the nervous system. Comments from participants related to the underlying mechanism of symptom maintenance. For example:

Expert G: I was actually thinking maybe there was a, a sort of an inflammatory wind up so I guess a, a secondary sensitisation to the pain

Expert I: still behaved mechanically to a degree. Um at rest it still gives her varied amounts of aches, um -- that makes it less, less likely to be a significant inflammatory pathology or some kind of nasty

metastatic thing or bony, bony thing that would give unrelenting night pain.

Category 4: Physical impairments and structural sources

Any structures or tissues hypothesised to be a pathological source of the client's symptoms and signs were placed in category 4. Given the assessment did not include any physical examination, the physical impairments included in this category were predictions of abnormal findings in the neuromusculoskeletal system:

Expert J: started to confirm that it wasn't the disc that it was the facet joints because most of the discs that I see don't like to sit and often they won't, they can't sit. They'll stand in the waiting room, and the fact that standing made her worse and she sat to relieve it and sat slouched made me think it's not a disc.

Novice S: I suppose you'd have to describe it as non specific low back pain, but the structure I was particularly interested was a, a lumbar disc.

Category 5: Contributing factors

Reference to any aspect of the client's condition that may have contributed to the onset or maintenance of the presenting problem(s) has been listed in category 5. Any reference to instability without statement of any specific structure was coded within contributing factors. Examples of category 5 included:

Expert A: lack of rest and the fact she's doing the same thing on her feet, bending, just her body can't cope with constant demands

Expert E: I'm going to expect if it's happened on a regular basis that she's going to be um, really maybe weak in her core. She's she may have some instability in her back.

Novice M: there's a postural component, um to her pain and I guess I'm not really thinking about so much about structurally what's going on.

Category 6: Precautions and contraindications

Hypotheses that related to safety of the client relative to the type of pathology / disorder, stage of healing, irritability and patient's perspectives are noted in category 6. Precautions and contraindications were categorised as safety related hypotheses with respect to both physical examination and treatment:

Expert H: she doesn't like extension so I would need to be careful not to leave her lying on her back or even leave her lying prone for extended periods

Novice N: Just making sure that there's, she doesn't have any um -- symptoms like that which could indicate something more insidious that was meant for further investigation by medical officers rather than physio.

Category 7: Management and treatment

Any comment relating to therapeutic intervention, including specific treatment techniques, was considered a hypothesis in management or treatment:

Expert I: led me to think that she was probably not really resting as much as she thinks she is, she's still got a significant aggravating component to it and that, that may be something what we needed to address as far as um -- time off when she needed to. She may need time off uni. She may need to look into special consideration and social factors that might need to be addressed in relation to her pain.

Novice R: I'm starting to think well maybe some investigations, but you have to wait till after the objective to say that definitively.

Category 8: Prognosis

Predicting a possible response to treatment intervention or an outcome for a particular problem / pathology is a prognostic hypothesis. Any reference to a feature of the case that may influence the outcome in a positive or negative way was placed in this category:

Expert G: at that time I was um thinking this, this might not be someone I am aiming to get pain free but maybe to get back to her, to her preclinical levels perhaps.

Expert D: I guess probably maybe that makes me think about if from a prognostic sort of factor -- With just that information alone the only estimation that I would make would be perhaps it's going to be more difficult to help her than someone who has really intermittent sort of pain.

Category 9: Non-specific

This sub-code was added to the eight previously reported hypothesis categories to place any hypothesis that the student researcher could not clearly place into any other category. These were mostly descriptive comments without a clear case understanding:

Expert H: I'm trying to work out the relationship of the pains, to make sure they're all connected, so I don't so I'm not moving to, following individual pains. So I've got, I've worked out, I'm pretty convinced now that they're all -- the leg one is a progression of the back one

Novice Q: the time frame that she'd had the back pain, like, leaning towards more of an acute on chronic condition rather than just an acute

<u>Planning</u>

Interview transcript comments from participants relating to planning were divided into those relating to examination and those of management. Sub-coding in both divisions provided an indication of the direction of participant's thought processes.

Examination:

Any participant statement relating to the physical examination of the client's condition was coded within examination 'planning':

Expert G: that's going to make me look in the assessment when I check her postural control through movement. When she sits up straight how it, how is she doing that, where is that coming from

Novice M: I'm going to do a McKenzie, a McKenzie um assessment now to go through the symptoms that make it better or worse

Management:

Participant comments relating to management planning included any comment relating to therapeutic intervention. The quotations found in this sub-code included all of those in 'Hypothesis category 7' in addition to those that did not have a clearly stated management hypothesis. Examples of the quotations unique to this node only included:

Expert A: looking for interventions. Yeah like if she had some intervention that had done something for her that would be a big clue for me in which way to head treatment

Novice Q: I'm really exploring um treatment options, um pain management options ah obviously she's um reasonably in, in a lot of pain, so I mean I guess the first priority trying to settle things down.

Significant case feature

The significant case features associated with identifying PR have been introduced in section 2.5.1. This code was identified when the therapist highlighted the importance of the data obtained to the case at hand. It may be singular or grouped data that is considered significant to the participant. This code was only identified in the transcripts of expert participants:

Expert I: When she said it started when she was 11, um I deliberately went into that in a lot more detail and asked a question about did it trouble you as a teenager because you occasionally get patients who recall it to something that's happened in their past, something completely random that may be irrelevant or may not be irrelevant and if having said that she recalls an incident as an 11 year old and then had problems with manageable back pain right the way through the past 11 years, is more likely to mean that that initial episode is significant.

Expert D: Right there from that perspective I'm really starting to think hard about some sort of like structural dysfunction. Like a spondylolisthesis or like a pars defect, some sort of, you know just the way she's describing landing on her bottom and then

physically walking for a couple of days that's when I'm really starting, start to head off down that way.

Knowledge

Knowledge coding was necessarily based on the clinical reasoning literature. In this study, any participant reference to their knowledge in an attempt to apply it to the problem at hand was knowledge coded.

A sub-coding process took place following the completion of coding all participant transcripts into knowledge and other pre-determined codes. The knowledge sub-coding tree (Figure 4.1) depicts the final catgeorisation of transcript text at three further levels. These sub-categories of knowledge were developed based on the literature (section 2.7). The purpose of sub-coding knowledge related transcript text into separate categories was for easy retrieval and subsequent analysis.

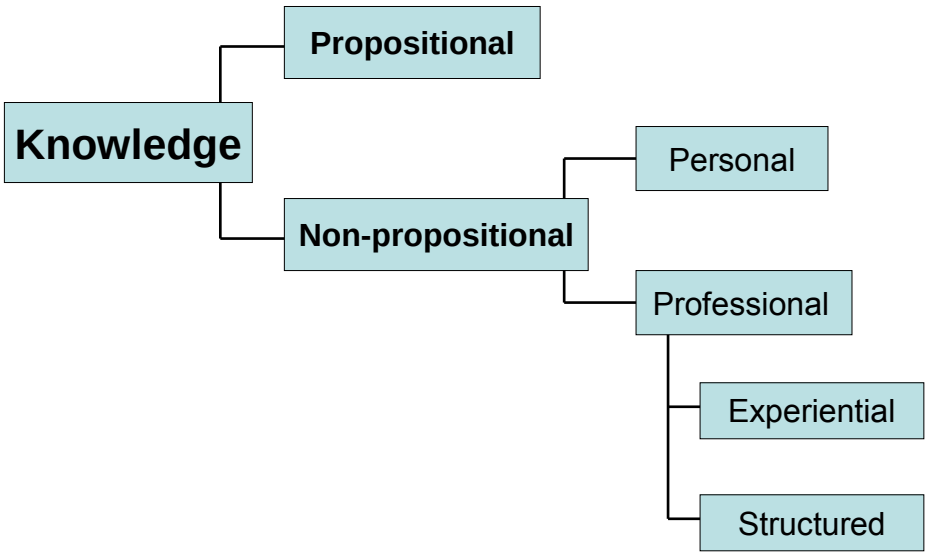

Figure 4.1 Knowledge sub-coding

Separating propositional and non-propositional knowledge is reasonably clear in theory, as outlined in section 2.7. However a practical separation was more complex due to the overlap between knowledge types within a clinician's highly structured and integrated knowledge base. Importantly, the sub-coding of knowledge into propositional and non-propositional knowledge types was not necessary from a perspective of identifying PR as all knowledge coded comments could offer insight into the reasoning process when considered individually.

The following transcript quotes are all examples from the knowledge node. They have been presented in their sub-codes to present the reader with a view of the potential overlap between knowledge types. All knowledge coded text was placed in either propositional or non-propositional sub-codes. Similarly all non-propositional text was placed in either personal or professional sub-sections. Lastly, all text placed in the professional sub-section of non-propositional knowledge was then separated into either experiential or structured. The definitions used for each sub-code are stated prior to the examples.

Propositional knowledge

Identifying propositional knowledge required reference to research or learning from textbooks, journal articles, conferences or specific structured learning courses that would indicate use of public knowledge (section 2.7.1). It was recognised that propositional knowledge most likely underlies a large number of the coded transcript text segments but could not be clearly identified. This code was only identified in expert transcripts:

Expert C: that's based on the information we have collected over twelve years on our back program … and those benchmarks have been published

Expert I: there's that extension aggravator, and flexion is a, a relieving um factor. Um based on the last MPA conference in Brisbane where they reported disc was aggravated by sitting -- that, that probably

changed what I was thinking, traditionally thought about, discy behaviour.

Non-propositional knowledge

Professional non-propositional knowledge

Non-propositional knowledge was reported in the literature to incorporate several knowledge types including professional, personal and experiential (section 2.7.1). The sub-coding of non-propositional knowledge depicted in Figure 4.1 was created as a practical categorisation of such knowledge types that often overlap or cannot clearly be separated. Sub-coding 'experiential knowledge' was useful to monitor the use of participant's own professional experience, except those that were coded under propositional knowledge. The 'structured knowledge' sub-code was developed as an alternate non-propositional knowledge category to experiential.

Experiential knowledge

Experiential knowledge was coded with any reference to knowledge directly attributed to clinical experience or clearly able to be inferred from experience:

Expert I: No I don't see a lot of kids because kids typically don't get, get low back pain

Novice Q: you know usually when everything's flared up, you know it mucks up the tests and it cause everything hurts so I'm looking at some treatment options to settle things down and then hopefully that will present a clearer picture over the next few, few treatment sessions

Structured knowledge

Any use of structured or a conceptual type of professional non-propositional knowledge that could not be directly attributed to clinical experience was coded within this category:

Expert J: if it's equal left and right I'm usually thinking it's a central problem and therefore it could be the disc

Expert G: I do tend to think of it more as a, as a motion segment rather than a disc and joint.

Novice R: it's still going to be one of you're balls that you're juggling, but the 24 hour pattern doesn't really fit

Novice P: when she was talking about the nursing um thing, it could, given her age could be a possible discy type irritation.

Personal non-propositional knowledge

Personal knowledge was placed within the non-propositional sub-code along with professional knowledge. This division was to acknowledge during coding that clinicians of all levels of professional experience utilise their own personal experiences during practice. This sub-coding was only used during one expert transcript:

Expert D: I guess probably the way she described or she said she's a nursing student and I know from personal experience, not that I've been a nursing student or anything, but seeing nursing students in hospitals and things like that, they spend a hell of a lot of time standing around. Standing, listening to people talk to them, being shown things.

Self-awareness

Self-awareness was created as a pre-determined code due to its importance as an element of expert clinical practice. It was hypothesised that the expert participants would display greater self-awareness during cognition than their novice counterparts. The inclusion of the self-awareness code did not however offer any direct evidence for the identification of PR.

Any occasion when the participant verbalised an awareness of their own thinking was coded as self awareness. These were likened to metacognitive reflections and could relate to any aspect of reasoning including data, process, hypotheses, decisions or knowledge:

Expert H: Because that was going to be quite confusing, that would send me down a completely different track … I thought I'll just make a

note of it. I put a star by it to make sure that I do chase it up … I put it aside, I put in the slightly too hard at the moment basket and then I'll come back to it

Novice S: I don't like to um to rush into decision-making at the end of my subjective. Um so I, I try to, to piece together the information that I've, I've collected and, and form an objective around that, and sort of ah gradually um get to, get to an answer in my head. Which is the way I normally go about it

The self-awareness coded text was reviewed following the complete coding of all transcripts and separated into 11 sub-codes (Table 4.1). Although these categories offered potential to provide insight into the cognitive process of participants, these data were not seen by the researchers to be useful towards the aims of the study. Examples of each of the self-awareness sub-coded text have been provided in Appendix 14.

Table 4.1 Self awareness sub-codes

Concern	Thoughts conveying concern related to the assessment
Deferred integration	Participant comments on the approach towards understanding being one of collect data now and think later
Diagnosis	Thoughts relating to diagnosis
Direction	Awareness of the direction of the thought process in this case
Interesting	The participant verbalises the awareness of the data or the case as interesting
Prediction	A thought process that is predicting a response or outcome
Process	General approach to an assessment is commented on as a process with all cases, not specific to this case alone
Significance	Recognition of the importance of the data collected
Surprise	Unexpected response leading to thoughts of surprise regarding the understanding of the case
Uncertainty	Confusion or uncertainty acknowledged relating to the case understanding at that point in time
Other	Including: Distrust of client / Client's perception / Doesn't fit / Data not useful

4.3.2 Intra-coder reliability

Intra-rater reliability was considered given the sole coding process during the majority of data analysis. The first two transcripts of each group were repeat coded after complete coding of all transcripts. The duration between initial

and repeat coding of each transcript was greater than 3 months to reduce the likelihood of memory recall during repeat coding. The intra-rater reliability was analysed via percentage agreement and kappa reliability coefficient (Domholdt, 2005). This process was undertaken only for tree nodes which included the six codes outlined in Table 3.2.

The reliability analysis indicated a very high level of agreement between the two episodes of coding. Individual agreement percentage and kappa coefficient statistics have been provided in Table 4.2.

Table 4.2 Intra-rater coding reliability

Participant	Percentage agreement	Kappa coefficient
Expert J	97%	0.96
Novice R	96%	0.94
Expert I	96%	0.94
Novice S	98%	0.97

4.3.3 Free codes

New codes were created during the overview reading and coding stages of analysis. These were entered into NVivo 7 software as free nodes and notes taken by the student researcher as outlined in section 3.5.3. Each identified free node has been documented below with definition and examples provided. A summary of free nodes is listed in Table 4.3.

Table 4.3 Free nodes

- Analytical reasoning
- Data confirmation
- Direction of reasoning
- Goal setting
- Hypothesis confirmation
- Hypothesis elimination
- Negative predictive
- Pattern related
- Predictive reasoning
- Simulated assessment
- Thinking after the event

Analytical reasoning

Definition: Any comment that could directly be seen to support HDR (and thus potentially negate PR)

Purpose: Subsequent review of this free node attempted to provide qualitative support to the quantitative interpretations regarding reasoning process.

Examples:

Novice S: at that stage I didn't have a clear cut diagnosis in my head. Um, I had some areas and some structures that I, I was interested in that I would have um been testing

Expert J: Cause I was still confused whether I really thought it was a disc or the facet joints which is what I'm really trying to work out, and it didn't quite fit to me

Data confirmation

Definition: The participant repeated information back to client for confirmation of accuracy in understanding a single piece or collective group of data

Purpose: Reiteration is potentially an interview method that increases accuracy of data collection. Errors in reasoning may in part be related to data collection. Identification of this free node was able to be compared with overall accuracy.

Examples:

Novice M: I'm trying to make sure that I've got everything important and haven't missed anything and I'm also just trying to clarify in my mind what's going on and making sure that there's no discrepancies in the story

Expert I: trying to clarify that she's telling me that it has been an 11 year history of episodic low back pain. It's always been there, um that it's been specifically this clinical placement, that, that's brought it to a head.

Direction of reasoning

Definition: During the retrospective recall interview the participant referred to their direction of thought process from the client assessment.

Purpose: Direction of thoughts was directly related to the interpretation of forwards or backwards reasoning process.

Examples:

Novice S: I think if I felt that I was thrown off a little bit, then I was just more intent on getting more data, um to clear that up

Expert I: I generally tend to keep it as open as I can with the history so that people could volunteer as much information and if they're not doing it, then I'll prompt them a little bit more, but otherwise let them go with it. Um when she said it started when she was 11, um I deliberately went into that in a lot more detail and asked question about did it trouble you as a teenager because you occasionally get patients who recall it to something that's happened in their birth or something completely random that maybe irrelevant or may not be irrelevant

Goal setting

Definition: The participant refers to the client's goals within the interview. This was either goals obtained from the client or reference to a question that was attempting to investigate the client's goals.

Purpose: Goal setting clearly involves the client collaboratively in the assessment process which is an important part of clinical reasoning. It is not known whether collaboration is particularly associated with any one type of reasoning strategy.

Examples:

Novice P: a few of the questions getting back to see what does she want out of life, where are we going from here, what's important to her, and are we just looking to get, get rid of the pain or are we looking to get rid of the pain and then getting to play netball for Australia

Expert G: looking at a goal of hers that you know she's worried she's got another clinical placement starting to think about again goals or treatment where we, what sort of goals we're going to have for her from that point of view

Hypothesis confirmation

Definition: Any direct or indirect reference towards a prior hypothesis being confirmed.

Purpose: The grouping of text segments highlighting confirmation of a hypothesis potentially added to the identification of a forwards reasoning process.

Examples:

Novice Q: feels pretty good in the morning it's less likely to be disc. Um and tends to you know um support more that lumbopelvic instability

Expert I: it's further adding to my um thoughts that there's something structural underlying the, and structural and permanent underlying the, the problem

Hypothesis elimination

Definition: Reference to removing a hypothesis from the overall understanding following new information or data from the assessment.
Purpose: Hypothesis related data organised within the hypothesis tree node were also placed in this free node if they related to eliminating any hypotheses through ongoing data collection. This node was included to monitor hypothesis elimination as a component of HDR.
Examples:

Novice R: Pattern really wasn't that discy … you know most people say stiff and sore, she said she's usually pain free in the morning

Expert D: OK that starts to sort of in her case rule out some of the other things that I was wondering about like you know, a lot of times people with disc problems for example sitting might aggravate it

Negative predictive

Definition: Participant questions deliberately used during the assessment to provide evidence that a clinical hypothesis is false.
Purpose: Process of elimination was observed in association with both analytical and non-analytical reasoning types and monitored as a client questioning strategy.
Examples:

Novice Q: I was just sort of you know chucking in a few questions to sort of negate structures perhaps, and it sort of leads me towards more, more that chronic um instability

Expert G: I was expecting that she would say um that she didn't have any pins and needles or numbness so definitely more to confirm what I was thinking

Pattern related

Definition: Any data found during analysis that related to participant pattern use, including recognition and elimination.
Purpose: Similarly to the analytical reasoning free node, the subsequent review of this free node attempted to provide qualitative support to the quantitative interpretations regarding reasoning process.

Examples:

Novice Q: Even though it doesn't seem likely given the pattern and the description and aggravating, um or something ah maybe something like a um stenosis or foramina or something like that. Um which may, may relate given the area and that and that extension

Expert C: the pattern is one that I recognise and looks mechanical

Predictive reasoning

Definition: The participant predicts a response to confirm a picture or comments on a prediction after data is gathered. Any comments on the therapist's predictive strategies in clinical practice were also coded.

Purpose: Predictive reasoning is a strategy reported in the literature that was noted during coding. It was monitored during qualitative analysis for thematic purposes and comparison with PR users.

Examples:

Expert G: And what muscles is she using … she said sitting up straight makes it worse, I was then getting in my head I'm guessing that when she sits up straight she does it with the wrong pattern so she uses her superficial muscles

Expert F: it hasn't fitted into what I thought. And I mean I guess as you, I mean that's what makes your practice interesting. I mean I do play games with myself at guessing what I think the problem is. I'll guess, I'll try and guess what their answers are going to be before they give me answers. Yeah and then I see whether I'm right or wrong.

Only one participant using a PR process was also observed to use predictive reasoning during the study.

Simulated assessment

Definition: Any comments that relate to the simulated patient's realism or performance.

Purpose: Easy storage of participant comments relating to the research method increases efficiency of analysing this information.

Examples:

Novice R: at one point I um I looked up at Michelle and I thought, gee she's a good actor (laugh) and that just sort of swayed me a bit but you know other than that no not at all

Expert D: I started wondering I wonder if she's actually got this problem.

Thinking after the event

Definition: Any direct or assumed reference that indicates the participant was thinking after the event (i.e. problem solving the data whilst watching the video) is placed in this node

Purpose: Any text coded in this free node was reviewed relative to study findings. The possibility of thinking after the event is a potential limitation of this methodology and was monitored for discussion purposes.

Examples:

Novice Q: in hindsight I probably didn't explore that enough.

Expert J: Maybe I should have asked if it was the rotation opening but I don't know if she would have known that. Because then that might have helped if it was the disc. But because it's bilateral, I don't think, I wouldn't manipulate it.

Review of data in this code found no occasions that influenced the study findings relating to PR identification or its accuracy.

4.3.4 Thematic analysis

The primary research aim was to investigate the phenomenon of PR within musculoskeletal physiotherapy clinical reasoning. Thematic analysis in the study served two purposes. Firstly, to provide a qualitative source of data that can support the identification of forwards and backwards reasoning strategies. Secondly, to identify additional findings from a sole qualitative theme development process that may inter-relate to the reasoning process.

In particular, noting differences between expert and novice physiotherapists relating to clinical reasoning.

The themes were common observations identified during coding. These have been documented wherever a topic was noted in two or more participant transcripts. The frequency of underlying observations of a theme (Table 4.4) highlights the weakness or strength of that theme relative to the participants in the study. Those findings identified in the responses of only a small number of participants have been presented to offer a comprehensive view of the complexity and variability of problem solving in practice.

In respect of the first intention of thematic analysis, only two of the themes directly assisted identification of directional reasoning process. Analytical reasoning and pattern related themes were utilised to further support the quantitative study findings. This provided strength to the study via triangulation using different types of data sources and analysis methods. Section 4.5 details the qualitative data from these two themes.

The qualitative aspect of the study allowed for the identification of new themes as outlined in section 3.5.5. All themes other than ‘analytical reasoning’ and ‘pattern related’ have been analysed and reported as additional study findings in section 4.7.

Table 4.4 Themes identified

Theme	Description	Experts	Novices
Analytical reasoning	When hypothetico-deductive reasoning was determined to have taken place	E,F,G,H,J	K,L,M,N,O,P,Q,R,S
Collect data now and think later	Participant refers to their approach in this manner	A,J	R,M,L
Focused on diagnosis	Predominant focus on identifying a diagnosis	J	S
Importance of history versus physical examination information	Stated emphasis on client history information Stated emphasis on physical examination information Stated emphasis on integration of all data	F,J E G,H	 R,S
Open minded approach to problem solving	Participant refers to their desire to be open to other possible hypotheses whether having a primary understanding or not	D,H,I	
Outcome data search	The search for data that can be used later as an outcome measure. Including reference to client goal setting	A,C,B,G	K,L,Q
Pattern related	• It doesn't 'fit' – pattern not recognised • Disbelieving approach • Differentiating from hypothetico-deductive reasoning • Recognition	E,F E G C,D,I	 Q,R
Person centred approach	A search for an understanding of the person is apparent along with a problem based understanding	A,B,C,D,F,G,H,I	K,N,O,P
Predictive reasoning	Participant is predicting the outcome of a question prior to asking it	D,F,G	N,Q
Reference to recent professional education	Participant refers to formal education during interview	A,F	K,M
Reiterating information back to client	Participant was observed to repeat data collected back to client during the assessment	D,I	M,P,Q
Search for symmetry in symptoms	Reference to searching for symmetry or asymmetry during symptom location	C,E,F,H	L

4.4 PATTERN RECOGNITION

The primary study aim was to determine whether PR is utilised by expert and novice clinical physiotherapists in the musculoskeletal field. This section provides quantitative results with respect to the research aims of identifying PR and evaluating its relationship to accuracy and efficiency. Agreement between all three researchers was achieved with respect to the reported findings.

4.4.1 Identification of pattern recognition

The identification of PR incorporated the use of a 'time stop identification tool' and an 'overall scoring tool' (Appendix 13). These were applied to all participant transcripts via the NVivo 7 software and coding retrieval options. Section 3.6.1 and Table 3.3 have detailed the individual features of PR used in this analysis.

An example of an 'overall scoring tool' finding positive identification of PR has been provided in Table 4.5. Conversely an example of the same tool unable to locate any evidence of PR is provided in Table 4.6. The percentage time row of these tables is the actual time at which the central hypothesis was formed as a percentage of the total assessment time. This relates to efficiency data which has been detailed in section 4.4.4.

Table 4.5 Overall participant scoring tool identifying pattern recognition for Expert D

Feature of pattern recognition	Present	Evidence	Comments
Central hypothesis formed	Yes	Time stop 3:50 "I'm really looking for is if she's got any time signs of spinal cord compression, cauda equina sort of issues" Did you have those at this point in mind? "Yeah, yeah" "one of the things that I sort of think about there would be say **spondylolisthesis"** Time stop 5:45 "Right there from that perspective I'm really starting to think hard about some sort of like structural dysfunction. Like a **spondylolisthesis** disorder. Like a pars defect, some sort of, you know just the way she's describing landing on her bottom and then difficulty walking for a couple of days that's when I'm really starting, start to head off down that way"	Distinct point in time.
Actual time of central hypothesis formation as a percentage of the total assessment time	21%	Central hypothesis formed at 3 minutes and 50 seconds, equating to 21% of Expert D's total assessment (18 minutes)	
Significant case features	Yes	Time stop 3:50 "bilateral nature of the symptoms, the spread, the fact that she's sort of saying she's, she's up, she's active that sort of stuff" Time stop 5:45 "the way she's describing landing on her bottom and then difficulty walking for a couple of days"	3:50 was the distinct point in time.
Professional knowledge	Yes	Time stop 6:30 "you know sometimes some people will lay, they'll say if I lay flat on my stomach I'm better and if it was what I'm thinking **spondylolisthesis** or some sort of extension based sort of disorder, um that probably wouldn't be the case"	Repeatedly relates knowledge to primary hypothesis.

		Time stop 7:50 "I know from personal experience, not that I've been a nursing student or anything, but seeing nursing students in hospitals and things like that, they spend a hell of a lot of time standing around. Standing, listening to people talk to them, being shown things, doing pretty crappy sort of jobs … or they're sort of leaning over making beds and things like that, and I'm thinking OK it's upright postures, um maybe sort of sustained semi flexion, that sort of stuff seems to be the thing that's made her worse. It's a significant sort of change in her normal activities which if she's a student normally she'd be sitting down … if she's got a spondylolisthesis or some sort of posterior sort of structural issue, but now she's upright and on her feet a lot more and it's you know it's made her condition feel worse" Time stop 13:09 "Manipulation induced analgesia is pretty common in a lot of back problem … and I'd also just think even with like some sort of posterior element to the instability, the spondylolisthesis or you know some sort of hard defect or even just an instability generally you can manipulate around that area and it will give you some symptomatic relief"	
Prior clinical experience of this case	Yes	Time stop 15:41 "So it kind of confirmed what I was thinking". So does that fit with then what you've seen before? "Yeah, that's based on previous experience with people who are describing a similar story to what she is" Time stop 18:00 Have you seen a case similar to this before? "several times … several times previously I would have this story being described"	Directly referring to prior experience with the same type of case.
Management stated	Yes	Time stop 15:41 "from a treatment perspective we'll need to teach her how to control her spinal position"	

Table 4.6 Overall participant scoring tool without evidence of pattern recognition for Novice S

Feature of pattern recognition	Present	Evidence	Comments
Central hypothesis formed	No	Time stop 5:30 "I was fairly certain at this point that um her, her pain level was very activity dependent. Um and that it was directly related to how much activity specifically netball, she was doing as to how bad the pain got, and I also wanted to know whether her thigh pains her knee pain, buttock pain and back pain were all related. And um from the way that she described that, each of them came on fairly systematically with levels of activity. Um that made me start to think that they were all related, to the one problem" Time stop 7:35 "I was tossing up things like um ah, disc, ah pain that was originated from a L, a lumber disc, um SIJ pain. Things like that um and I was, I was leading more towards the um the lumber spine um maybe disc related pain or the joint related pain, um because of the movements and things that were stirring it up" Time stop 10:55 "I had narrowed down … my main hypotheses for her pain and that was that she had um -- I suppose you'd have to describe it as non specific low back pain, but the structure I was particularly interested was a, a lumbar disc. Um -- and I was thinking that her clinical had stirred that up, um and made that, made that more painful" Time stop 14:20 "sort of chasing a lumbar disc as a possible structure. Um but also the, the referral pain down both legs and into her knee I hadn't um clearly determined whether that was, was coming from a structure in her lower back, or not. So I wanted to look at things like um her piriformis, her SIJ a little bit more with some testing, um to try and determine whether I could figure out if those all were referred pain into her buttocks and thighs and just below the knee where it related to the one area"	Initial hypothesis was activity dependent and all pains were related to the lower back. Then structural hypotheses highlighted a deductive process. Disc became the developing hypothesis but was considered alongside other possible hypotheses.

		Time stop 14:20 “a lumbar disc is one that is standing out um, more than others. Although it’s -- just the lumbar spine specifically that is standing out some more, so I wouldn’t, um, I wouldn’t rule out ah some Z joint involvement um or some, some muscular involvement either. Um -- but that, those are probably my, my top ones”	
Actual time of central hypothesis formation as a percentage of the total assessment time	Nil		
Significant case features	No		
Professional knowledge	No	Time stop 8:45 “she was still standing when she did that, that should take some pressure off. Um, something like a disc or the low back when she’s in standing, so that refocused me a little, which was good”	Use of knowledge related to the structural disc hypothesis but within a reasoning process with several possible hypotheses.
Prior clinical experience of this case	No	Time stop 14:20 “I was thinking at, at the time going through the subjective that I didn’t have something else to compare it to”	No similar clinical experience was noted.
Management stated	No		

The results of the two analysis tools were then summarised in Table 4.7. This tabled information identified each feature of PR and provided an overall view of the presence of PR within each participant interview. A central hypothesis was necessary throughout the assessment for overall identification of PR (section 3.6.1). Any alternative hypotheses in conflict with another indicated a deductive process and opposed the identification of PR.

In all cases where PR use was determined, both a ‘central hypothesis’ and associated ‘significant case features’ where identified. The ‘number of yes responses’ did not determine whether PR was used however higher scores provided greater support for utilisation of PR. The ‘number of yes responses’ formed a score from 0 to 5 for each participant. Those participants using PR were found to have a score of 3 or above.

The numbers of participants clearly utilising PR during the study can be seen in the final column of Table 4.7. In all five participants, four out of ten experts and one out of nine novices, incorporated PR into their reasoning of the clinical case. The overall novice score was 3 out of 5, whilst three of the experts scored 4 and one scored 5 out of 5.

Table 4.7 Summary of pattern recognition related results

	Central hypothesis formed	Time formed	Significant case features	Professional knowledge	Prior clinical experience	Management stated	Number of yes responses	Pattern recognition identified
Expert B	Y	23%	Y	Y	N	Y	**4**	**Yes**
Expert I	Y	36%	Y	Y	N	Y	**4**	**Yes**
Expert A	N	.	N	N	N	N	**0**	**No**
Expert G	N	.	N	N	Y	N	**1**	**No**
Expert J	N	.	N	N	N	Y	**1**	**No**
Expert E	N	.	N	Y	N	N	**1**	**No**
Expert C	Y	31%	Y	N	Y	Y	**4**	**Yes**
Expert H	N	.	N	Y	N	Y	**2**	**No**
Expert D	Y	21%	Y	Y	Y	Y	**5**	**Yes**
Expert F	N	.	N	N	N	Y	**1**	**No**
Novice N	N	.	N	N	N	N	**0**	**No**
Novice R	N	.	Y	N	N	N	**1**	**No**
Novice L	N	.	N	N	N	N	**0**	**No**
Novice P	Y	26%	Y	Y	N	N	**3**	**Yes**
Novice O	N	.	N	N	N	N	**0**	**No**
Novice S	N	.	N	N	N	N	**0**	**No**
Novice M	N	.	N	Y	N	N	**1**	**No**
Novice K	N	.	N	N	N	Y	**1**	**No**
Novice Q	N	.	N	N	N	N	**0**	**No**

Y = Yes; N = No

'**Time formed**' is the actual time at which the central hypothesis was formed as a percentage of the total assessment time

'**Number of yes responses**' is the total number of Y responses in each row (not including 'Pattern recognition identified')

'**Pattern recognition identified**' required the 'central hypothesis' and 'significant case features' to have a Y response

4.4.2 Comparison of expert and novice use of pattern recognition

A comparison of experts and novices was undertaken based on the model of PR being associated with experience and expertise. That is, in order to determine whether the findings were associated with expertise the novice group was included in the study. Table 4.8 provides a direct comparison between groups and includes the conversion of data to categorical form for statistical analysis.

Table 4.8 Comparison of pattern recognition use between groups

Participant	**PR Identified**	**Categorical data conversion**
Expert B	Yes	1
Expert I	Yes	1
Expert A	No	0
Expert G	No	0
Expert J	No	0
Expert E	No	0
Expert C	Yes	1
Expert H	No	0
Expert D	Yes	1
Expert F	No	0
Total / 10		**4**
Novice N	No	0
Novice R	No	0
Novice L	No	0
Novice P	Yes	1
Novice O	No	0
Novice S	No	0
Novice M	No	0
Novice K	No	0
Novice Q	No	0
Total / 9		**1**

0 = No 1 = Yes

First, Fisher's exact test was conducted using SPSS statistical program (version 15) to determine group differences with respect to identifying PR. This analysis produced a value of 0.303 when comparing experts to novices

indicating no significant difference between groups based on a significance level of 0.05.

Secondly, the credible intervals for proportions were calculated. Credible intervals are from frequentist statistical theory and refer to the Bayesian equivalent of a confidence interval (Gelman et al, 2004). This approach to analysis was used given the common approach, involving normal approximation to the binomial distribution, being less reliable with small samples. The 2.5 and 97.5 percentile points of the beta posterior distribution were used to determine the limits, the posterior being based on a binomial likelihood and conjugate beta prior, with both parameters being equal to 1 to give a uniform prior distribution (Gelman et al, 2004). In cases when the number of events observed was zero or equal to the numbers of trials the interval was calculated as one sided as recommended by Carlin and Louis (1996).

The credible intervals for the identification of PR amongst all participants and each group separately are displayed in Figure 4.2. These findings suggest no significant difference between groups, but this is particularly related to the small sample size and lack of power. Additional sample size calculations determined that 42 participants would be required in each group to demonstrate a statistically significant difference between expert and novice participants. This sample size calculation used a proportion derived from a Po of 0.111 (based on 1 of 9 novices utilising PR equating to 11.1% of this group) and Pi of 0.4 (based on 4 of 10 experts utilising PR equating to 40% of this group) with a type I error rate of 0.05 and power of 0.80.

Closer analysis of the credible intervals produced by Bayesian analysis finds PR to exist as a phenomenon. This is based on the view that the lower margin of each interval was above zero for both groups and all participants combined (Figure 4.2).

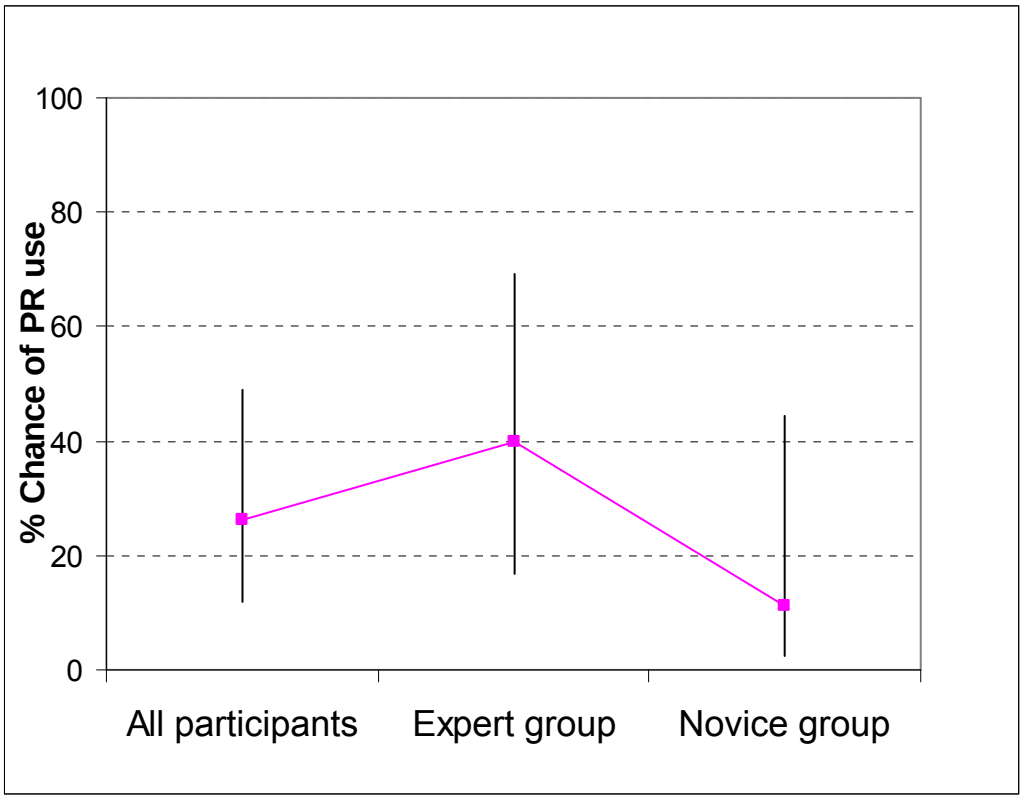

Figure 4.2 Credible intervals for the identification of pattern recognition (PR)

4.4.3 Accuracy

Accuracy of any case depends on comparison with a stated known diagnosis. As described in section 3.2.2, the case utilised in the study was known to be a lumbar spine spondylolisthesis in a 20 year old female. An accurate outcome was therefore only considered if the participant labelled spondylolisthesis as their primary or predominant hypothesis in the case. The overall summary of participants' stated primary hypotheses is outlined in Table 4.9 which highlights that three of the experts correctly identified the pathology. Details of transcript data leading to the primary hypothesis summary are provided as Appendix 15.

Table 4.9 Stated primary hypothesis relative to pattern recognition use

Participant	Pattern recognition identified	Stated primary hypothesis
Expert B	Yes	**Spondylolisthesis**
Expert I	Yes	**Spondylolisthesis**
Expert A	No	Instability
Expert G	No	Motion segment dysfunction / Neurogenic / Instability
Expert J	No	Disc vs Joint
Expert E	No	Instability
Expert C	Yes	Mechanical pelvic asymmetry
Expert H	No	Instability / Joints
Expert D	Yes	**Spondylolisthesis**
Expert F	No	Nil clearly stated
Novice N	No	Lack of support / restriction
Novice R	No	Instability
Novice L	No	Disc
Novice P	Yes	Instability
Novice O	No	Sacroiliac joint
Novice S	No	Disc > Joint
Novice M	No	Postural
Novice K	No	Disc / Sacroiliac joint / Postural
Novice Q	No	Instability

Three of four expert participants using PR achieved an accurate diagnosis of spondylolisthesis. The only novice participant using PR did not attain the correct diagnosis. Conversely all the participants not using PR (six experts and eight novices) did not achieve the correct stated diagnosis. Converting the PR accuracy data into a two by two table for the separate groups (Table 4.10) allows accuracy relative to PR to be more easily viewed. If considering PR accuracy across all participants regardless of experience, the number of participants using PR accurately (3) was only just higher than those who did not (2). Table 4.11 depicts overall PR accuracy across all participants.

Table 4.10 Pattern recognition accuracy between groups. Accuracy was only considered as identification of spondylolisthesis

		Pattern recognition		Pattern recognition	
		No	Yes	No	Yes
Accuracy	No	6	1	8	1
	Yes	0	3	0	0
		Experts		**Novices**	

Table 4.11 Pattern recognition accuracy overall. Accuracy was only considered as identification of spondylolisthesis

		Pattern recognition	
		No	Yes
Accuracy	No	14	2
	Yes	0	3

Statistical analysis of the two by two tabled data was conducted using Fishers' exact test for all participants using PR regardless of group and for

the expert group alone. Analysis of PR users achieving a correct diagnosis across all participants when compared with participants using analytical reasoning strategies produced a significance value of 0.01. Relative to a significance level of 0.05, this indicates that the use of the PR strategy was significantly more likely to produce a correct diagnosis during a subjective history than using analytical reasoning strategies.

Similar analysis of the expert participant group alone was considered appropriate with respect to accuracy as the phenomenon is one that is associated with experience. The Fishers' exact test applied to experts using PR as compared with those using analytical reasoning in achieving a correct diagnosis produced a significance value of 0.033. Relative to a significance level of 0.05, this calculation also indicated that the use of the PR strategy was significantly more likely to produce a correct diagnosis during a subjective history than the use of analytical reasoning strategies.

4.4.4 Efficiency

The 'time stop identification tool' allowed for timing data to be easily obtained relative to the formation of a predominant hypothesis. The timing data collected per participant included the total amount of time taken to conduct the client history and the time taken to the formation of a predominant hypothesis. Due to the varying lengths of each participant assessment the time for formation of a predominant hypothesis was compared as a percentage of each overall assessment time. Table 4.12 provides the overall assessment times for each participant and the timing data relating to hypothesis formation.

The actual time elapsed when the central hypothesis was first mentioned (formed) by the participant was calculated as a percentage of the total assessment time. In gradually developing hypotheses this stated time was when the final predominant hypothesis was stated and held above other possibilities. The timing data was able to be confidently and clearly stated in

those cases where PR was identified but less so in those without. Therefore the time to initial predominant hypothesis was more of an estimate in non-PR cases and not an exactly defined point in time. As such, these times were not deemed useful in the interpretation of efficiency.

Table 4.12 Timing data relating to central hypothesis formation

Participant	Overall assessment time	Time to initial central hypothesis	Initial central hypothesis as % of overall time
Expert B	20:10	3:35	23%
Expert I	19:00	6:51	36%
Expert A	13:45		
Expert G	22:05		
Expert J	14:00		
Expert E	10:00		
Expert C	9:55	3:03	31%
Expert H	18:50		
Expert D	18:00	3:50	21%
Expert F	17:20		
Novice N	8:10		
Novice R	10:08		
Novice L	12:00		
Novice P	19.35	5:25	26%
Novice O	15:10		
Novice S	14:20		
Novice M	18:50		
Novice K	16:00		
Novice Q	15:20		

Pattern recognition efficiency

The results of timing data highlighted that when PR use was identified the predominant hypothesis that was maintained throughout the entire assessment was formed in the first 36% (range 21% - 36%; median 26%; mean 27%) of the subjective client assessment.

The overall assessment time for those using identified PR as compared with those using analytical reasoning strategies have been analysed and compared via simple statistics (Table 4.13).

Table 4.13 Total assessment time relative to reasoning method and participant group

Both participant groups	Number	Range	Median	Mean
Pattern recognition identified	5	9:55-20:10	19:00	17:21
Analytical strategies without pattern recognition	14	8:10-22:05	14:45	14:42

Experts	Number	Range	Median	Mean
Pattern recognition identified	4	9:55-20:10	18:30	16:46
Analytical strategies without pattern recognition	6	10:00-22:05	15:40	16:00

Novices	Number	Range	Median	Mean
Pattern recognition identified	1	19:35	19:35	19:35
Analytical strategies without pattern recognition	8	8:10-18:50	14:45	13:44

Comparison of efficiency between groups

Comparison of overall time taken for the assessment between experts and novices was also analysed independently from reasoning strategy and compared via simple statistics as shown in Table 4.14.

Table 4.14 Total assessment time relative to participant group only

Participant Group	Number	Range	Median	Mean
Experts	10	9:55-22:05	17:40	16:18
Novices	9	8:10-19:35	15:10	14:25

4.4.5 Participant order of questioning

The physiotherapy questions observed in the study were obtained from review of the videorecorded data of the simulated client assessment. Transcription of this data was conducted by the student researcher. Following this the participant questions that directed the problem solving process were able to be analysed. The questions were subsequently grouped based on standard areas within a musculoskeletal physiotherapy history (Petty, 2006). Categories of questions included:

- Introductory question
- Body chart of symptoms
- Current and past history of symptoms
- Social history
- Previous treatment
- Aggravating and easing factors for symptoms
- Specific questions relating to condition irritability
- 24 hour behaviour of symptoms
- Exercise related
- Goal setting
- Special questions relating to bladder / bowel dysfunction
- Special questions relating to balance
- Special questions relating to coughing and sneezing
- General health
- Medication
- Investigations

- Work related
- University participation
- Client beliefs
- Age

The categories of questions were similar to the areas used in the training and assessment of simulated client response accuracy. The primary purpose was to provide a comparison of the order of questions posed with respect to analytical versus non-analytical reasoning and between groups.

The analysis involved placing the categorised questions into a Microsoft Excel 2003 spreadsheet (Microsoft, 2003) based on the order of questions irrespective of time. A second spreadsheet was then developed relating when each question was asked to the minute of time during each participant assessment. These data are not included in the thesis due to the shear size of the spreadsheets and the lack of useful outcomes. However, the observational data relating to grouped standard questions displayed some similarities and differences between the expert and novice participants. The entire expert participant group commenced the assessment with an introduction question followed by body chart related questions. The novices similarly use an introduction question but only three of the novices then requesting body chart information, with the others asking about current or past history information. Following this there are no obvious differences between groups relative to the order of information requested. The data were not analysed statistically based on the results of visual analysis. To analyse such data requires a question of value and comparison of such data between groups was not considered useful relative to the research question.

The primary benefit of collecting and analysing this observational data was the potential for obtaining evidence for confirmation questions following the identification of a pattern. Interestingly two of the experts using PR (Experts D and I) formed their pattern immediately at the time of asking a special question relating to bladder / bowel dysfunction. This question was

considered potentially related to a high grade spondylolisthesis condition. The significance of this finding however was countered by the fact that two of the experts using analytical reasoning and not considering spondylolisthesis (Experts G and H) also asked the same question. It may therefore have been an observation of question order based on undergraduate or postgraduate training and has no relation to confirmation questioning post PR. No other trends were observed in the data of those experts using PR or analytical reasoning.

4.5 QUALITATIVE ANALYSIS FINDINGS

Transcript data from the free codes 'analytical reasoning' and 'pattern related' were utilised to provide qualitative support for the identification of a diagnostic reasoning strategy. Clearly both analytical and non-analytical strategies existed within quantitative data analysis (section 4.4). A qualitative review of transcript quotations underlying these two themes offers an element of triangulation to the prior reported study findings.

4.5.1 Analytical process

HDR is undoubtedly a strategy employed when unfamiliarity with a case is present. Repeated quotations supporting an analytical reasoning process were observed during analysis of all novice transcripts with the exception of novice P who was previously identified as using PR. Examples of qualitative data supporting the presence of an analytical strategy are provided. Interestingly, these are all competing hypotheses within the 'physical impairments and associated structure / tissue sources' hypothesis category (Table 2.2) and are predominantly competing structural sources of the symptoms:

Novice N: I was automatically thinking lumbar spine joint or SIJ (sacroiliac joint) then with the aggravating factors ah I was thinking that it, it's in that area but I wasn't yet sure which one of those it would be more likely to be

Novice O: I was initially thinking discy kind of pain but with the um sitting as an easing factor usually not so much but then again prolonged sitting ah but then sitting in extension, so I don't know whether there's ah like a, I guess it's a facet joint kind of thing going on with the extension kind of or still maybe an SIJ kind of thing with the extension

Five of the ten experts were coded with 'analytical reasoning' and none of these were identified as using PR (section 4.4). Only Expert A of the participants not using PR was absent from this code. Examples of the 'analytical reasoning' code in expert participants are:

Expert J: Cause I was still confused whether I really thought it was a disc or the facet joints which is what I'm really trying to work out, and it didn't quite fit to me

Expert G she landed on her buttocks again that made me think oh maybe it is, is an SIJ component and um -- or is it just sort of still a lumbar spine motion segment getting that, that compression over ten years you know if, if she's had fairly significant trauma then what sort of processes have been going on.

4.5.2 Pattern related

The 'pattern related' free code was separated into four sub-codes as listed:

1. It doesn't fit – pattern not recognised
2. Disbelieving approach
3. Differentiating from HDR
4. Recognition.

The first two of these sub-codes related to pattern elimination (It doesn't fit – pattern not recognised) or the case data not fitting a known pattern (disbelieving approach). These sub-codes could not qualitatively support PR but had relevance to experts attempting to fit the presenting case findings

with prior known experiences. Examples of the first sub-code 'It doesn't fit – pattern not recognised' include:

Expert E: I'm thinking I'm eliminating the disc as the cause. The early morning first thing is to get out of bed. And coughing and sneezing there's sometimes the two of them can go together. Um and um it doesn't sort of fit so I've gone onto something else then

Expert F: I think it's surprising that someone her age can say that she's like basically got constant pain there all the time ... I mean that surprises me. It doesn't, it still doesn't seem to fit into a proper pattern, to me. Yeah, usually someone her age, I mean you can have intermittent back pain over a long period of time, but you'll usually have periods where you have no pain

The second 'pattern related' sub-code of particular interest was a 'disbelieving approach' from Expert E. Several comments were made during the retrospective interview in relation to questioning the client's responses because they did not fit a recognisable form:

Expert E: I wouldn't have expected it … I may need to check her reliability of her information because she might not either clearly hear me or interpret me or give me the correct feedback OK so a couple of times I'm gunna requestion her and just check her out

Expert E: I'm gathering information, um but already I didn't like the fact that it was symmetrical … I was just thinking that I don't believe you … There has to be an asymmetry

The third sub-code of 'pattern related' had elements of pattern use but also clear identifiable analytical strategies. These formed a 'differentiating from HDR' sub-code. Novices Q and R were identified from this sub-code and qualitatively analysed as developing patterns (section 4.5.3). The only expert identified from this sub-code was Expert G who made reference to patterns but during analysis via the 'time stop identification tool' (Section 4.4.1) was found to develop an understanding of the case gradually. Expert G stated a

broad overall understanding of “motion segment dysfunction” with “less muscle control” and referred to their clinical experience in “hearing patients say”:

Expert G: just from a -- hearing patients say that over and over again, so I guess from a pattern, pattern point of view, um yeah time on her feet, bending over, so that can still, to me still fits in with um with the motion segment dysfunction probably less muscle control sort of standing being perhaps a, a weight bearing um bit of in extension but then having that control of support into flexion

The last ‘pattern related’ sub-code included quotations from transcripts that individually supported pattern ‘recognition’ as a non-analytical reasoning strategy:

Expert C: the pattern is one that I recognise and looks mechanical

Expert D: that’s based on previous experience with people who are describing a similar story to what she is

Expert I: I don’t see a lot of kids because kids typically don’t get, get low back pain … but when we do we, we seem to get them with long term symptoms but a lot of the time there’s structural reasons why

4.5.3 Developing patterns

The identification of PR in the present study could only be assured with a clear dominant hypothesis throughout the entire clinical assessment. This allowed for clear separation and comparison between participants using PR versus those incorporating more analytical methods of reasoning. Analysis also found evidence of developing patterns in the transcripts of two of the novice participants. Novices Q and R referred to an ‘instability’ hypothesis early in the assessment but then continued with an analytical reasoning process with multiple competing hypotheses. Developing hypotheses from the transcripts of Novices Q and R have been included for visual review and subsequent discussion in Chapter 5.

Novice R hypotheses:

Time stop 2:26	A previous injury and something reasonably serious and the inability to walk for two days is indicative of something fairly strong or fairly strong pain. Um so there could be some previous instability or damage that's been re-aggravated
Time stop 3:34	the amount of referral is something that's you know, a fair degree of instability or something's going on there. She's getting a fair bit of referral, so start to you know, lean towards a, a more serious sort of thing
Time stop 3:34	Could be instability. Could be disc bulge, could be a few things
Time stop 8:02	Pattern really wasn't that discy
Time stop 10:55	that referral could be due to um sciatic impingement … that was something that I was juggling. Um, but also there could be you know she might have other things going on. Um facet joint irritations or general instability, global instability

The problem solving of Novice R commenced with what seemed to be recognition of an instability pattern labelling the past history and strong pain as the case features. However progression to multiple competing hypotheses gave greater overall weight to evidence of a HDR process. The development of the instability hypothesis is viewed as forwards movement within an analytical process. Analytical evidence from the Novice R transcript was provided in the following statements:

Novice R: I hadn't really at this staged locked myself into any sort of hypothesis. I was really just sort of pulling it all, just making a stew, just getting all that information in there and some, seeing what I thought in the end (Time stop 6:14)

Novice R: when you look at it, you know it's (disc hypothesis) still going to be one of you're balls that you're juggling, but the 24 hour pattern doesn't really fit, you know (Time stop 8:02)

Novice Q hypotheses:

Time stop 4:30	I'm starting to think disc, discogenic sort of given that it's radiating up into, into the glut's. Um -- also you know I'm looking at possibly from adverse neural tension involvement as well. Um, but it, yeah likely you know given the time frame and that I, I'd certainly start to think discogenic, um overall and, and more, more likely like a chronic ah a lumbopelvic instability
Time stop 6:19	It's reasonably consistent um with what I'm thinking, with the that lumbopelvic instability
Time stop 6:56	again it's sort of, there is a, um there is some um some support again for that, that lumbopelvic instability. But then again it could be discogenic as well
Time stop 7:19	Um sort of confirmed it. There's certainly an extension to the aggravation um -- sitting with good posture is obviously or reasonable posture is quite difficult for her which would suggest instability. Um sort of takes away that disc … I guess I mean there could be a more ah a lesion anteriorly in the disc perhaps
Time stop 8:40	I think it does tend to support um (prior understanding of instability). I guess the other, other structures particularly with extension and that, you have to consider is a SIJ. But not very likely given the area of pain um it's my understanding that SIJs rarely go beyond that you know, that far around the groin and things like that
Time stop 10:10	tends to you know um support more that lumbopelvic instability … there's no, not a really inflammatory response or anything like that with it. Um -- which there tends to be at times you know with particularly with discs you know they report stiff and sore in the mornings and that sort of thing

Time stop 10:58 I'm still leaning towards um that, that instability um you know lack of, lack of stability through that area

Time stop 15:25 I guess really there's two possibilities. But I, that sort of sit in my mind. Um that still that same, you know that lumbopelvic instability in that area, um poor activation of transversus, it certainly would be interested to see her ability to activate um through there and see if there was any alteration in her symptoms. Um, the other, other possibility is ah like a stenosis compression of a nerve root

Gradual development of the multiple hypotheses in the Novice Q transcript indicates a predominant analytical process. However, some evidence of clinical patterns within a hypothetico-deductive process is apparent. The participant's references to the use of patterns was not indicative of clear recognition of a known pattern but may be considered as evidence of a developing pattern triggered within an analytical process. The evidence for a developing pattern was observed in the following statements:

Novice Q Looking at patterns um to see if there's any. Um given that it feels pretty good in the morning it's less likely to be disc. Um and tends to you know um support more that lumbopelvic instability … there's no, not a really inflammatory response or anything like that with it. Um -- which there tends to be at times you know with particularly with discs you know they report stiff and sore in the mornings and that sort of thing (Time stop 10:10)

Novice Q it gives me an idea, I guess I'm trying to establish ah a pattern recognition, you know, relating the pattern to, to the possible problem (Time stop 10:10)

Forwards reasoning movement was evident at one stage in the form of confirmatory questioning:

Novice Q I was just sort of you know chucking in a few questions (cough & sneeze) to sort of negate structures perhaps, and it sort of leads

me towards more, more that chronic um instability (Time stop 8:00)

4.6 PARTICIPANT HYPOTHESES

Participants were encouraged to verbalise their understanding of the case during the stimulated recall interview. As outlined in the 'orientation to the interview' sheet (Appendix 10) read by participants prior to the interview, the term hypothesis was used to refer to any understanding or explanation of the case. This was particularly emphasised to be in any form or any way that suited each individual clinician. Analysis included coding and sub-coding within the hypothesis node which enabled an overall view of the extent of hypotheses formed during the clinical reasoning task.

A summary of each participant's final hypothesis has been listed in Table 4.9. The data associated with each summary has been provided as evidence behind the student researcher's interpretation of final hypothesis, along with the breakdown of hypothesis categories (Appendix 15). This section provides the analysis of participant's hypothesis category use within the final stated hypothesis (section 4.6.1) and during the entire participant interview (section 4.6.2).

4.6.1 Final hypothesis category utilisation

Final hypotheses described by the participants were also analysed with respect to the hypothesis categories outlined in section 2.3.1. This involved each final hypothesis being labelled with any number corresponding with the category observed within the data. Table 4.15 presents the final hypotheses for each participant by the type of categories used.

Table 4.15 Final hypothesis extent of category use

Participant	Categories	Participant	Categories
Expert A	4,5	Novice K	4,5
Expert B	4,6	Novice L	4
Expert C	4,5	Novice M	5
Expert D	2,4,5	Novice N	5
Expert E	4,5	Novice O	4
Expert G	3,4,5	Novice P	5
Expert H	4,5,6,7	Novice Q	4,5
Expert I	3,4,5,7	Novice R	4,5
Expert J	4,5,6	Novice S	4

The total range of categories used in expert final hypotheses included 2, 3, 4, 5, 6 and 7; whereas comparative use by novices included only categories 4 and 5. Four of the experts utilised only category 4 and 5 or 4 and 6 in their final hypothesis. The remaining five experts utilised a combination of three or four categories in their final understanding. One expert did not state a final understanding. The data from Table 4.15 have been used to display the percentage of participants per group using each hypothesis category in the final stated understanding of the case (Figure 4.3).

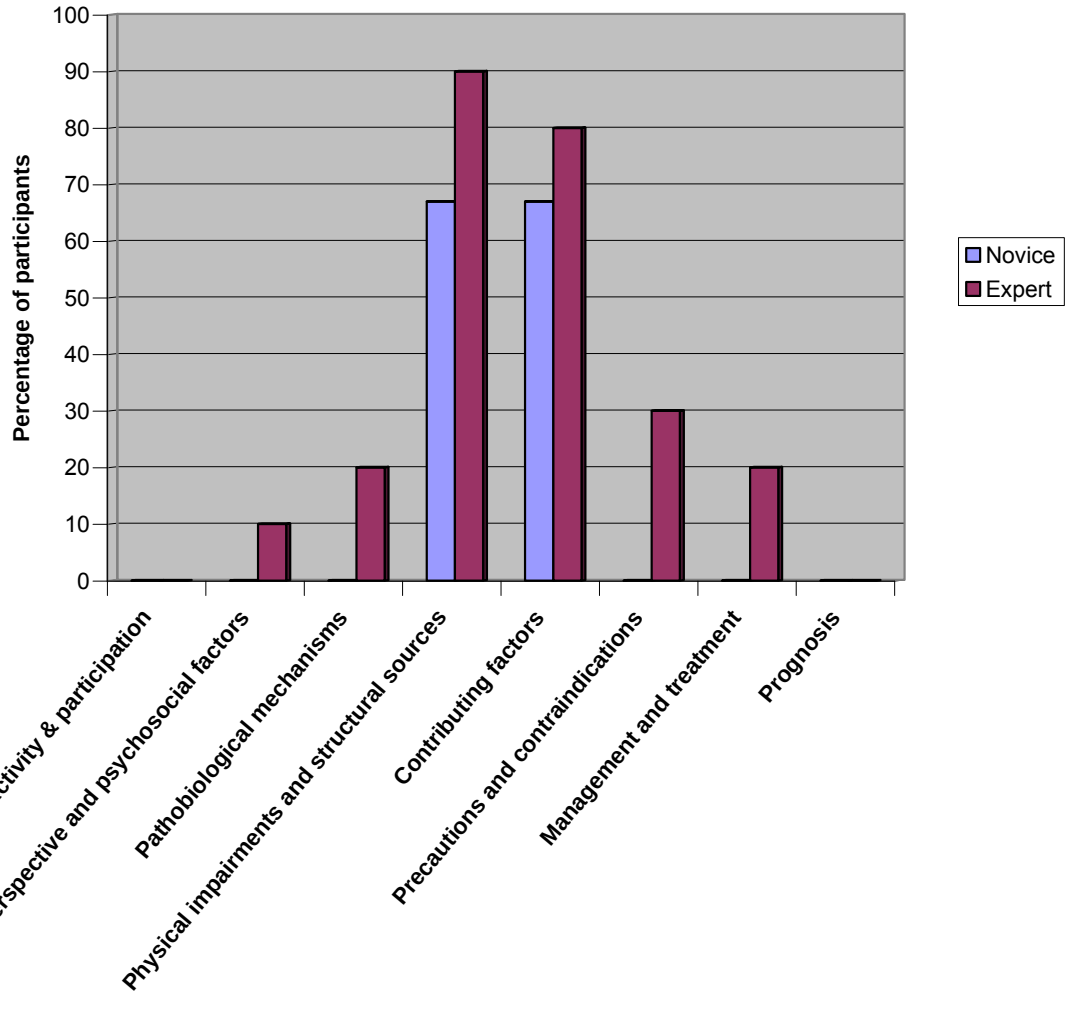

Figure 4.3 Final hypothesis category use by experts and novices

4.6.2 Overall hypothesis category utilisation

The extent and frequency of hypothesis formation with respect to the eight reported hypothesis categories (Jones & Rivett, 2004) outlined in Table 2.2 during a clinical assessment has not been previously reported. Analysis of the frequency of hypothesis category use at any stage during the interview was assessed to provide information pertaining to the extent of hypothesis development by physiotherapy clinicians. This process notably differed from the final hypothesis category use in Table 4.15 as it involved a review of any hypothesis observed in the transcript data. Examples of each hypothesis category observed in the transcripts have been provided in section 4.3.1.

The extent of use was assessed via review of the hypothesis coding and sub-coding obtained during qualitative analysis. The overall extent of hypothesis category use has been presented in Table 4.16, including the additional 'non-specific' category for hypothesis types not indicated in the literature. These data present the number of participants in each group and overall that utilised each hypothesis category at any stage during their reasoning. The frequency of use by each participant and the depth of content within each category were not included in this analysis.

Table 4.16 Extent of overall hypothesis category use

Hypothesis Category	Experts n=10	%	Novices n=9	%	Overall N=19	%
1 Activity / participation	6	60	4	44	10	53
2 Patient's perspective / psychosocial	8	80	2	22	10	53
3 Pathobiological mechanisms	7	70	5	56	12	63
4 Physical impairments / structural sources	10	100	9	100	19	100
5 Contributing features	10	100	9	100	19	100
6 Precautions and contraindications	6	60	7	78	13	68
7 Management and treatment	9	90	5	56	14	74
8 Prognosis	6	60	3	33	9	47
9 Non-specific	7	70	5	56	12	63

The percentage use of each hypothesis category by the 19 participants reflects the extent of hypothesis formation within a small sample of physiotherapists assessing the same case. The results of hypothesis categories use by all participants demonstrated a predominance of the impairment / structure / source and contributing features categories which were utilised by all participants during the problem solving task. Management (74%) and precautions / contraindications (68%) were next in frequency of use, followed by pathobiological mechanisms (63%). Prognosis (47%), activity / participation (53%) and patient's perspective / psychosocial (53%) were the least frequently used hypotheses. Hypotheses that did not fit clearly

into any of the eight reported categories and were placed in the non-specific group were used by 63% of all participants.

Table 4.16 also allows for comparison of each hypothesis category relative to participant group. The stand out difference between groups occurred within category 2 (patient's perspective / psychosocial factors) where 80% of experts described their understanding within this category as compared with only 22% of novices. The percentage of participants per group (Table 4.16) using each hypothesis category at any stage during problem solving is displayed in Figure 4.4.

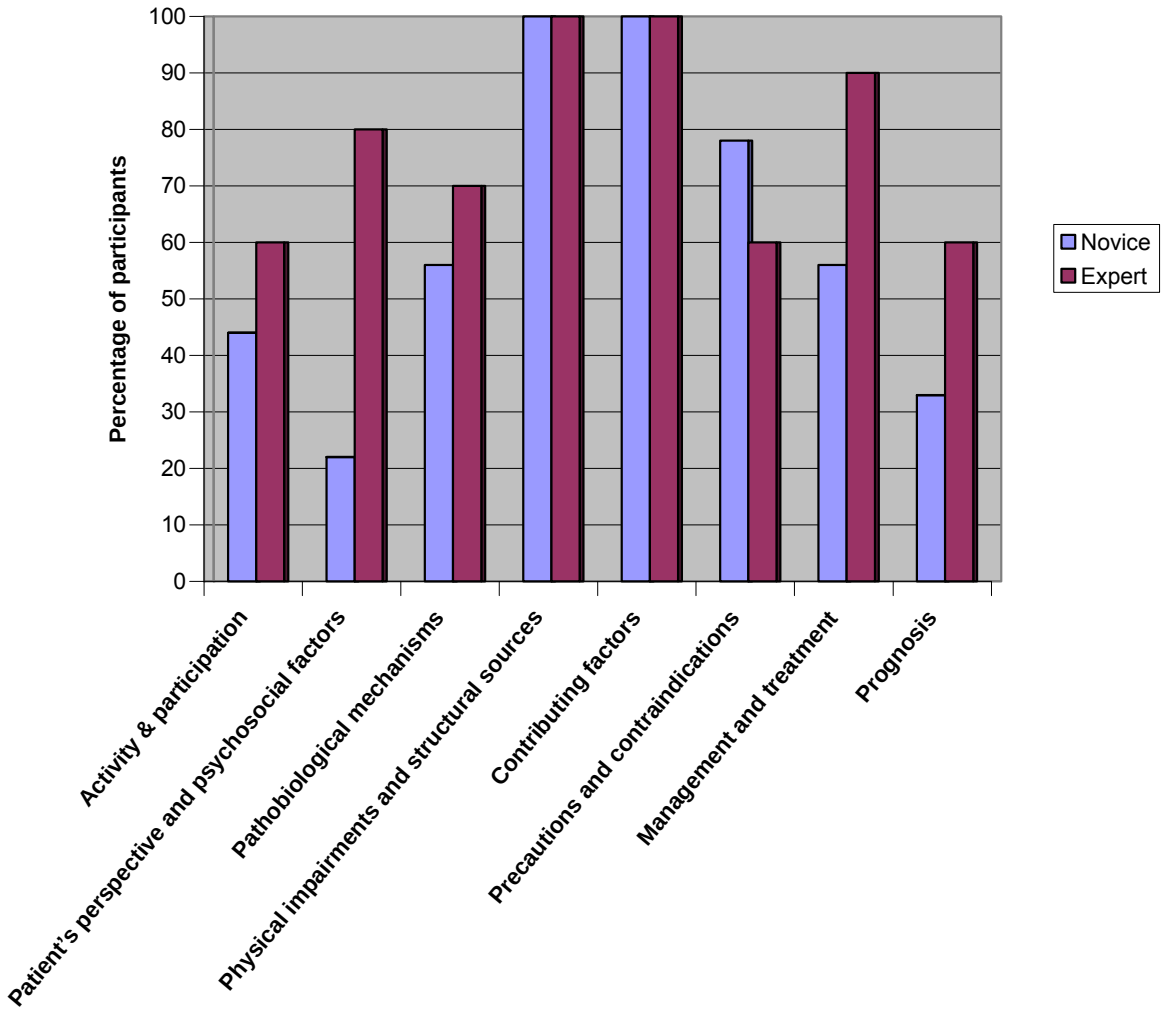

Figure 4.4 Overall hypothesis category use by experts and novices

The existence of any significant difference between groups was analysed individually for each hypothesis category. Fisher's exact test was utilised given the small numbers in the groups and the results demonstrated that only the second hypothesis category of 'patient's perspective / psychosocial factors' was found to be significantly different between the groups using a significance level of 0.05 (Table 4.17). No calculation was possible for categories 4 and 5 given no differences in frequency occurred between groups.

Table 4.17 Group comparisons for the use of each hypothesis category (using Fisher's exact test)

Hypothesis category	Experts n=10	Novices n=9	p value
1	6	4	0.656
2	8	2	0.023*
3	7	5	0.65
4	10	9	-
5	10	9	-
6	6	7	0.628
7	9	5	0.141
8	6	3	0.37

* ≤ 0.05 significance level

Table 4.18 highlights the extent of use of hypothesis categories by each novice and their overall use by novices as a group. The overall median number of categories used by novices was 5 (62.5%) and mean was 4.9 (61.1%).

Table 4.18 Novice use of hypothesis categories

Participant	1	2	3	4	5	6	7	8	Total	%
Novice P	1	1	1	1	1	1	0	1	7	87.5
Novice Q	0	0	1	1	1	1	1	1	6	75
Novice M	0	0	1	1	1	1	1	0	5	62.5
Novice O	1	1	0	1	1	0	1	0	5	62.5
Novice L	0	0	1	1	1	1	0	1	5	62.5
Novice N	1	0	1	1	1	1	0	0	5	62.5
Novice S	1	0	0	1	1	1	0	0	4	50
Novice R	0	0	0	1	1	1	1	0	4	50
Novice K	0	0	0	1	1	0	1	0	3	37.5
								Median	**5**	**62.5**
								Mean	**4.9**	**61.1**

The experts were notably higher than novices with their use of hypothesis categories within the single case. The overall median number of categories used by experts was 6 (75%) and the mean was 6.2 (77.5%). Table 4.19 presents the expert data.

Table 4.19 Expert use of hypothesis categories

Participant	1	2	3	4	5	6	7	8	Total	%
Expert G	1	1	1	1	1	1	1	1	8	100
Expert A	1	1	1	1	1	1	1	1	8	100
Expert B	1	1	1	1	1	1	1	0	7	87.5
Expert I	1	1	1	1	1	1	1	0	7	87.5
Expert F	1	1	0	1	1	0	1	1	6	75
Expert C	0	1	1	1	1	0	1	1	6	75
Expert H	1	0	1	1	1	1	1	0	6	75
Expert D	0	1	1	1	1	0	1	1	6	75
Expert J	0	0	0	1	1	1	1	1	5	62.5
Expert E	0	1	0	1	1	0	0	0	3	37.5
								Median	**6**	**75**
								Mean	**6.2**	**77.5**

4.7 ADDITIONAL FINDINGS

The primary study aims related to identifying PR and its relationship to accuracy and efficiency, however the qualitative nature of data collection and analysis provided additional findings worthy of reporting and discussion. These results have been obtained from the thematic analysis process that has been outlined in section 4.3.4 and Table 4.4 and are summarised into five areas:

- Relative importance of data
- Concurrent integration of data
- Awareness of errors
- Predictive reasoning
- Person centred approach to assessment.

4.7.1 Relative importance of data

Musculoskeletal physiotherapy can be viewed as having two main sources of information; data from questioning a client and that obtained from a physical assessment. This study was based around the subjective data obtained from questioning the simulated client, given that no physical examination was conducted during this investigation. It was noted during free coding and subsequent thematic analysis that some participants verbally commented on the importance of a specific data source. These comments were considered to fall into three areas:

- Emphasis on patient history information during problem solving
- Emphasis on physical examination information during problem solving
- Emphasis on integration of all data.

In total seven participant transcripts were considered by the student researcher to have data relating to this additional finding, including five of ten experts and two of nine novices. The data presented may have been directly

stated by the participant during the interview or the student researcher may have inferred the finding from the transcript data.

Examples of statements inferred by the student researcher relating to the relative importance of data:

Expert F: by this stage I normally have a very clear picture of what I think's wrong with someone whether it right or wrong

Expert H: **P:** Um, I guess I was trying to, to make sure that I wasn't missing a disc, a disc problem"

R: And is that something you would now be able to put aside?

P: Not, not entirely until I'd done the physical examination so if I found things like SLR restricted flexion and obviously neurological signs, I'd probably put it back. Yeah but at the moment I'm not thinking that

Expert G: I was a bit surprised about given I thought there was, there is a neural component to that, but again I, you know, I've just, I've gathered that information, I'm going to store it but I will then just I would probably probe it more in the, in the objective with her (referring to further questioning at an appropriate stage during the physical examination)

Examples of direct comment made by participants relating to the relative importance of data:

Expert E: I would place more (emphasis) on the objective … Because I find that's more reliable

Expert J: **P:** the objective assessment I do, is pretty standard … I mean I just do everything and then at the end, decide what, what the diagnosis was

R: Do you find you get more information in terms of understanding what might be going on from your subjective, or more from your, your physical testing?

P: Subjective

R: More from your subjective?

P: Mm.

R: And then you've just got a standard -- physical testing that you do to confirm or further understand?

P: Yeah, yeah. Yeah I think I do pretty well a full assessment on everyone.

Novice S: I don't like to um to rush into decision-making at the end of my subjective. Um so I, I try to, to piece together the information that I've, I've collected and, and form an objective around that … I think more often than not um I don't, I have an answer to a particular structure that might be causing pain at the end of the subjective. Um I, I'm more often have an answer at the end of my objective

Novice R: from pretty much the majority of the subjective I was just really pooling information and formulating ideas and just waiting, I usually just wait till after the objective before I, and even then I still might have three different diagnoses. So yeah at this stage it's all pretty in the formative stage

The quality of the data are unable to lead to any specific conclusions relating to a preference of one part of the clinical examination over another with experts or novices, but rather highlights variability in each clinician's weighting of clinical findings. This area of findings was not requested of participants but noted during coding of the interview transcripts.

4.7.2 Concurrent integration of data

Metacognition relates to the awareness of one's thinking about data collection, reasoning, hypotheses or knowledge at the time of cognition (Jones & Rivett, 2004). It is considered an important expert characteristic and supports the development of clinical reasoning skill via reflective practice. The results of the present study highlight that several participants including two of the experts adopted a delayed integration of data process, arguably at odds with metacognition. Examples of the two experts include:

Expert J: I usually take the history and then think what -- I just go through the sheet I've got, and then at the end I really start thinking, putting it together. I usually get all the facts before I start putting it together … the objective assessment I do, is pretty standard … I mean I just do everything and then at the end, decide what, what the diagnosis was

Expert A: I think I tend to data gather and stash it in a big heap and use it later … I'm pretty much in automatic mode asking questions … I don't try and bundle it too much at this stage, although I guess I must do in my head.

Expert A stated their delayed integration approach but makes comment somewhat to the contrary in the statement "I don't try and bundle it too much at this stage, although I guess I must do in my head". This could be interpreted as reflective of an automated approach without good awareness of the problem solving processes employed.

Both experts A and J demonstrated an ability to reason individual pieces of information / data along the way but were not found to effectively integrate clinical data during the assessment. The difference noted between these experts was that expert J was focused on the search for a structural pathology based diagnosis, whereas expert A stated that the clinical diagnosis was the focus and not the pathology.

The novice participants found to use a delayed integration approach included:

Novice R: at the time I was really just running through the process. I wasn't really nutting it out that, that much in detail

Novice L: I'm thinking at the time I was just sort of collecting information and wasn't really um contemplating what that was

Novice M: I'm more concentrating on collecting the data as accurately as I can

Novice L stated this delayed integration related to one aspect of clinical data collection. This quotation was not necessarily indicative of their approach to

the entire assessment. Novice M tended to revert to a delayed integration approach later in the assessment, possibly when the clinical data was not able to be interpreted as a clear case understanding. These results are not unexpected for a novice physiotherapist with little exposure to such a case, however only three of the nine novice participants referred to a delayed integration approach. The remainder were clearly integrating the data during the assessment even when their level of knowledge and clinical experience arguably did not allow for effective assimilation.

The effect of delayed integration of data on assessment time was analysed (Table 4.20). The timing data compares total length of the client assessments for those participants using a delayed integration approach versus those concurrently integrating clinical data.

Table 4.20 Total assessment time (minutes:seconds) relative to delayed versus concurrent integration of data (all participants)

	Number	Range	Median	Mean
Delayed integration (participants coded delayed integration)	5	10:08-18:50	13:45	13:44
Concurrent integration (participants not coded delayed integration)	14	8:12-22:08	16:40	15:59

The five participants having some evidence of delayed integration of clinical data were found to have a lower mean and median time for the total assessment when compared with all other participants. All five of the participants coded 'delayed integration' were not found to use PR and were subsequently compared with all other participants using HDR (Table 4.21).

Table 4.21 Total assessment time (minutes:seconds) of participants using hypothetico-deductive reasoning relative to delayed versus concurrent integration of data (excluding participants using pattern recognition)

	Number	Range	Median	Mean
Delayed integration (participants coded delayed integration and using hypothetico-deductive reasoning)	5	10:08-18:50	13:45	13:44
Concurrent integration (participants not coded delayed integration and using hypothetico-deductive reasoning)	9	8:12-22:08	15:20	15:14

The data were not analysed statistically due to the possibility that the presence of this code did not reflect the participant's approach to the whole assessment. Section 5.5.2 discusses this limitation further.

4.7.3 Awareness of errors

The potential for error is an important element when considering clinical reasoning process. The non-analytical strategy of PR has been described in the literature as being associated with both error and accuracy in clinical practice. The results show three experts made reference to a willingness to remain open to other possibilities during the interview, arguably minimising one potential source of error (bias):

Expert H: I do try and keep quite an open mind as far down the track as I can because I know that you can get quite influenced and then, and then find that it's not really the case, so I try really to make judgment ah, fairly far down the track

Expert I: I generally tend to keep it as open as I can with the history so that people could volunteer as much information

Expert D: That would be my working hypothesis that I would be wanting to test with my examination … but I would be completely prepared to find something completely different

Experts D and I had attained a central hypothesis that was correct prior to these statements, but both indicate they were still capable of discounting this hypothesis if contradictory data were found.

4.7.4 Predictive reasoning

A predictive strategy during questioning was anticipated by the student researcher to be potentially associated with a forwards reasoning process. Evidence of this strategy was found in the transcripts of three experts and two novice participants. Of these five participants, only one expert utilised PR based on the results in section 4.4. Examples of predictive reasoning quotations included:

Expert G: that probably wasn't what I was expecting her to say. I probably would have expected her to say when I slouch its worse and when I sit up straight its better

Expert D: If my hypothesis of it being some sort of either structural instability or like a dynamic instability or spondylolisthesis is correct maybe she'll be able to tell me that when she's running and then stops suddenly bang it will grab her

Novice Q: I was just sort of you know chucking in a few questions to sort of negate structures perhaps, and it sort of leads me towards more, more that chronic um instability

Novice N: based on the aggravating factors and the area of the pain I'd expect it to be sore in to flexion … Well, in, in a way that if, if she flexed all the way down to her toes I'd be surprised … Um, it wouldn't fit what I was going down

A unique observation of predictive reasoning involved Expert F who described a game like approach to predicting client responses:

Expert F: **P:** it hasn't fitted into what I thought. And I mean I guess as you, I mean that's what makes your practice interesting. I mean I do play games with myself at guessing what I think is the problem

R: And you're playing those sort of games mentally?

P: Oh yeah, yeah, yeah … I'll try and guess what their answers are going to be before they give me answers. Whether I'm right or wrong

R: Yeah so you ask a question and try and have a prediction in mind?

P: Yeah and then I see whether I'm right or wrong

Predictive reasoning was therefore a strategy used by some physiotherapists but not found to be associated with PR.

4.7.5 Person centred approach to assessment

The current study method was targeted towards identifying a diagnostic reasoning process and involved an actor, which may have biased participants in their behaviour accordingly. Despite this some participants

attempted to understand the client as a person. Eight of the ten expert transcripts and four of the nine novice transcripts were found to contain some evidence of a 'person centred' approach to the assessment (Table 4.4). This theme was based on the student researcher's notes during analysis of the hypothesis sub-codes such as category 1 (activity and participation) and 2 (patient's perspective / psychosocial factors), along with the 'management' tree node and the 'goal setting' free node. Transcript examples supporting a person centred approach include:

Expert G: looking at a goal of hers that you know she's worried she's got another clinical placement

Expert I: she's still got a significant aggravating component to it and that, that may be something what we needed to address as far as um -- time off when she needed to. She may need time off uni. She may need to look into special consideration and social factors that might need to be addressed in relation to her pain

Novice N: She hasn't lost any time off work although she's stopped playing sport and it does hamper her ability to perform the normal things that she needs to do

Novice O: I was just trying to get a, a kind of idea of where she's at like with, cause it's been going on for so long I don't exactly know her age but um she, her ah pain behaviours and how she deals with the pain like she says rest is the best thing but she still, she's still playing netball despite the pain and so just trying to get an idea of how she copes with the pain and that sort of thing

These quotations provide evidence that the participants were able to think about the person within the problem solving process, which therefore adds support to the realism of the clinical encounter and suggests the study design had minimal effect on their reasoning behaviours.

4.8 STUDY DESIGN RELATED RESULTS

Any research relies on sound methodology for the validity of its overall conclusions. This is particularly the case with clinical reasoning research due to the complexity of investigating cognitive processes. Several aspects of the current study method that could impact on the outcomes were monitored during data collection and subsequently analysed. The results of the study design on participant behaviour are presented hereafter.

4.8.1 Case simulation data

A potential criticism of simulated case research involves realism and accuracy of case portrayal. The videorecording of the client assessment was primarily utilised for stimulated retrospective recall but was also subsequently reviewed and analysed for accuracy of the case portrayal. A simulated case response checklist (Appendix 4) was developed incorporating fifty-two response areas which allowed the accuracy of the actor's responses compared with the case data to be determined. This was undertaken immediately following data collection for the first four participants and feedback provided to the actor. Continued data collection for all participants occurred in relation to case accuracy and statistical analysis followed the completion of participant recruitment.

The data obtained from the simulated client response checklist was transferred to nominal data and analysed via proportions averaged over the fifty-two response areas. A summary of the response data is provided in Table 4.22. For each question response area the number of occasions it was requested could be viewed in addition to the number of times it was answered accurately and inaccurately. This resulted in a proportion of correct responses out of the total number of times requested for each response area. This basic method of analysing data accounted for the fact that not all response areas were requested by every participant. The results found that only two of the fifty two response areas had a proportion of below 1,

indicating fifty questions were answered correctly on 100% of occasions. The average proportion of all fifty-two response areas was 0.99 equating to 99% accuracy of overall responses to participant questions.

The breakdown of fifty-two response areas found the question on ‘unsteadiness of gait / giving way of the legs’ was answered inaccurately during the first two participant assessments. Feedback provided to the actor led to accurate responses in this area of questioning for the remaining participants (if requested). The simulated patient’s age was the only other area of questioning to be answered incorrectly on one occasion when the date of birth was requested rather than current age.

Accurate portrayal of the case by the actor was a critical part in achieving valid and meaningful results. The participants were aware of the case being portrayed by an actor via the study information statement (Appendix 7) as ethically required. They were subsequently requested to comment on their overall experience compared with a real clinical situation, including the realism of the case and simulated client. Eight of the nineteen participants directly commented on the actor, while others remarked on the study setup as a whole without specifically making comment on the actor.

Table 4.22 Simulated client response data

Response area	Experts requested	Novices requested	Total (out of 19)	Incorrect responses
Location of pain types (Pain A)	10	9	19	0
Location of pain types (Pain B)	10	9	19	0
Association of pains A & B	10	9	19	0
Location of pain types (Pain C)	10	9	19	0
Location of pain types (Pain D)	10	9	19	0
Location of pain types (Pain E)	10	9	19	0
Association of pains C, D & E	10	9	19	0
Severity of pain types (Pain A)	6	8	14	0
Severity of pain types (Pain B)	6	7	13	0
Severity of pain types (Pain C)	6	5	11	0
Severity of pain types (Pain D)	6	5	11	0
Severity of pain types (Pain E)	6	5	11	0
Description of pain types (Pain A)	9	7	16	0
Description of pain types (Pain B)	9	7	16	0
Description of pain types (Pain C)	9	7	16	0
Description of pain types (Pain D)	9	7	16	0
Description of pain types (Pain E)	8	7	15	0
Constancy of pain (Pain A)	10	9	19	0
Constancy of pain (Pain B)	10	9	19	0
Constancy of pain (Pain C)	10	9	19	0
Constancy of pain (Pain D)	10	9	19	0
Constancy of pain (Pain E)	9	8	17	0
History of current episode	10	9	19	0
Past history	10	9	19	0
Mechanism of injury	10	8	18	0
Primary aggravating activities	10	9	19	0
Standing tolerance	8	8	16	0
Walking tolerance	6	2	8	0
Sitting tolerance	9	6	15	0
Primary easing factors	10	9	19	0
Previous physiotherapy treatment	9	5	14	0
Other previous treatment	10	9	19	0
Morning pain / stiffness	10	8	18	0
Night pain / ability to sleep	10	9	19	0
Pain behaviour through day	10	9	19	0
Primary patient goals	8	7	15	0
Activity – netball participation	10	7	17	0
Anterior knee pain	6	3	9	0
Unsteadiness / giving way of legs	4	2	6	2
General health	10	9	19	0
Paraesthesia / numbness	10	9	19	0
Cough / sneeze	7	2	9	0
X-rays	10	9	19	0
Prior surgery	9	6	15	0
Weight loss	9	7	16	0
Medications	10	8	18	0
Investigations	10	9	19	0
Social history	6	1	7	0
Age of patient	8	6	14	1
Cord / cauda equina questions	8	6	14	0
Current employment	3	4	7	0
Nursing student – full time	10	9	19	0

The participant comments provide a qualitative view of the realism of the case presentation:

Expert I: She was really good and certainly not enough things that changed um the way you were thinking.

Expert D: She's realistic to the point where I'm, I started wondering I wonder if she's actually got this problem.

Novice R: It seemed like an actual patient.

Novice M: Yeah, I forgot I was not seeing a real person.

The influence of the simulated client on participant behaviour was commented on during a few participant interviews. These quotations highlight a brief focus on the study's use of client simulation for these two participants:

Novice K: **R:** You mentioned halfway through one of the questions you asked you got a response that you thought was um an impromptu response as opposed to a real response.

P: Um from the patient? Ah yeah that was I don't think though that that had anything to do with the camera or the audiotape. I think that was ah something which ah I guess I, it's quite a, I guess I'd say just from my limited experience that would be quite a funny um ah symptom to get

R: So were you thinking about this person on the way being an actor in that role the whole time or was it just at that sort of moment.

P: No just for 15 seconds that she said it was an achy, crampy (pain) but apart from that I was just thinking that she was a patient.

R: So apart from that you thought she was fairly realistic?

P: Yeah I thought she was good. Did she actually have back pain before?

Expert J: I thought she was very good. Um at first I was thinking oh she's an actor and she's been told what to say. But she knew all the ans, like there wasn't any question that she, except when I said -- ah with the leg pain was it superficial or deep she sort of didn't

really know -- And other than that I thought she knew it all well and then I started to really believe that she had this problem. When I asked her about what treatment – you know when she was 11 and she went to the chir, going to the chiropractor when he cracked her back. Oh when I come home, I'm at uni but when I come home in the holidays I still go and see the chiropractor, every two or three months and he cracks it. I started to think then that she really had the problem.

4.8.2 Study context influences

The main location of the study and placement of equipment attempted to minimise any effect on the behaviour of the participant during the study. However the potential effect of the context on participant behaviour was unavoidable. Consequently participant perception on the impact of study context on participant behaviour was surveyed at the end of the interview. The final questions outlined in the interview protocol (Appendix 11) were in relation to:

1. Did the location of the assessment influence your assessment compared to normal?
2. Did the presence of the video camera influence your assessment compared to normal?
3. Was your assessment conducted more thoroughly than normal?

The majority of participants did not think the context or study equipment altered the process of conducting a subjective assessment in this case:

Expert A: **R:** what you did today with this particular case… do you think that was fairly standard of what you would have done for the subjective with the next person that walks in the door?
P: Yeah pretty standard.
R: So the video and the audio equipment didn't interfere too much with what you did?
P: Oh no, not at all.

Expert D: **R:** This environment do you think it changed how you went about that assessment, the video camera?

P: No, no I think probably that's pretty much as I would

Expert J: **R:** did you think the location of the assessment, the video camera influenced the way you went about your subjective assessment?

P: No not at all.

R: And do you think you conducted your assessment any more or less thoroughly than normal?

P: No that's standard.

Expert E: **R:** Did you think the, the video camera made you do the assessment differently than what you would do normally?

P: No, no.

Novice P: **R:** Did the location of this assessment … influence the way you went about your assessment?

P: Um being a subjective ah, not greatly.

R: Did the video camera um and the audio recorder influence?

P: No it didn't bother me at all.

Novice K: **R:** In terms of the set up here, do you think the camera or just being audio recorded actually changed or altered or influenced the way you went about your subjective?

P: Ah not really. No.

R: You mentioned halfway through one of the questions you asked you got a response that you thought was um an impromptu response as opposed to a real response.

P: Um from the patient? Ah yeah that was I don't think though that that had anything to do with the camera or the audiotape. I think that was ah something which ah I guess I, it's quite a, I guess I'd say just from my limited experience that would be quite a funny um ah symptom to get.

Novice O: **R:** Did the recording equipment -- Or the environment influence the way you went about it?

P: No, no didn't even notice.

R: Did you think that was reasonably -- normal to what you would normally do.

P: Yeah absolutely. Yeah, yeah, yep. I didn't, I didn't feel like it was invasive or anything like that, so.

The occasions where contextual effects were noted by expert participants have been reported to allow the reader to make judgement on this component of the study. All comments were considered by the student researcher to indicate minimal overall influence on the results of the study:

Expert H: **R:** do you think this location did in the end influence the way you went about your assessment?

P: No probably not.

R: The video camera or the audio recorder didn't --

P: No, I was able to forget about that -- I started, I started to find myself thinking halfway through -- about the process but managed to sort of but then I started losing the plot a bit.

R: So as an assessment it's fairly standard as to what you would have -- generally done in the clinic.

P: Yes, it's, it's not different I would always do that that sort of way.

Expert B: **P:** I just think sometimes when I'm watching the video I probably wouldn't go into that amount of detail the questioning. I think I'd probably make those jumps um ah you know clinically I probably wouldn't go through as much detail. I think that's probably one of the um -- the fact that it 's sort of like this video and that type of thing.

Expert G: **R:** so the location of the assessment, do you think that influenced how you went about your assessment today -- Not being in your normal environment?

P: Um -- no I think that probably the only thing that, about the environment might have been the presence of the, the video camera.

R: And so did that affect you much in, in the end in terms of how you went about it, or changed anything?

P: No, no I don't think so.

Novice S: **R:** did the video affect do you think, the way you assessed the patient in this case. The fact that you have a video in the background or being audio recorded?

P: No

R: Being in this environment as opposed to in a clinic with a plinth beside you, do you think that changed the way you went about things at all?

P: Not the way that I went about things in any way. Um, it was, it did feel a bit unfamiliar though, so I don't know whether that would have affected me. I don't feel like it has.

Participant comments regarding the research process highlighted an awareness of the context mid-way through the client assessment, however this was generally brief and did not alter the overall flow of the assessment compared with a normal client history.

CHAPTER 5. DISCUSSION

The present study used a carefully designed high fidelity case study method as outlined in Chapter 3. It is the first study of its type in physiotherapy that has assessed diagnostic accuracy relative to reasoning process. In particular, the study findings add to the physiotherapy clinical reasoning literature with respect to our understanding of PR. The findings also potentially impact on our understanding of pattern development from the perspectives of both accuracy and education.

This chapter specifically addresses several key discussion points based on the aims of the reported study:

- The presence of PR as a clinical reasoning process in musculoskeletal physiotherapy
- Evidence for the diagnostic accuracy of PR, and
- Observations and limitations relating to the efficiency of PR.

Following the discussion relating to the primary study aims, this chapter also addresses:

- The ‘makeup’ of a clinical pattern as the basis of recognition
- Significant case feature use in PR
- Observations of hypothesis category use in problem solving with respect to differences between experts and novices
- Relevant comparisons between novice and expert groups
- Additional findings relating to different approaches to reasoning observed during the study, and
- Limitations of the study based around the retrospective recall methodology and context specificity.

5.1 NON-ANALYTICAL REASONING

The research literature supporting PR is largely based on studies of the medical profession. Comparison studies exist between medicine and physiotherapy in analytical reasoning processes (Payton, 1985), however non-analytical reasoning has not been compared in the same way. PR has been reported in qualitative physiotherapy research in two studies involving high fidelity real cases (Doody & McAteer, 2002; Noll et al, 2001), however these have not allowed for assessment of diagnostic accuracy. A more recent medical study assessing the overall benefit of PR including outcome was based on low fidelity paper case methods (Coderre et al, 2003). In neither profession has a high fidelity case been utilised to undertake a replicable study investigating the accuracy of non-analytical diagnostic reasoning strategy. High fidelity case study methods allow participants to obtain the clinical data that are suited to the case and their reasoning style rather than be guided by what is presented to them.

A concern relating to the PR literature involves the varied reports of its makeup. This has been extensively discussed in section 2.5.1, resulting in an amalgamation of the commonly reported elements of PR. Subsequently criteria for identifying PR were identified (Table 3.3), derived from published authoritative commentaries and research articles. These criteria then became the basis for the PR identification tools (Appendix 13) and are worthy of further discussion.

The essential requirement in identifying PR during this study (and separating it from an analytical strategy) was evidence of a predominant or central hypothesis based on significant case features. This is similar to the low fidelity study conducted by Coderre et al (2003), where the basis for identifying PR involved “a single diagnosis with only perfunctory attention to the alternatives” (Coderre et al, 2003, p. 703). These researchers also described PR as being based on salient cues but this was not a component they used in its identification.

The additional three components used in identifying PR in the present study involved the use of professional knowledge, reference to prior clinical experience, and a stated management plan. It was essential that these components had to relate to the central hypothesis that was based on significant case features. Including these additional criteria was intended to strengthen the divide between analytical and non-analytical strategies, and not rely just on a single feature of PR such as detection from prior clinical experience.

The study has provided strong evidence for the existence of PR in current musculoskeletal physiotherapy practice. The fact that four of ten expert participants were clearly found to be using PR using the stringent identification criteria indicates that it exists. This was supported by the credible interval calculations (section 4.4.2; Figure 4.2) having a lowest margin above zero.

The nature of PR as a reported strategy of experienced clinicians and dependent on past experience led to expectations that differences would exist between the expert and novice groups. The novices were found to only have one participant using a form of non-analytical reasoning, whereas the expert group had four participants. The statistical analysis of differences between experts and novices in the use of PR found that no significant difference existed (section 4.4.2). However the lack of power resulting from the small sample size was likely contributory to the lack of significance. Furthermore, analysis of the five criteria indicative of PR found the single novice participant using PR only scored three out of five (including the central hypothesis, related case features and associated knowledge). Of the four experts identified to have used PR, three utilised four criteria and one employed all five criteria. It is plausible that the novice (who identified a neuromuscular instability pattern) was using a broad form of PR but one that wasn't necessarily closely associated with prior clinical experience. The pattern could have been one learned via academic education, for example.

Prior clinical experience as a non-essential component of identification of PR was supported in that it was present in the transcripts of only two of the four experts utilising PR. Although it underpins the phenomenon, it was considered insufficient alone as a feature for identifying PR and was not stated at times when PR clearly existed. The two experts who did not refer to their experience of a similar case may have utilised recognition based on a conglomeration of propositional and non-propositional knowledge, rather than a single prior experience. This will be further discussed in relation to categorisation in section 5.3.1.

The relatively broad inclusion criteria for the expert group facilitated the generalisability of the results to standard physiotherapy practice of musculoskeletal therapists. In essence, it was considered that the physiotherapists comprising the expert group had clinically practiced for a sufficient time and completed a recognised postgraduate musculoskeletal or manual therapy qualification that enabled the development of experience based patterns. The pattern used in this simulated case (i.e. spondylolisthesis) was considered likely to be familiar to at least some expert participants in this group based on the prevalence of the condition. This assumption was supported by the PR results.

The primary research aim was to determine whether PR is utilised by expert and novice clinical physiotherapists in the musculoskeletal field. The results demonstrate that it was used by four experts and one novice participant. These findings therefore support a similarity in diagnostic process models between the medical and physiotherapy professions. Non-analytical diagnostic reasoning that is highly dependent on case and context specificity has been observed in both professions.

Although not statistically significant, the comparison between groups in this study also tends to support the view that PR is a strategy increasingly utilised with greater knowledge and relevant clinical experience. The

question of what type of and how much experience is required to develop the use of this strategy was beyond the scope of this study. Arguably the answer will lie with the integration of knowledge and experience relevant to any specific condition.

5.1.1 Accuracy of pattern recognition

Clinical reasoning research in medicine has utilised case study methodology to investigate PR accuracy (Coderre et al, 2003; Norman et al, 1992; Patel & Groen, 1986). These studies however have utilised either visual cues in radiology or low fidelity paper cases to achieve their respective outcomes supporting its accuracy in diagnostic reasoning. The transferability of these results to present physiotherapy clinical practice is questionable.

Careful consideration was given to the study design relating to high fidelity case methods. The study was developed with the purpose of not only being able to identify PR, but also to shed light on the question of its accuracy. A key element in interpreting diagnostic accuracy in clinical reasoning research lies with the level of confidence in the clinical data leading to the actual case diagnosis. The specific diagnosis for the real case used as the basis for the simulated case study was that of a lumbar spine spondylolisthesis pathology (section 3.2.2), a condition with a substantial level of research evidence in the published literature. Thus the assessment of accuracy was limited to the diagnosis of a structural pathology alone.

The study found positive results for the use of PR in identifying the case diagnosis of spondylolisthesis. The 2X2 table relating to the expert group (Table 4.10) demonstrated that PR appeared to facilitate accuracy but its use did not guarantee accuracy. Three of the four experts adopting a PR strategy identified the correct pattern based on case data from no more than the initial 36% of the total client assessment time, which only included the client history.

Statistical analyses (section 4.4.3) compared the accuracy of those participants using PR to those using analytical reasoning. It was found that the expert participants using PR were significantly more likely to achieve an accurate outcome when compared with the experts using analytical reasoning strategies ($p=0.033$). When the same statistical test was repeated with both participant groups combined, PR remained significantly more likely to achieve an accurate outcome ($p=0.01$). These findings support an association between accuracy and the PR reasoning strategy. The statistical assumption of these analyses is that all participants are aware of the diagnostic condition of spondylolisthesis. Given the level of experience and education of the expert group it is highly likely that this would be the case. It is also likely that the novice physiotherapists had been exposed to this condition during their education, although they may not have encountered it clinically.

The presence of the spondylolisthesis pattern in only three of the ten expert interview transcripts could be considered surprising. However PR relates to experience with the case at hand and may have been identified in more instances had more data from different cases been collected with the expert group. At least two of the experts stated within the interview that they predominantly practised in a sole body region other than the lumbar spine. Obtaining further qualitative data relating to the participant's awareness and prior experience with high grade spondylolisthesis pathologies could have provided more insight relating to the presence and makeup of such a pattern.

The possibility of errors relating to PR has been stated as a concern regarding its use in physiotherapy. The finding that three of the four experts using PR identified the precise pathology based on just findings from the patient history reduces this concern in an expert group of clinicians. The only evidence from the study relating to the inaccuracy of PR use by experts involved expert C who identified a mechanical pelvic asymmetry. It is possible that the pelvic hypothesis could have been a contributing factor to

the clinical symptoms but pelvic assessment data were not available from the original case. The additional difficulty in including such a hypothesis in the research investigation relates to the confirmation of pelvic dysfunctions. The assessment of positional variations in pelvic position usually relies on surface palpation during the physical examination which is known to have poor reliability (Holmgren & Waling, 2008). Thus the only conclusion that could be made relating to this expert's understanding was that it was incorrect with respect to identifying a spondylolisthesis pattern.

The analysis of the expert C interview found evidence of a deductive 'fall back' strategy that led (albeit inefficiently, based on a time perspective) back to the correct diagnostic pathology. It could be stated that the identified pattern was incorrect based on the participant's statement that a spondylolisthesis would be separately considered, along with more serious disc pathologies, if no positive response occurred with treatment of the pelvis. This fits with a deductive fall back strategy that follows when the treatment associated with the predominant pattern didn't result in expected outcomes. The following data have been presented here in relation to this discussion point:

Expert C: **P:** If we can't keep the leg raise above fifty degrees day one … I start to worry about um getting something structurally …
R: What do you mean by that?
P: If the disc if the annulus has sequestrated come adrift or just dissect totally, if there's an underlying structural instability with a pars defect with a grade two or three spondylolisthesis.

The only occasion of novice PR use in the present study led to a diagnosis of neuromuscular instability. This case understanding was similarly identified by two other novices and four experts who used analytical reasoning. A clinical link between neuromuscular instability and spondylolisthesis is supported by research that found the presence of neuromuscular dysfunction in a sample of patient's with grade 1 or 2 spondylolistheses and chronic LBP (O'Sullivan, Twomey, Allison, Sinclair et al, 1997).

Neuromuscular instability, or clinical instability as it was originally termed (Panjabi, 1992), is considered a contributing factor to LBP, however it lacks a clear clinical presentation. Age, bilateral symptoms and history of trauma were the significant case features (section 2.8.3) used by the experts in obtaining the hypothesis of spondylolisthesis (section 3.2.2), whereas consistent symptoms and case features for neuromuscular instability are not defined within the literature. Consequently it could be argued that neuromuscular instability is a contributing component of spondylolisthesis, but neuromuscular instability alone cannot be considered accurate as a case diagnosis.

The concerns relating to PR accuracy may relate more to less experienced clinicians who may lack the experience and ability to integrate all clinical data effectively. This study provides minimal evidence of such ineffective use of PR in first year practising physiotherapists who overwhelmingly were found to use analytical reasoning. This does not allay the possibility of this outcome in physiotherapists with intermediate levels of experience which is an area deserved of further investigation.

5.1.2 Efficiency of pattern recognition

Does PR actually increase the efficiency of problem solving? This question was considered from the perspective of time to reach an end point, which was the central understanding of the case, and the overall time spent conducting the client history.

The original inclusion of a novice group in the study primarily related to exploring whether PR is a strategy of more experienced or expert practitioners. However the use of two groups also allowed for the comparison of assessment time between experts and novices, regardless of reasoning strategy employed. The results provided in section 4.4.4 showed a trend towards experts taking longer to conduct a client history when compared with the novice group. This finding was similar to that of prior

physiotherapy studies (Doody & McAteer, 2002; King & Bithell, 1998). The simple data analysis provided in Table 4.14 demonstrates the median and mean time taken for novices was 15% and 12% respectively less than that for the experts.

The identification of PR occurred in the first 36% of the client history (section 4.4.4). In relation to actual time, all the patterns were identified within the first 7 minutes of the assessment. This gives an appearance of efficiency, however the overall assessment times for expert participants relative to reasoning strategy (Table 4.13) found that the identification of PR was associated with a longer time taken to complete the client history. Similarly the only novice to incorporate PR into their assessment took the greatest amount of time out of the entire novice group. When placing all participants into either PR or analytical reasoning groups irrespective of experience, the outcome was the same.

This outcome is seemingly at odds with the assumption that PR is more efficient. However it should be remembered that the study consisted of only part of a complete physiotherapy assessment (the client history). If participants were also required to complete a physical examination these results may well have been different. Where a clear understanding and correct pattern exists then arguably the physical examination should be more specific and targeted in nature, as compared with a series of tests to prove or disprove several hypotheses.

The completion of an entire assessment (history and physical examination) might provide a better view of efficiency but has its own research limitations. Training an actor to portray the physical findings from a simulated case in an accurate way is difficult and complex. Additionally, research involving real life high fidelity cases is much more suited to assessing the accuracy of PR but is limited with respect to efficiency. The present study design had a greater focus on the identification of PR and assessment of its accuracy which consequently influenced the findings relating to efficiency.

A final consideration of efficiency relates to the outcome of the case used in the present study (section 3.2.2). Best management of a high grade spondylolisthesis case involves referral to medical specialist. Earlier identification of the correct pathology would presumably improve efficiency to the referral part of management. However this would not necessarily equate to overall efficiency given the spondylolisthesis condition was monitored by a medical specialist over a 12 month period. Identifying the correct pathology could also increase the efficiency of appropriate physiotherapy management but this would rely on knowing the appropriate management for this client based on agreed best practice for this condition. To consider efficiency based on the cost effectiveness of treatment services is beyond the scope of this study but worthy of further research.

5.2 PARTICIPANT ORDER OF QUESTIONING

The nature of the high fidelity study allowed for unbiased collection of clinical information at the discretion of each participant. It was anticipated that retrospective inspection of the order of questions posed to the simulated client would provide another means of gaining insight into the predominant diagnostic reasoning strategy. A summary of the results relating to the participant order of questions was provided in section 4.4.5.

During the design phase of the study, the order of questions were considered a data source able to provide a form of data triangulation. However, the results indicated that no firm conclusions could be made with respect to identifying confirmation questions following the use of PR. No evidence was found that opposed or supported the identification of PR from the order of questioning. The only conclusion that could be taken from this data source is that each participant took a unique pathway with respect to the order of gathering clinical information.

5.2.1 Triangulation

The insufficient findings relating to the observational order of question data precluded complete data triangulation as introduced in section 3.8. This type of triangulation requires separate data sources all reaching the same conclusions.

The methodology of this study did not use the student researcher's own interview notes as a data source to provide triangulation. Although this data source is common with qualitative research, it has potential for introducing personal bias to the results and consequently was not considered with triangulation of this study.

Confidence in the primary study findings relating to the presence of PR can be taken from the methodological triangulation of the mixed qualitative and quantitative methods utilised. The use of the participant's own words as qualitative data relating to reasoning process, in addition to application of the predetermined coding schema and identification tool relating to PR, were complemented by the quantitative statistical analyses regarding its presence and accuracy. The actual study method triangulation is depicted in Figure 5.1.

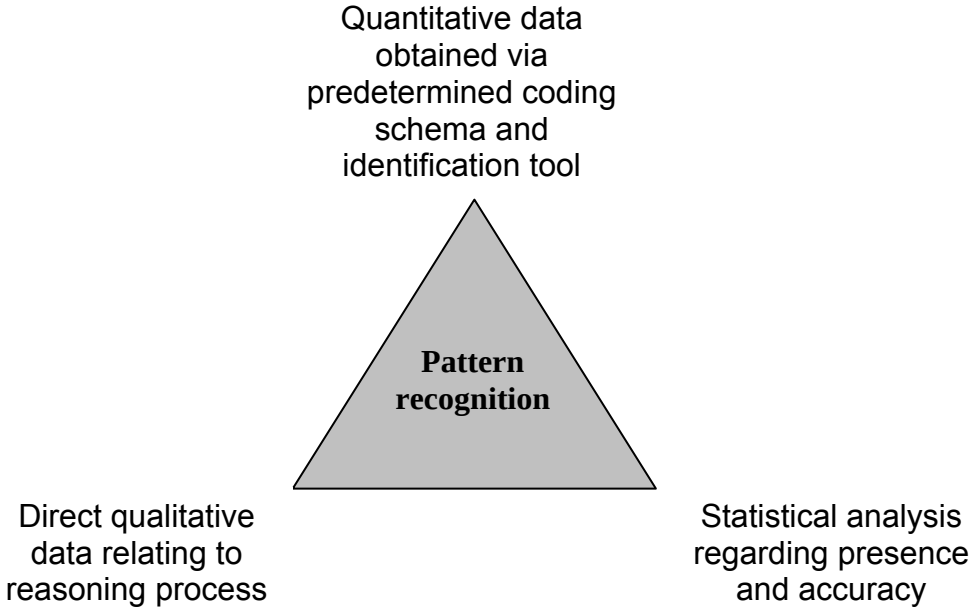

Figure 5.1 Study method triangulation

5.3 PATTERNS

The phenomenon of PR should always be considered in relation to the understanding of what comprises a pattern. The makeup and development of a pattern has been included in this chapter as it forms a foundation for the use of PR as a reasoning strategy. This section is based not on direct evidence from the results, but rather the student researcher's unfolding view of what comprised the participants' patterns and consideration of the theoretical concepts existing in the literature. This multi-faceted presentation of a pattern has not been previously reported within the medical and allied health literature and helps provide a more detailed understanding of the concept.

5.3.1 Categorisation and patterns

PR can be better understood if considered alongside categorisation theory where similarities between objects or events have associated underlying knowledge structures. The models of categorisation described from the literature in section 2.5.3 provide a clear basis to analyse patterns. The patterns found in the present study findings were viewed from the perspective of either 'prototype' (abstracted patterns from several cases) or 'exemplar' (instance-based recognition).

In relation to 'exemplar' and 'prototype' patterns, the underlying knowledge compositions were considered from a varying complexity perspective (Figure 5.2). Arguably an increased complexity of knowledge structure will associate with prototype or multiple abstracted cases and lesser complexity with instance-based case recognition. However even single accurate exemplar patterns may have an elaborate underlying knowledge structure consistent with prototypes.

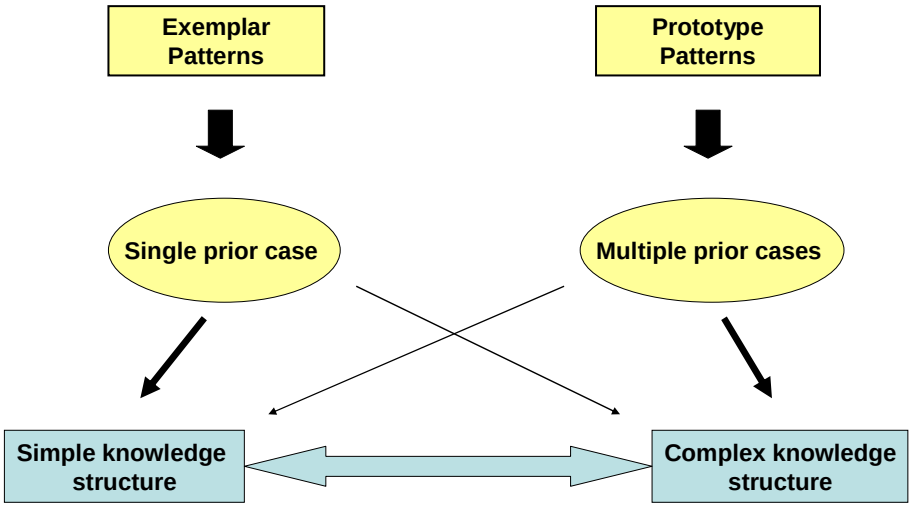

Figure 5.2 Knowledge structure and pattern types

Of the five participants employing PR during the study, the knowledge code / experiential sub-code data was analysed in an attempt to provide insight into the type of patterns triggered by the simulated case. The experts correctly identifying spondylolisthesis were found to use a 'prototype' model of the case at hand. Several observations provided insight to this effect:

Expert I: I don't see a lot of kids because kids typically don't get, get low back pain … but when we do we, we seem to get them with long term symptoms but a lot of the time there's structural reasons why

Expert D: R: So does that fit with then what you've seen before?
P: Yeah, that's based on previous experience with people who are describing a similar story to what she is
R: Have you seen a case similar to this before?
P: Several times
R: Recently or over the years?
P: not recently, not immediately in short term memory but certainly, several, several times previously I would have this story being described

Interestingly there was no evidence in the data that could support the use of an ‘exemplar’ pattern in the participants employing PR. The only participant employing PR and making reference to having seen this type of case before was expert D who recognised the case on multiple occasions from prior experience.

5.3.2 Knowledge structure and pattern accuracy

The study data relating to knowledge in the observed ‘prototype’ patterns was unable to provide a good view of knowledge complexity. Therefore a view of the type of knowledge (propositional and non-propositional knowledge types as described in section 2.7.1) integrated within a pattern formed the basis to discuss the structure and accuracy of a pattern.

The overall accuracy of any pattern is likely far greater when knowledge from clinical experience exists in conjunction with structured knowledge from a public perspective (Figure 5.3). The continual comparison of individual / personal knowledge to that of public / common knowledge (Higgs and Titchen, 2000) in relation to a familiar case is likely to result in a more integrated knowledge structure for that pattern. This is effectively integrating experiential and propositional knowledge types via active reflection.

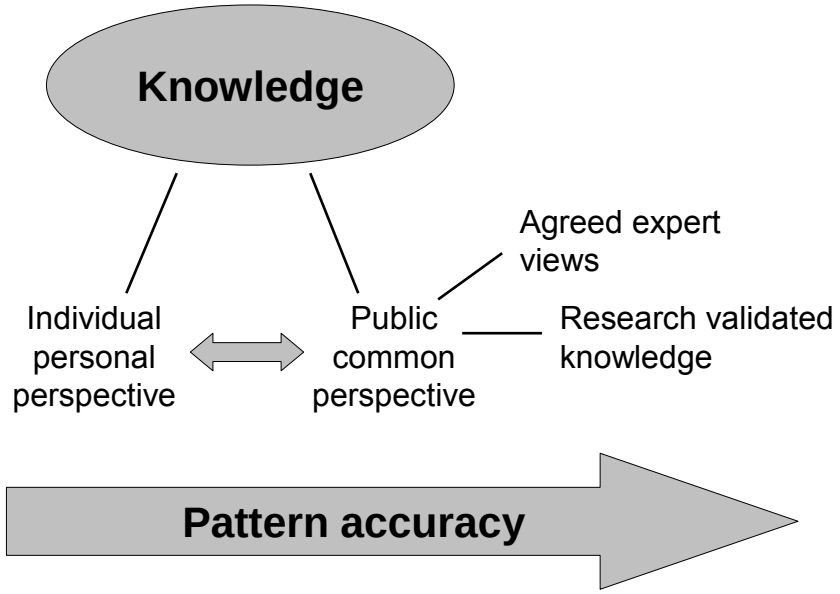

Figure 5.3 Pattern accuracy and knowledge relationship

Reflection in clinical practice has long been discussed in relation to deeper learning (Boud et al, 1985; Schon, 1987). The use of active reflection by a clinician with respect to a given case, its familiar aspects and the level of evidence supporting that case will likely be associated with a better outcome. Critical reflection on the integration of knowledge types during clinical experience is a method of education that may enhance the accuracy of developing patterns.

Returning to the perspective of non-analytical reasoning, it is likely that those experience based patterns refined with public / propositional knowledge should be more accurate. This does not mean that personal patterns are not useful in clinical practice, especially to the novice practitioner. As long as these personal patterns are utilised with some caution and awareness of their limitations, they form a basis for development and refinement of more accurate patterns. The end point of pattern development is that those patterns with better underpinning evidence are likely to lead to more effective management decisions and

improved outcomes. To develop a pattern within non-analytical reasoning requires reflection on the knowledge structure that triggers its activation.

The coded data relating to knowledge were separated into propositional and the various non-propositional types as outlined in section 4.3.1. Only one of the three experts identifying the correct pathology and two of the five participants using PR were coded using propositional knowledge. Out of all the participants using analytical reasoning only one was similarly sub-coded as using propositional knowledge. This review of the data does not offer much support for integration of knowledge types with respect to reasoning pathway or level of clinical experience. There may be several reasons for these findings.

Firstly, there was a dominance of non-propositional knowledge over propositional knowledge coded from the transcripts. Although counting the occurrences of a code or sub-code was not undertaken in this study, the sub-coding of knowledge found that only three expert participants and no novices referred to propositional knowledge during their interview. Secondly, these findings are potentially a limitation of the semi-structured interview utilised, which did not specifically seek out participants' knowledge types or structures being utilised. Returning to the study methods introduced in Chapter 3, exploring the knowledge basis to reasoning would require a less structured interview but with a focus on exploring participants' knowledge behind their primary hypothesis. Although some attempts were made to obtain such data during the interview, exploring knowledge in greater depth had considerable potential to influence the participants' responses and therefore bias results relating to the primary study aims.

5.3.3 Developing patterns

PR has been shown to be a characteristic of more experienced physiotherapists. Therefore somewhere along the pathway of gaining clinical experience, patterns are developed. Prototype patterns will presumably be

formed and continually refined with exposure to clinical cases and information relevant to the specific pattern. An exemplar pattern may start as a single case and remain so with frequent exposure to the same type of case. Alternatively, exemplar patterns may develop into prototypes if variations of the single case are encountered. From a research and educational perspective it is interesting to ask whether we can actually identify a developing pattern in a physiotherapist.

This study has introduced the notion of a developing pattern based on a prototype model. As reported in section 4.5.3, two novices were considered during analysis to have attempted to use patterns within their clinical assessments but not found to employ PR as a predominant reasoning approach. The reasons behind this interpretation were different for each participant, and necessitate individual discussion in further detail. The hypotheses developed by novice participants Q and R were listed in time sequence relative to the clinical assessment to provide a view of potential patterns within analytical reasoning.

The display of novice R data indicated possible PR use on one occasion when judged by the criteria of a single hypothesis based on significant case features. This ‘instability’ hypothesis however was immediately followed by deductive reasoning with several hypotheses. Is this potentially a developing ‘instability’ pattern or in fact an occasion where a known pattern did not clearly fit with the case and led back to deductive strategies? The ‘central hypothesis’ requirement of PR clearly indicated novice R did not use this strategy, however the data potentially highlights a developing pattern.

Listing the hypotheses for novice Q (section 4.5.3) resulted in a deductive multiple hypothesis interpretation but interestingly the participant made reference to a search for a pattern amongst the data. In addition to “Looking at patterns um to see if there’s any”, novice Q used a forwards confirmation questioning strategy during the latter stages of their assessment. Novice Q stated they were “chucking in a few questions to sort of negate structures

perhaps, and it sort of leads me towards more, more that chronic um instability". This qualitative data potentially provides an alternate view of a developing pattern and an attempt to use it in practice.

The present study aimed to identify clear use of PR strategies but as reported in the literature (section 2.5.1), separating PR from a deductive reasoning process is not without complexity. The chosen methodology was designed to determine evidence of PR distinct from deductive strategies. Although PR was identified, some occasions of pattern use may not have been identified because of the central hypothesis requirement. The data from these novices may indicate possible occasions of attempted pattern use that cannot be clearly separated from deductive strategies. The question is whether this is a premature use of patterns or just hypothesis formation via deductive reasoning, or a mixture of both.

5.3.4 Specificity of patterns

The term 'pattern specificity' has been used in relation to the level of intricacy or complexity of a clinical pattern. This is distinct from the term 'specificity' used within quantitative research. Considering the specific depth of patterns may well be useful in understanding their development. For example, a specific pattern may be a well known diagnosable condition such as the case utilised in the present study.

Spondylolisthesis pathologies may be associated with more specific patterns as compared with that of neuromuscular instability (Figure 5.4). Yet as discussed in section 5.1.1, spondylolistheses are also known to sometimes have neuromuscular instability as a contributing factor (O'Sullivan, Twomey, Allison, Sinclair et al, 1997). A spondylolisthesis condition is therefore one of several lumbar clinical presentations that can be associated with a neuromuscular instability pattern. This view of 'pattern specificity' was helpful in separating two common but similar patterns held by participants in this study.

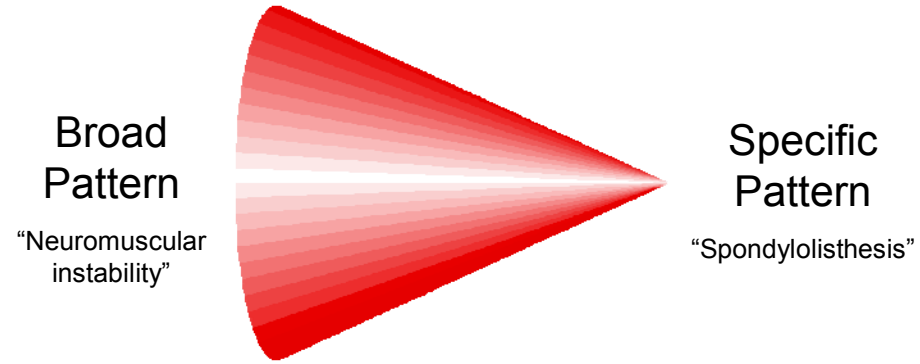

Figure 5.4 Specificity of patterns

Pattern specificity may be worthy of consideration in further research targeting the development of patterns. Based on the study findings, novice patterns are likely to start more broadly. These early patterns are then likely to become interrelated with other more specific patterns via clinical experience, such as the example of spondylolisthesis to neuromuscular instability. Developing specific patterns arguably depends on the extent of reflection undertaken with common clinical presentations. A visual mind mapping or concept mapping educational strategy (Beissner, 1991) might assist reflection on such compositions.

Another factor influencing the specificity of patterns is research evidence relating to the condition or case. Where clear evidence exists, there is more opportunity for a pattern to be specific. This provides another link back to prototype patterns with integrated propositional knowledge.

5.3.5 Significant case features

There has been sufficient support in the literature to introduce the concept of significant case features within a definition of PR (section 2.5.1). This study used reference to significant case features (Groves et al, 2002), similar to other terms such as salient cues (Coderre et al, 2003) and key features (Groves et al, 2003). Based on the specificity of patterns discussed in section 5.3.4, Figure 5.4 has been modified to include the input of clinical data that leads to an end point or diagnosis (Figure 5.5). The clinical data considered significant may allow for recognition of broad or specific patterns.

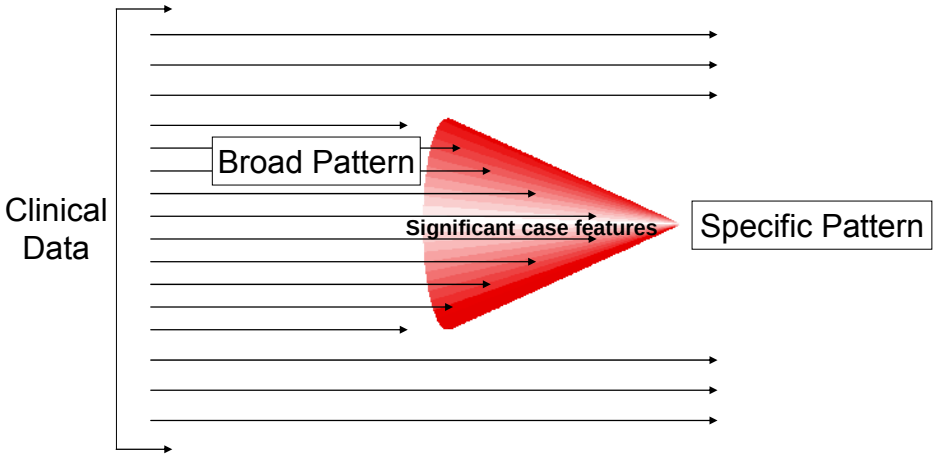

Figure 5.5 Input of clinical data into broad and specific patterns

Recognition of significant case features were observed in the identification of the specific spondylolisthesis case / pattern in this study. All three of the experts identifying the precise diagnosis utilised similar features leading to the recognised pattern. The significant case features included age, bilateral nature of the symptoms, and the history of trauma as an 11 year old. These common significant features were directly comparable with the case literature in section 3.2.2, including bilateral lower lumbar pain spreading to the gluteal regions and posterior thighs and either insidious onset or

associated with a history of minor trauma. The additional unmentioned feature that could have influenced this pattern was potentially that of female gender, however spondylolisthesis is not restricted to this gender (Earl, 2002).

The use of significant case features was an important component of the PR identification tool. However, this does not mean that the use of significant case features is exclusive to those using non-analytical reasoning strategies, as identifying multiple deductive hypotheses may also include key features to develop each hypothesis. Significant case features were particularly interesting in their ability to trigger and support the patterns observed in the study.

5.3.6 Pattern elimination

The pattern related free code (section 4.3.3) made reference to the possibility of pattern elimination being used during reasoning in the study. Two experts (E & F) indicated on several occasions that the clinical case data 'did not fit', which was inferred by the student researcher to be not 'fitting' when compared to previous experience and possibly familiar patterns. These experts were not found in the primary study results to have utilised PR due to the lack of a central hypothesis.

Instead of this data providing evidence of pattern elimination, closer inspection of the expert transcripts led more towards a picture of failed pattern matching which subsequently influenced the reasoning strategy employed. The comparison of the experts' known pattern(s), which did not fit with the presenting case, led to a deductive reasoning process. In other words, these experts were observed to be possibly using a pattern matching strategy during the assessment but the lack of familiarity or recognition led them to revert to a different reasoning pathway.

On reflection of pattern elimination, it should be similar to the inclusion features of PR. The key element to clearly identify PR was the reference to a central hypothesis. Based on this perspective finding evidence of pattern elimination would require participant statements that excluded a single case hypothesis.

5.4 HYPOTHESIS CATEGORY USE

The predetermined coding schema of the study was such that it allowed for observation of hypothesis category use. The two experience-separated groups provided an interesting assessment of the extent of hypothesis use learned via undergraduate physiotherapy programs as compared with experienced clinicians. The obvious limitation of this section relates to the numbers per group relative to the stated differences in observations. However these observations may still be useful with respect to education and further research relating to hypothesis development. This is in line with previous research in earlier hypothesis classifications (Payton, 1985; Rivett & Higgs, 1997). The classification of hypothesis types utilised in this study follow the trend towards holistic healthcare of a person with their own experiences and limitations (Jones & Rivett, 2004). No further reports of hypothesis category use have been reported in the musculoskeletal physiotherapy literature since 2004.

The hypothesis categories utilised in the study also allow for reporting on use of hypotheses that are outside that of diagnostic reasoning. As introduced in sections 2.1.3 and 2.3.2, the types of reasoning reported in the literature can be separated into those associated predominantly with diagnosis and those with management (Edwards & Jones, 2007). Although this study was primarily focussed on identifying hypotheses developed via diagnostic reasoning pathways, the extent of hypothesis categories utilised by participants provides an indirect view of the other reasoning types in action (Figure 5.6). The final understanding of a case, whether diagnostic or

otherwise, should be a composite of the various hypothesis types (Edwards & Jones, 2007).

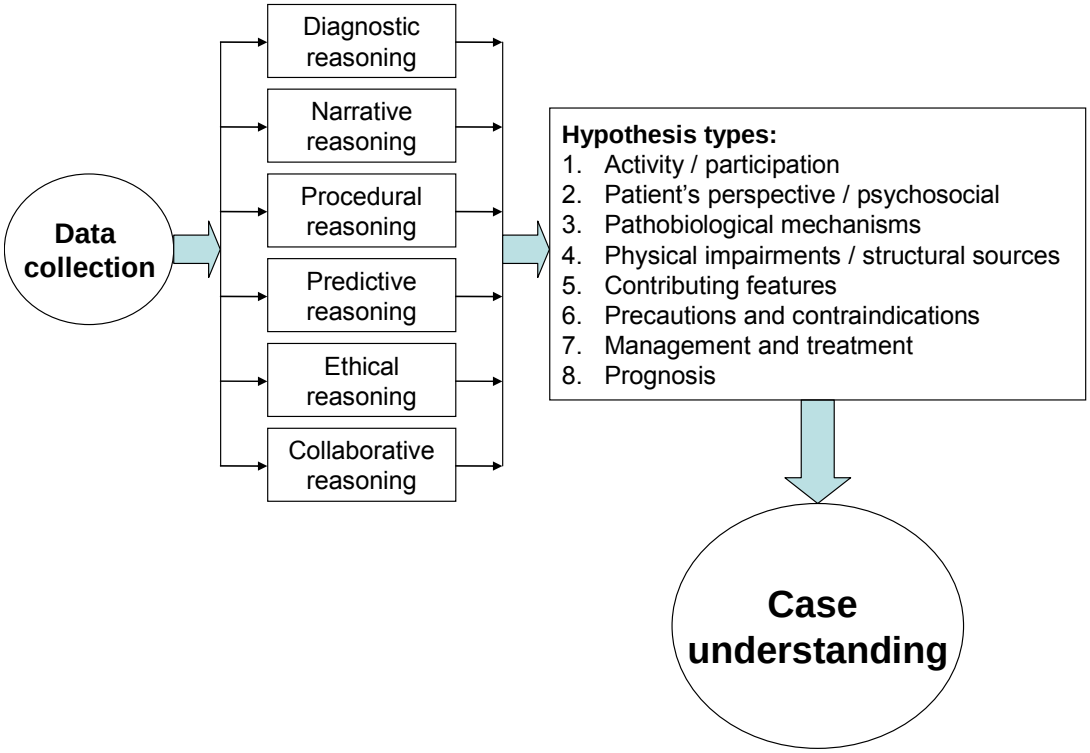

Figure 5.6 Hypothesis categories and reasoning types (based on Edwards & Jones, 2007)

The selected examples of coded hypotheses and associated categorisation via sub-coding have been detailed in section 4.3.1. The simple analysis of these data (sections 4.6.1 and 4.6.2) found a few interesting outcomes worthy of discussion. Firstly, the clinical hypotheses developed by participants were spread across all eight categories, which provide support for the classification of hypothesis types described by Jones and Rivett (2004). Secondly, a comparison of expert and novice groups with respect to hypothesis category use demonstrates a trend for increased breadth of hypothesis generation with more experienced or expert physiotherapists.

The review of all hypotheses developed at any stage during the client history was used to compare the two groups with respect to the extent of hypothesis formation (Figure 4.4). A greater degree of hypothesis formation was observed in the expert group as compared with the novices. However statistical analysis of the results found the only category to be significantly different in its use was that of Category 2 (patient's perspective / psychosocial factors). Although not statistically different, the use of 'management' and 'prognosis' hypothesis categories suggested that experts tend to think ahead more so than novices when problem solving.

The difference between the groups in the spread of hypotheses generated throughout the history compared with the final hypothesis could be theorised to be indicative of the expert clinician's ability to integrate the various case hypotheses. A review of the final stated hypotheses (Figure 4.3) found the expert group used a greater number / broader range of hypothesis categories in comparison to the novice participants. This could be interpreted as a greater depth of understanding via integration of more hypothesis categories. Figure 4.3 also highlights the limited ability of the novice participants to integrate hypotheses outside of categories 4 (physical impairments and associated structure / tissue sources) and 5 (contributing factors) into their final understanding.

A final question that lay within the observation of hypothesis categories related to the depth of cognition during clinical reasoning. Can we state that integrating a greater number of hypothesis categories in reasoning indicates more complex or deeper cognition? These data may provide some insight into the potential effects of experience and / or postgraduate education relative to hypothesis generation. Further research specific to the integration of hypothesis types in problem solving is clearly required. Additionally, the limited ability of novice participants to integrate the majority of hypothesis categories into their understanding of a case is worthy of investigation.

5.5 OBSERVED APPROACHES TO REASONING

It appears that each physiotherapy clinician has a clinical reasoning style or approach that varies with the clinical context and case at hand. The physiotherapy literature has highlighted various interpretive reasoning strategies (Table 2.1) that can be incorporated alone or in combination with each other and alongside analytical or non-analytical reasoning processes. This section utilises the additional study findings reported in section 4.7 to support several aspects related to clinical reasoning in the physiotherapy literature.

5.5.1 Predictive reasoning

One reasoning strategy reported from the interpretive paradigm was that of predictive reasoning (section 2.1.3). The present study findings include the identification of predictions within the problem solving of some clinicians (section 4.7.4). Interestingly, none of the predictive reasoning data identified from transcripts related to predictions of management as previously reported. Rather all predictions were based around the interpretation of clinical assessment findings. This finding could have related to the fact the study requested a case understanding during the assessment but did not specifically seek management information from participants.

The use of predictive reasoning in relation to assessment data was theorised to be more a strategy utilised following the recognition of a pattern. This hypothesis was effectively linking assessment predictions to confirmation questioning. For example, a triggered clinical pattern such as an achilles tendinopathy should be followed by targeted questions and specific physical tests to confirm the pattern. The location and description of pain may trigger the pattern which is tested by search questions relating to morning stiffness or the 24 hour symptom behaviour, and physical testing via direct palpation of the tendon. The pattern would most likely have links with the potential effectiveness of various treatments and consequently

more accurate predictions of treatment outcomes or prognosis. This relationship however was not found during analysis in this study. The direct comparison of the data relating to predictive reasoning and PR found only one participant to be utilising both within their assessment. Despite the small numbers of participants, the study results do not support the hypothesis that PR and predictive reasoning would be observed in conjunction.

5.5.2 Metacognition

An important element of the collaborative hypothesis oriented model of clinical reasoning in physiotherapy (Jones, 1995; Jones et al, 2000) is the theoretical notion of metacognition. Arguably metacognition should be observable, partly via concurrent integration of data throughout a client history. Logically this would suggest that any clinician using a delayed integrative approach is not metacognitively skilled. However the use of this approach could also be a deliberate strategy employed with the awareness that a more comprehensive and possibly unbiased interpretation is able to be gained once all the clinical information is available to the practitioner.

The study findings identified the delayed integrative approach within both participant groups but did not explore the reasons associated with its use. The timing data related to the free code of 'delayed versus concurrent data integration' (section 4.7.2) found those participants who stated their approach to involve collecting the data then subsequently reasoning, took less time to complete their client history (Table 4.21). This time data was misleading with respect to efficiency because the time was stopped on completion of client questions. Any potential reasoning time following data collection was not taken into account.

The limitation of associating the total assessment time data to the participants coded with delayed integration lies with the assumption that coding is indicative of one predominant approach. Novices L and M were coded with delayed integration at one instance but this approach was not

applicable to the entire client assessment. As such, it was not appropriate to conduct a statistical analysis of the timing data. The primary insight obtainable from this aspect of analysis was that the 'collect now, think later' approach did not appear associated with PR use and did not result in the generation of the correct spondylolisthesis hypothesis. A more explorative unstructured interview would be required to fully understand the potential interaction between delayed integration of clinical data and metacognition.

5.5.3 Awareness of errors

A common theme amongst a small number of expert participants involved an open minded approach during data collection (Table 4.4). This is viewed as an important mechanism to ensure that potential errors such as hypothesis bias are avoided throughout the interpretative phase of data collection. This theme was introduced in section 4.7.3 and only identified in expert participants who displayed concurrent integration of data. Types of errors have been reported in section 2.9.1. Several of the errors reported in the literature (Rivett & Jones, 2004) may have been potentially avoided in the study via a consciously open minded method of assessment. These could include:

- Neglecting or misinterpreting relevant information
- Premature decision-making
- Not recognizing data inconsistencies
- Confirmation bias – overemphasis on supporting features and neglecting negating features of a hypothesis
- Presumption that a relationship between symptoms confirms cause and effect and thus diagnosis.

Particularly insightful was the finding that two of the three participants who used PR with a correct diagnostic outcome, also showed an open minded approach to other possibilities. This suggests that it is possible to use non-analytical reasoning strategies and avoid common errors made during the data collection and interpretative phases of clinical assessment. These two

participants confidently held their predominant case hypothesis throughout the assessment but were willing to alter it if non-supportive information became available. This open mindset that arguably is a desirable accompaniment to PR is clearly displayed in the following transcript quotation:

Expert D: That would be my working hypothesis that I would be wanting to test with my examination … but I would be completely prepared to find something completely different

The third participant showing a willingness to remain open minded did not use a delayed integrative approach and was not found to have utilised PR. They displayed an 'error prevention' approach within analytical reasoning particularly associated with the case not fitting a known pattern:

Expert H: I do try and keep quite an open mind as far down the track as I can because I know that you can get quite influenced and then, and then find that it's not really the case, so I try really to make judgment ah, fairly far down the track

The ability to remain open minded could in itself be interpreted as indicative of skilled metacognition, especially in the presence of PR. A balance between non-analytical reasoning and an open minded approach is likely to help minimise errors of data collection and interpretation.

5.5.4 Person centred approach

This final approach identified in the study findings involved a non-diagnostic approach. Although the study aimed to explore the accuracy of a diagnostic non-analytical reasoning strategy, it also allowed for interpretation of the case using non-diagnostic reasoning strategies. It has been stated that a case understanding solely based on the hypothesis category of 'physical impairments and associated structure / tissue sources' is insufficient in current physiotherapy practice (Edwards & Jones, 2007). A more global understanding includes hypotheses relating to a person's activity /

participation capacity or limitations and the patient's perspective and / or psychosocial factors that may present. This creates a holistic understanding of a person with a diagnosable pathology rather than just a medical label or diagnosis. The person centred approach to assessment has been introduced in section 4.7.5 of the study findings.

The view of a person centred approach within physiotherapy is consistent with the direction of recent research relating to diagnosis and outcomes. A specific diagnosis for LBP is only possible in 15% of all lumbar spine cases. Thus a more holistic and not a purely diagnostic approach may lead to a better understanding of a larger number of LBP clients and their problems. Even in specific LBP cases it can be argued that management decisions should include the person and not just be based on diagnosis (Edwards & Jones, 2007).

Considering the restrictions of a person's desired activity levels or ability to participate in life is an example of taking a person centred approach to clinical reasoning. Outcome based research indirectly supports the view that impairment based clinical findings are insufficient to justify a diagnosis or evaluate the benefit of an intervention. Including functional activity / participation findings within clinical practice has support via recommendations to use functional disability instruments such as the Quebec and Roland Morris questionnaires (Maher et al, 1999).

The analysis of hypothesis category use (section 4.6.2) supported the findings relating to a person centred approach to problem solving. The depth of thought processing (range of all hypothesis categories sub-coded) was observed during the entire retrospective interview. Use of hypothesis categories 1 (activity and participation) and 2 (patient's perspective / psychosocial factors) are particularly indicative of this approach.

Consideration of the client as a person with their own perceived problems varied within the study sample. Both expert and novice groups had

participants who were holistic in their approach and others who were narrowly focussed on a specific impairment based understanding. Not surprisingly the novices were more likely to lack the holistic approach (as indicated by use of the various hypothesis categories), which has potential educational implications at an undergraduate level. Interestingly one participant from the expert group also adopted a slightly narrower approach to problem solving during the study, not utilising either activity and participation or patient's perspective / psychosocial categories of hypotheses. This participant utilised the five other hypothesis categories and adopted the delayed integration approach as discussed in section 5.5.2.

The simulated nature of the study may well have impacted on the participants and their reasoning. However given that 80% of the experts considered 'patient's perspective / psychosocial' hypotheses and 60% the 'activity and participation' hypothesis, it would suggest that the results are reasonably valid. The participant reports of the realism of the client encounter were also of a satisfactory level despite knowing the client was an actor.

5.6 STUDY DESIGN

Several key elements of the study design were monitored due to their potential impact on the results. This section considers participant recruitment with respect to study numbers attained, and the influence of the study conditions on participant behaviour. The accuracy and realism of the actor role playing the simulated case is also discussed, and lastly the coding process is examined in further detail.

5.6.1 Participant recruitment

The outcome of recruiting ten expert and nine novice participants was acceptable to the study aims. The findings relative to the primary research question and qualitative analysis methods were considered adequately

supported by the sample size. Although a greater number of participants in each group could have potentially altered the results comparing PR use in experts to novices (section 4.4.2), this did not detract from the primary study finding that PR was evident.

The sample population was chosen with consideration of the feasibility of recruitment and those who potentially had sufficient experience in such a case to demonstrate PR. The recruitment of the first ten participants in each group meeting the inclusion criteria and consenting to participate provided an unbiased sample that was not pre-selected. Had the study pre-selected musculoskeletal physiotherapy clinical specialists (Australian Physiotherapy Association, 2008) with significant experience in the lumbar spine as the expert group, the proportion of observations of PR may have been greater. This is nevertheless dependent on experience with the specific condition chosen for this study. The inclusion criteria used for expert selection in the present study greatly increases the generalisability of the study findings.

The novice recruitment target number of ten participants was not quite achieved but this is unlikely to have impacted on the overall results of the study. The original number of ten was based on previous clinical reasoning research as discussed in Chapter 3, however saturation of data was achieved in the novice group with respect to PR as the primary focus of the study. A final participant was not able to be recruited via the method as outlined for this group in Chapter 4. Potential reasons included the method of advertising, time available to participate and novice self-confidence relating to the research task.

5.6.2 Experimental context influences

The influence of the location of the study (section 3.4.1) and the video / audio recording equipment (section 3.4.2) were evaluated by questioning at the end of the interview. The qualitative interview data reported in section

4.8.2 provided confidence that the behaviour of participants was minimally affected by the study setting.

It is possible that participants could have undertaken the clinical assessment more thoroughly than normal due to the observational nature of the study. The 'orientation to the patient assessment' information sheet (Appendix 10) was designed to minimise this. Qualitative results found an early participant focus on recording equipment was quickly transferred to a focus on assessing the client (section 4.8.2). No comments were made by participants that indicated the equipment altered their client assessment from normal practice.

The effect of location could have been lessened by undertaking the data collection process in each participant's clinical practice. This was considered during the study development phase but would have increased the overall cost of conducting the study via actor employment and associated travel costs. The recording equipment also required a closed and relatively quiet room for effective recording and subsequent transcription accuracy. This was considered difficult to ensure in some participants' clinical environments. Nevertheless, difficulty in recruiting experts was subsequently managed by conducting the study in their usual clinical setting following ethics variation approval (Appendix 8).

5.6.3 Simulated client

Critical to the study was the need for an actor who could roleplay a realistic version of the case on repeated occasions. The time invested in this facet of the study was described in section 3.2.3 and was consistent with prior studies using simulated clients (Ladyshewsky et al, 2000). The results relating to client simulation accuracy have been outlined in section 4.8.1 and indicate a high level of response precision. This is consistent with prior published results relating to case simulation in physiotherapy (Ladyshewsky et al, 2000).

The qualitative responses from participants also indicated a high level of case realism. The only two occasions where participants commented on the case being simulated by an actor suggested the influence on participant responses was brief and inconsequential (section 4.8.1). The ethical requirement of making the participants aware of the simulated nature of the case made it impossible to fully control this aspect of the study. Use of a real client has significant ethical implications and raises other methodological issues relating to diagnostic accuracy.

5.6.4 Coding process

Coding was used to organise textual data and allow for meaningful analysis. Given the research question aimed to investigate an existing phenomenon, codes were developed to identify PR rather than emerging from the data. These codes were developed into the predetermined codebook (section 3.5.1). It is generally quite difficult to ensure validity in qualitative coding, however it is important that the codes have face validity (Sim & Wright, 2000). General agreement related to interpretations of the data and their coding was obtained between researchers (section 3.5.1) as a means of ensuring face validity of the codes.

The reliability of coding was another factor considered with respect to the rigour of the data collection. Coding reliability is generally optimised if more than one coder is involved and results compared. This process was undertaken qualitatively between researchers (section 3.5.1) for the first two interview transcripts of each group which provided general agreement on the predetermined tree codes and the hypothesis sub-codes. Subsequently the coding reliability of the student researcher was considered with respect to repeated coding as outlined in section 3.5.3. Intra-coder reliability was found to be very high (section 4.3.2) in relation to the predetermined codes.

It is possible that such an intra-coder reliability process could be biased by the sole coder's recall of the first occasion of coding analysis. Every attempt was made to minimise this by the time frame between initial and repeat coding being greater than 3 months. Despite this possible limitation the reliability evaluation indicated that the majority of data available for coding from each transcript had been obtained.

5.7 STUDY LIMITATIONS

Several potential limitations of the study have been considered with regards to the results. These can be separated into limitations of:

- Retrospective recall data accuracy
- Participant voice
- Semi-structured interview, and
- Case / context specificity.

It has been well reported that retrospective recall data may be limited in its accuracy relating to actual cognition at the time of problem solving (Elstein et al, 1990; Elstein & Schwartz, 2000). The basis for the chosen methodology was reported in section 2.2.4, however it is recognised that this remains an unavoidable limitation of the study method given the use of a high fidelity case. This limitation was managed via the immediacy of the retrospective recall and the stimulated form of recall using the videotaped observation data.

During the participant interview, instructions were repeated to provide only thoughts from the time of the actual assessment. Clear instructions were also provided prior to the interview (Appendix 8): "Try to describe what was going on in your mind at the actual time and not thoughts or decisions from afterwards. In other words, it is important that you try to recall your thinking at each step of the assessment and not to be influenced by information you may have obtained later". Despite these efforts, problem solving during the

retrospective observation of the clinical assessment remains a potential limiting factor of this type of methodology.

One qualitative coding approach to monitor the limitation of the retrospective recall method was via a free code labelled ‘thinking after the event’. During the coding stage of analysis this code flagged attention to whether the retrospective method was leading to a bias of ‘problem solving after the event’. This free code (section 4.3.3) was used to monitor occasions where problem solving using clinical data was noted to occur during the review of the videotape recorded assessment. Thus, the use of this free code was a means to identify occasions where problem solving after the event had occurred. This was observed during analysis, however none of these occasions were considered likely to influence the primary study findings.

The potential for participants to have unstated thoughts from the client assessment (during the retrospective recall interview) is a possible limitation of the study. The skill of the interviewer during the semi-structured interview was essential in obtaining the necessary data but care was needed to not influence the participant with leading prompts. The possibility existed though that some participants were not able to articulate their thoughts or were less willing to do so due to the nature of the study design. Similarly those with less reflective ability may not have been able to fully describe their thought processes. This potential limitation of participant voice relates back to the chosen retrospective recall methodology. The alternative is to employ a cognitive psychology approach of obtaining evidence via determining relationships between observed responses and cognitive stimulus (Elstein et al, 1990; Elstein & Schwartz, 2000). Such an approach relies on low fidelity case types which were deemed not suited to this study. Further reading from the literature relating to this consideration is summarised in section 2.2.

It is possible that the type of semi-structured interview used in the study did not always elicit a participant’s comments relating to knowledge use during problem solving. An example of this was introduced in section 5.1.1, where

additional data relating to the observed occasions of PR use could have provided more insight into the presence and makeup of the patterns. This potential limitation may have been managed by questions relating to the participant's awareness of spondylolisthesis pathology and their associated prior clinical experience. Although such a discussion could have been included following complete data collection relating to problem solving, this was not included to minimise study bias due to participant contamination. Even though participants were requested not to discuss the case study with fellow professionals, the disclosure of the diagnosis would have increased the chances of contamination and thus bias.

The last potential limitation of the study method relates to generalisability. A case / context specificity effect is possible given that only one case was utilised and mostly done so out of the clinical environment. This potential limitation does not lessen the evidence presented that PR was found to exist and appears to be more accurate than HDR. However the fact that only 15% of LBP cases can be diagnosed (Waddell & van Tulder, 2004) potentially limits the frequency of PR use in diagnostic reasoning of clients with lumbar spine complaints. A further consideration in the diagnostic accuracy of PR is the current lack of a positive relationship between the specificity of management and the clinical outcome in chronic non-specific LBP (Critchley et al, 2007; Kent et al, 2005). In other words, the cost-effective benefit of an accurate diagnosis can only be stated if the subsequent related treatment provides a superior outcome. Any benefits with respect to PR in non-specific LBP are arguably potentially linked to the ability to sub-classify LBP.

5.8 SUMMARY OF DISCUSSION

Chapter 5 has provided discussion on the study results with respect to the primary research aims and several related clinical reasoning findings. Along with considering several design features of the study and potential limitations, this chapter leads to conclusions (Chapter 6) relating to the key findings and possible future implications for education.

CHAPTER 6. CONCLUSION

Research in clinical reasoning can adopt high or low fidelity study design methods. Variations of both have been used extensively in the medical and physiotherapy literature when attempting to answer questions associated with problem solving in clinical practice. This study aimed to identify PR in musculoskeletal physiotherapy using high fidelity research methods and subsequently investigate its relationship to accuracy and efficiency.

6.1 KEY FINDINGS

This study provides supportive evidence for PR as a form of diagnostic reasoning in musculoskeletal physiotherapy. A set of strict assessment criterion for PR were developed to allow for definitive identification and clear separation from HDR. This method found a number of participants used PR during the clinical assessment of the lumbar spine case. Although there are some potential limitations in relation to the type of methodology used in this study, the findings support the conclusion that PR is utilised as a reasoning process by musculoskeletal physiotherapists.

Two participant groups with a large experience and knowledge divide were included in the study. This was to evaluate whether PR use is associated with greater domain specific and experiential knowledge. The results found that four of ten experts used PR, as did one of nine novices. Closer inspection of the PR identification data in all five participants using PR suggested that its use by the single novice was weak when compared with the four experts. Despite the lack of statistically significant difference between the groups, the presence of PR as a predominant reasoning process in five of nineteen participants supports its existence in musculoskeletal physiotherapy.

Accuracy of PR has not previously been assessed in physiotherapy and rarely has it been evaluated in medicine using high fidelity case simulation. The present study utilised a real life spondylolisthesis case consistent with the

reported literature, to facilitate the examination of PR accuracy. It demonstrated that PR was linked with accuracy but its use was not a guarantee of success with only three of the four experts using this strategy identifying the correct diagnosis. Nevertheless, statistical analysis found a significantly greater likelihood of PR achieving an accurate diagnosis when compared with the analytical process model of HDR. The results also suggest that incorrect use of PR initially is not fatal and may still lead to a correct diagnostic outcome if the clinician reverts to an analytical reasoning process.

PR use has been traditionally viewed as being a more efficient process when compared with analytical reasoning. The present study monitored time as a measure of efficiency during the clinical assessment (client history) but was not able to determine whether PR is more or less efficient than analytical reasoning strategies in physiotherapy. It was found that PR produced a predominant hypothesis early in the clinical assessment (within the first 36% of the client history time). However in these cases the total assessment time was actually longer than for the participants not using PR. The present study also demonstrated that experts took more time to conduct their client history than novices which is in line with prior physiotherapy research (King & Bithell, 1998; Doody & McAteer, 2002). The limitation of these results relates to the study incorporating only one component of a physiotherapy assessment (i.e. client history) and not the entire first clinical session which includes a physical examination and management.

The final key area worth considering from the study findings relates to the use of hypothesis categories amongst participants during problem solving. Although this was not a primary study aim, monitoring the use of hypothesis categories was particularly insightful in understanding differences in reasoning between participant groups. The experts had a significantly greater use of the ‘patient’s perspective / psychosocial’ hypothesis category than novices during problem solving. The expert group also utilised a larger number of hypothesis categories in their descriptions of the final hypothesis. In this regard, all of the

novices were limited to hypotheses in the ‘physical impairments & associated structure / tissue sources’ and / or ‘contributing factors’ categories.

6.2 IMPLICATIONS FOR FURTHER RESEARCH AND EDUCATION

The results of this study add to the increasing evidence for non-analytical reasoning within healthcare. The inclusion of PR as a type of clinical reasoning process in musculoskeletal physiotherapy is justified, however its use remains highly dependent on the clinician’s knowledge and experience of similar cases. This study is the first to investigate diagnostic accuracy of PR using a high fidelity case method. The positive association between PR and accuracy provides further support to the findings of recent low fidelity medical research studies (Coderre et al, 2003) and the similarity of results between studies in musculoskeletal physiotherapy and medicine.

Future research involving varied clinical cases would provide further insight into the accuracy of PR in musculoskeletal physiotherapy. Additional data collection regarding the expert participant’s level of knowledge and experience with respect to the presenting case would add to the understanding of developing patterns.

The educational implications for PR in physiotherapy were an important rationale for the study. However at the time of developing the study, the level of understanding relating to PR was insufficient for any meaningful educational research question. Given the present study has provided new insights regarding PR and its accuracy, the educational implications can now be considered.

An area of future research lies with educational design to enhance diagnostic reasoning in physiotherapy. Would a carefully designed case based approach to education facilitate the use of PR? Would it produce more accurate outcomes? If so, the time and cost associated with this type of educational strategy would then need to be examined.

Whilst raising educational questions it should be considered that authors advise against the use of PR by novices (Coderre et al, 2003; Norman et al, 2000; Norman, 2005). Certainly teaching the use of PR as a problem solving strategy in isolation is not the answer, but facilitating physiotherapists to recognise common conditions based on significant case features would potentially assist pattern use and possibly improve diagnostic accuracy. This notion is effectively stating that increased exposure to common clinical presentations and their variations increases the clinician's experiential knowledge and based on the findings of this study, may potentially increase diagnostic accuracy.

This educational theory is presumably reliant on developing sound reflective practice amongst novices to help develop patterns and to avoid inappropriate use of PR. Yet the interactions between the reflective abilities of physiotherapists and pattern development and accuracy are poorly understood.

Clinicians with several years or more of experience but not enough to enable expert practice are referred to as 'intermediates' in clinical reasoning research. Physiotherapists at this level were not included in this study to clearly separate groups from an experience and expertise perspective, however this is an area with potential in PR research. Do intermediate physiotherapists accurately use PR? The present study has introduced the notion of developing patterns amongst novice physiotherapists. Continual development and refinement of recognisable clinical patterns is arguably a characteristic of intermediates on the road to expertise. Yet there is a lack of research based understanding in this area.

The pressure on clinical education placements in physiotherapy presently requires more innovative thought to maximise the available clinical experience throughout undergraduate and postgraduate programs. Given the relationship between PR and accuracy in this study, the question of whether recognition of

clinical patterns can be facilitated through other educational activities is one worth considering.

The finding of limited hypothesis category use by novice participants in the study also merits consideration in educational design. Research into the extent of hypothesis category use by undergraduate physiotherapy students during clinical reasoning would complement the findings of this study. Subsequent research could then trial and evaluate methods to enhance novice capacity to think more broadly in clinical practice.

Research into the efficiency of clinical reasoning processes cannot be reduced to just time spent undertaking a client assessment. It should encompass the time taken to produce an accurate understanding of a case sufficient to implement appropriate management strategies. Future research therefore should strive to enhance our understanding of the complex interaction of clinical reasoning with accuracy, efficiency and cost effectiveness of treatment services.

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PATTERN RECOGNITION IS A CLINICAL REASONING PROCESS IN MUSCULOSKELETAL PHYSIOTHERAPY

APPENDICES

Peter Andrew Miller
B Phty, Grad Cert Health Science (Education)

Thesis submission for Master of Medical Science (Physiotherapy)
The University of Newcastle, Australia
Submitted March 2009

APPENDIX 1. ETHICS APPROVAL

The UNIVERSITY of NEWCASTLE
AUSTRALIA

Form HE2:1/05

HUMAN RESEARCH ETHICS COMMITTEE

Certificate of Approval
for a research project involving humans

Applicant

Chief Investigator/Project Supervisor: (First named in application)	*Associate Professor Darren Rivett*
Co-Investigators/Research Students:	*Mr Peter Miller* *Ms Rosemary Isles*
Project Title:	*The exploration of the physiotherapy clinical reasoning process*

In approving this project, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the *National Statement on Ethical Conduct in Research Involving Humans, 1999*, and the requirements within this University relating to human research.

Details of Approval

HREC Approval No: *H-149-1105*	**Date of Approval:** *16 November 2005*
Approval valid for: *3 years, or until project ceases, whichever occurs first.*	**Progress reports due:** *Annually*

NOTE: Approval is granted subject to the requirements set out in the attached document *Approval to Conduct Human Research*, and any additional comments or conditions noted below:

16 November 2005
Approved subject to a satisfactory response to issues identified by the Committee.

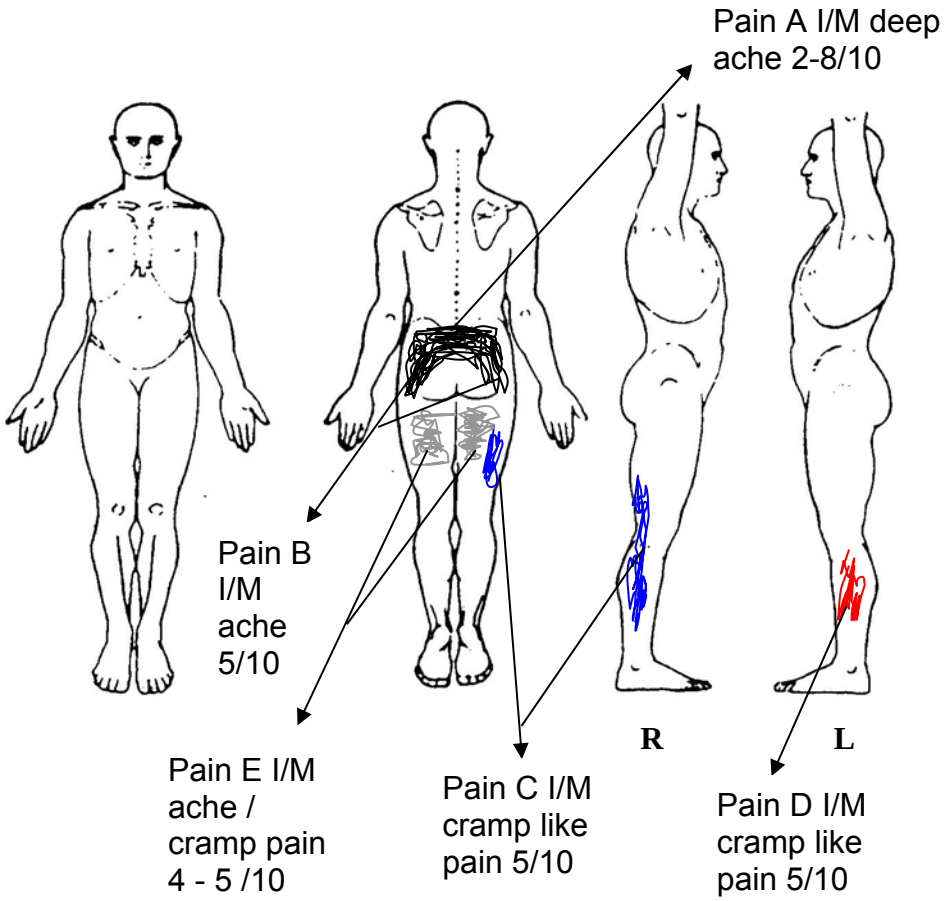
12 January 2006
Response received and accepted.
Approval confirmed.

Signed for the Committee: _____

Ms Susan O'Connor
Human Research Ethics Officer

APPENDIX 2. CASE SCENARIO

20 year old female 2nd year nursing student presented to physiotherapy with primary complaint of low back pain.



Primary Symptoms

- Pain as per body chart

Pain Relationship

- Pain B (both buttocks) occurs when Pain A (lower back) increases
- Pain C (right leg) & Pain D (left leg) can occur together or separately and always with Pain A / B
- Pain C more frequent than Pain D
- Pain E (posterior thigh) only presents after onset of Pain C & D
- Overall pain tends to start in lower back then spread to buttocks before either leg symptoms commence (Pain C – E)

Other Symptoms

- Intermittent giving way of legs with changing direction in walking – unrelated to pain
- Bilateral anterior knee pain with stairs or sport – unrelated to pains A – E
- The knee pains have not changed with recent increased back pain
- Feels generally tired from pain with standing

Pins and Needles / Numbness

- Nil

Current Goals

- Aim of going for treatment was to decrease pain to continue nursing placement

24-Hour Pattern

- Morning is better – usually no pain on waking then low back pain comes on within 10-15 minutes of standing / getting up (but currently wakes with 2/10 pain following clinical placement)
- No stiffness in mornings
- Through day pain levels are activity dependant but generally worsen
- In afternoons back and leg pains pain will come on more easily than mornings with same precipitating activities
- Night OK once got to sleep (not long to get to sleep – 15 min's on average) – mattress is OK (college mattress currently). No difference between home and college mattresses.

Current Precipitating Factors

- Flat Walking > 30-40mins (Uphill and downhill walking are both about the same as each other but both more difficult than walking on flat ground)
- Standing > 10mins (6-7/10 low back pain; worse the longer the period of time standing)
- Carrying loads out in front or load off to side (e.g. one shopping bag to side)

- Lying face down (especially with knees bent up behind)
- Clinical placement – bending over patients (5mins tolerance)
- Sitting > 30-40mins (worse if sitting upright – 10mins tolerance)
- Netball increases low back pain and mild leg pain (either side but R > L; commonly both together and with posterior thigh pains)
- Worst aggravating activity (Lower back pain 8-/10) is standing for prolonged periods (e.g. shopping for few hours). Leg pain would be onset after about half an hour of shopping

Irritability of Symptoms

- Onset of symptoms and associated severity in precipitating factors
- If standing / walking, gets immediate reduction of severity of pain with sitting (gets 3-4 point reduction of pain immediately i.e. 6-7/10 becomes 3-4/10). Mostly doesn't have to sit due to pain but habitually does so to control level of symptoms
- Pa/b settles quickly (10mins) with lying down (preferably side-ly), but if leg pains are present (Pain A – E) takes longer to settle. If all pains are present, can still reduce low back and buttock pain with lying down but only slight reduction of leg pains. Leg pains generally stay for rest of day and go away overnight.

Easing Factors

- Eases over 10mins on lying down (side-ly) after sport but doesn't go away completely
- Lying on back with knees bent (Lying with legs out straight can increase pain)
- Left side-ly with top leg (right) bent and bottom leg (left) out straight
- Standing with hands on knees – bent forwards
- Slouch sitting relative to sitting straight
- Sitting eased pain compared with standing
- Occasionally used heat for pain relief in past – not currently. Minimal relief.

General Functional Activity

- Sit to stand OK
- Generally prefers to keep moving
- Sits down whenever possible due to pains
- Lifting was generally OK when done correctly and light to moderate loads (avoided lifting heavy loads) – except as indicated in precipitating factors
- Hanging washing – OK for limited time

Current History

- Nursing student – pain has notably increased associated with first clinical placement (6 weeks - ended last week). Therefore pain has gradually increased over the last 7 weeks and has continued at same level since the placement ended last week. Thus worsened over the first 4 weeks of placement and been the same since then
- Especially worsened (increased LBP) with bending over patients – as little as 30 seconds endurance by end of shift; would have to stop assisting patient after that time. Generally tried to avoid bending over patients.
- Recently pain has increased in severity related to more time on feet and moving related to patient care
- More easily aggravated and more frequent pain. Harder to ease.
- Since clinical placement, waking with 2/10 pain in lower back (never wakes with leg pain). Prior to placement, can be pain free completely after sleeping overnight
- Legs give way occasionally (maximum 5 times in the last 12 months). Never falls just feels like legs buckle under – into bending direction. Not related to pain
- Previous exercises – 100 sit ups 2-3 times / week on bed (unable to on floor as direct pressure on lower back causes pain); self-initiated related to netball competition; generally didn't help reduce back pains

Past History

- Fell backwards as an 11 year old & landed on bottom
- Difficulty walking immediately after incident

- Intermittent pain since injury – has lived with pain associated with activity and aggravating activities. Flare-ups are usually not this severe (as rest can be utilised to reduce symptoms). Flare-ups are mostly related to netball carnivals (lots of games over a weekend). This episode is the worst it has been and is now interfering with potential career
- Assessed by GP and sports medicine doctor in home town as 12 year old – no Xrays taken; advised hamstring stretches (some improvement over few months of stretches. Continued with routine of stretching with netball training & games). Prescribed orthotics via podiatrist (no change in low back pain

Social History

- Plays competitive netball with 4hrs training / week & 1-2 games / week. Played from age 10yrs to currently (8-9 yrs)
- Swimming competitive for 7 years until 16 years old (no aggravation of pain; no significant changes in pain levels)
- School soccer
- School golf (generally made low back pain worse – max 20 games)
- Tennis – 2 seasons of once / week at age 16 –17 years

Current Work

- Full time nursing student
- Works as casual sales assistant (newsagents) one shift of 4 hrs / wk - generally could only stand at sales counter for 40 minutes before doing another activity where sitting or bending is allowed (e.g. tidying or packing shelves)

Previous Treatment

- Chiropractic at 14 years (self referral) 2-3 times / week for 8-12 wks (improved)
- Chiropractic every few months at home when on holidays (temporary relief)
- Orthotics as 12 year old from podiatrist

- No previous physiotherapy

Medications

- Nil currently
- No prior cortisone / steroid medications
- No NSAID's (neurofen, voltaren etc) in past
- Rarely would take paracetamol / panadol if pain at its worst (e.g. after netball carnival)

Other Special Questions

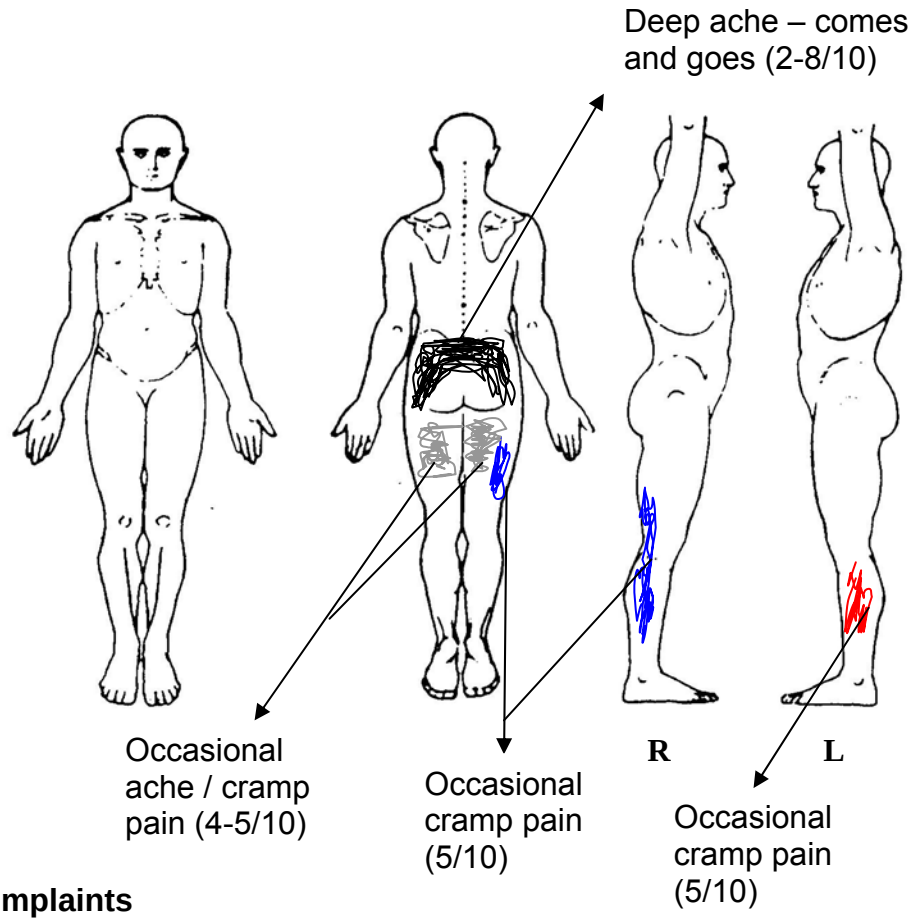
- X-rays with chiropractic but unsure of results
- Bladder / bowel function normal
- No paraesthesia (pins & needles / tingling) in saddle area
- General health – good
- Not aware of any diabetes, lung disorders (e.g. asthma) or heart conditions
- Nil surgery
- Nil weight loss
- Cough / sneeze – nil problems associated
- Nil blood tests or other tests
- No unsteadiness with gait (only after a few drinks)
- No clumsiness in hands

Visual Cues

- Nil Obvious
- Walks in normally
- Finished clinical placement last week – dressed in casual clothes
- Not overweight

APPENDIX 3. ACTOR TRAINING INFORMATION

20 year old female 2nd year nursing student presented to physiotherapy with primary complaint of low back pain.



Primary Complaints

- Pain as per body chart above

Pain Relationships

- Pain starts in lower back then spreads to both buttocks (as low back pain worsens)
- Outside leg pains (left and right legs) can occur together or separately but always occur with lower back and buttock pains.
- Right leg pain is generally more frequent than left leg
- Posterior thigh pain only presents after onset of lateral (outside) leg pains
- Overall pain tends to start in lower back then spread to buttocks before commencing in either leg

Other Symptoms

- Occasional giving way of legs with changing direction in walking – unrelated to pain
- Pain in front of both knees with stairs or sport – unrelated to back pain or other leg pains. The knee pains have not changed with recent increased back pain.
- Feels generally tired from pain with standing

Pins and Needles / Numbness

- Nil

Current Goals

- Aim of going for treatment was to decrease pain to be able to continue nursing placements (next placement in a few months)

24-Hour Pattern

- Morning is better – usually no pain on waking then low back pain comes on within 10-15 minutes of standing / getting up (but currently wakes with 2/10 pain following clinical placement).
- No lower back or leg stiffness in mornings
- Through day pain levels are dependant on amount of activity but generally worsen
- In afternoons back and leg pains pain will come on more easily than mornings with same precipitating activities (see next section)
- Sleeping at night is OK once asleep (doesn't take long to get to sleep – 15 min's on average). Mattress is OK (college mattress currently). No difference between home and college mattresses.

Current Precipitating Activities

- Flat Walking > 30-40mins (Uphill and downhill walking are both about the same as each other but both more difficult than walking on flat ground)
- Standing > 10mins (low back pain score 6-7/10; severity of pain gets worse the longer in standing)

- Carrying loads out in front or load off to side (e.g. one shopping bag to side)
- Lying face down (especially with knees bent up behind)
- Being on nursing clinical placement – bending over patients (5mins tolerance)
- Sitting > 30-40mins (worse if sitting upright – 10 mins tolerance)
- Netball increases low back pain and mild leg pain (either side but R > L, commonly both together and with posterior thigh pains
- Worst aggravating activity (Lower back pain 8/10) is standing for prolonged periods (e.g. shopping for few hours). Leg pain would be onset after about half an hour of shopping.

Irritability of Symptoms

- Details of onset of symptoms and associated severity is found in precipitating factors
- If standing / walking, gets immediate reduction of severity of pain with sitting (gets 3-4 point reduction of pain immediately i.e. 6-7/10 becomes 3-4/10). Mostly doesn't have to sit due to pain but habitually does so to control level of symptoms
- Lower back and buttock pain settles quickly (10mins) with lying down (preferably side-ly), but if leg pains are present takes longer to settle. If all pains are present, can still reduce low back and buttock pain with lying down but only slight reduction of leg pains. Leg pains generally stay for rest of day and go away overnight.

Easing Factors

- Pain eases over a 10-minute period of lying down (side-ly) but doesn't go away completely (e.g. after sport)
- Lying on back with knees bent up (lying with legs out straight can increase pain)
- Lying on left side with top leg (right) bent and bottom leg (left) out straight
- Standing with hands on knees – bent forwards
- Slouch sitting relative to sitting straight

- Sitting eases pain compared with standing
- Occasionally used heat for pain relief in past – not using currently (generally gives minimal relief).

General Functional Activity

- No problems with getting up from or down into a chair
- Generally prefers to keep moving when on feet
- Sits down whenever possible due to pains
- Lifting is generally OK when done correctly and light to moderate loads (avoids lifting heavy loads) Note the precipitating factors related to lifting
- Hanging washing – OK for limited time (within standing period 10-minutes)

Current History

- Nursing student – pain has notably increased associated with first clinical placement (6 weeks - ended last week). Therefore pain has gradually increased over the last 7 weeks and has continued at same level since the placement ended last week. Thus worsened over the first 4 weeks of placement and been the same since then
- Especially worsened (increased low back pain) with bending over patients – as little as 30 seconds endurance by end of shift; would have to stop assisting patient after that time. Generally tried to avoid bending over patients
- Recently pain has increased in severity related to more time on feet and moving related to patient care
- More easily aggravated and more frequent pain. Harder to ease.
- Since clinical placement, waking with 2/10 pain in lower back (never wakes with leg pain). Prior to placement, can be pain free completely after sleeping overnight.
- Legs give way occasionally (maximum 5 times in the last 12 months). Never falls, just feels like legs buckle under – into forwards bending direction. Not related to pain.

- Previous exercises – 100 sit ups 2-3 times / week on bed (unable to on floor as direct pressure on lower back causes pain); self-initiated related to netball competition; generally didn't help reduce back pains.

Past History

- Fell backwards as 11 year old & landed on bottom
- Difficulty walking immediately after incident due to pain
- Intermittent pain since injury – has lived with pain associated with activity and aggravating activities. Flare-ups are usually not this severe (as rest can be utilised to reduce symptoms). Flare-ups are mostly related to netball carnivals (lots of games over a weekend). This episode is the worst it has been and is now interfering with potential career.
- Assessed by general practitioner and sports medicine doctor in home town as a 12 year old – no X-rays taken; advised hamstring stretches (some improvement over few months of stretches. Continued with routine of stretching with netball training & games); prescribed orthotics via podiatrist (no change in low back pain).

Social History

- Plays competitive netball with 4hrs training / week & 1-2 games / week. Played from age 10yrs to currently (8-9 yrs)
- Swimming competitive 7 years till 16 years old (no aggravation of pain; no significant changes in pain levels)
- School soccer
- School golf (generally made low back pain worse – max 20 games)
- Tennis – 2 seasons of once / week at age 16 –17 years

Current work

- Full time nursing student
- Works as casual sales assistant (newsagency) one shift of 4 hrs / wk - generally could only stand at sales counter for 40 minutes before doing another activity where sitting or bending is allowed (e.g. tidying or packing shelves)

Previous Treatment

- Chiropractic treatment when aged 14yrs (self referral) 2-3 times / week for 8-12 weeks (helped)
- Now gets chiropractic every few months at home when on holidays (temporary relief)
- Orthotics as 12 year old from a podiatrist
- No previous physiotherapy

Medications

- Nil currently
- No prior cortisone / steroid medications
- No anti-inflammatory medications (neurofen, voltaren etc) in past
- Rarely would take paracetamol / panadol if pain at its worst (e.g. after netball carnival)

Other Special Questions

- X-rays with chiropractic but unsure of results
- Bladder / bowel function normal
- No pins & needles / tingling in saddle area
- General health – good
- Not aware of any diabetes, lung disorders (e.g. asthma) or heart conditions
- Nil surgery
- Nil weight loss
- Cough / sneeze – nil problems associated
- Nil blood tests or other tests
- No unsteadiness with gait (only after a few drinks)
- No clumsiness in hands

Visual Cues

- Nil Obvious
- Walks in normally
- Finished clinical placement last week – dressed in casual clothes

- Not overweight

Common Questions from Physiotherapists

Opening questions:

- As far as you are concerned what do you feel is your main problem?
- What is the problem today?
- What brings you here today?
- How can I help you today?

Pain / symptom related questions:

- Where exactly is the pain? (e.g. lower back both sides)
- What type of pain is that? How would you describe that pain?
- How severe would you rate the pain? If 0 was no pain and 10 was the worst pain imaginable, what score would you give that pain?
- Are the pains constantly there or do they come and go?
- Do the pains feel deep inside or close to the skin?
- Do you have any pain in the legs?
- Do you get any pins and needles? If so where? When do you get these sensations?
- Do you have any pins and needles in the pelvic or saddle area?
- Do your legs ever give way?

History questions:

- When did it start? When did your lower back pain start? How long have you had low back pain for?
- How did it start?
- When do you remember the leg pains starting? Were they at the same time as the low back pain?
- When did the pins and needles commence?
- Has the pain been the same since it first began?
- What has been happening with the pain more recently?
- Has the pain / problem changed at all? (Over the prior years)

Questions related to what makes pain better or worse:

- Does your pain vary in intensity?
- What activities make your pain worse?
- How long does it take for these activities to make the pain worse? How bad does it get with these activities?
- Is there anything you can do to ease the pain?
- How much can you ease the pain? (i.e. fully, partially etc)
- How long does the pain last for after it comes on?
- Can you be completely free of pain?

24-hour questions:

- Does the pain vary through the day or night?
- Is one period of the day worse?
- Does the pain affect your sleep? Getting to sleep?
- Does the pain wake you up at night? How many times do you wake due to the pain?
- How do you feel first thing in the morning?

Other questions:

- How is your general health? Do you have any medical conditions we should be aware of?
- Have you lost any weight recently? Is there any reason for this?
- Do you take any medications?
- How is your heart / lungs / etc?
- Do you have diabetes / epilepsy / etc?
- Have you had any changes to your bladder or bowel function recently? Do you have any problems with your bladder or bowel function?
- Do you ever feel clumsy when you walk? Do your legs ever give way?
- Have you ever taken steroid medications?
- Have you had any surgery in the past?

General points for training:

- Broad opening questions – provide a standard amount of information

- Pain scores are rated on a 0-10 scale where 0 is no pain and 10 is the worst imaginable pain. Only provide the score out of 10 if requested by the participant.
- Primary or main problem is low back pain
- Recent history relates to a nursing clinical placement

APPENDIX 4. SIMULATED CASE RESPONSE CHECKLIST

Participant number _____ **Date** _____

Case feature	Accurate response by simulated patient		Information not requested
Location of pain types (Pain A) *	Yes □	No □	□
Location of pain types (Pain B) *	Yes □	No □	□
Association of pain A & B *	Yes □	No □	□
Location of pain types (Pain C) *	Yes □	No □	□
Location of pain types (Pain D) *	Yes □	No □	□
Location of pain types (Pain E) *	Yes □	No □	□
Association of pain C, D, E *	Yes □	No □	□
Severity of pain types (Pain A) *	Yes □	No □	□
Severity of pain types (Pain B) *	Yes □	No □	□
Severity of pain types (Pain C) *	Yes □	No □	□
Severity of pain types (Pain D) *	Yes □	No □	□
Severity of pain types (Pain E) *	Yes □	No □	□
Description of pain types (Pain A)*	Yes □	No □	□
Description of pain types (Pain B)*	Yes □	No □	□
Description of pain types (Pain C)*	Yes □	No □	□
Description of pain types (Pain D)*	Yes □	No □	□
Description of pain types (Pain E)*	Yes □	No □	□
Constancy of pain (Pain A) *	Yes □	No □	□
Constancy of pain (Pain B) *	Yes □	No □	□
Constancy of pain (Pain C) *	Yes □	No □	□
Constancy of pain (Pain D) *	Yes □	No □	□
Constancy of pain (Pain E) *	Yes □	No □	□
History of current episode	Yes □	No □	□
Past history	Yes □	No □	□
Mechanism of injury	Yes □	No □	□
Primary aggravating activities	Yes □	No □	□
Standing tolerance	Yes □	No □	□
Walking tolerance	Yes □	No □	□
Sitting tolerance	Yes □	No □	□
Primary easing factors	Yes □	No □	□

* Pain A – E relate to pain location indicated on the body chart in Appendix 2

Previous physiotherapy treatment	Yes □	No □	□
Other previous treatment	Yes □	No □	□

Morning pain / stiffness	Yes □	No □	□
Night pain / ability to sleep	Yes □	No □	□
Pain behaviour through day	Yes □	No □	□

Primary patient goals	Yes □	No □	□
Activity – netball participation	Yes □	No □	□
Anterior knee pain	Yes □	No □	□
Unsteadiness / giving way of legs	Yes □	No □	□
General health	Yes □	No □	□
Paraesthesia / numbness	Yes □	No □	□
Cough / sneeze	Yes □	No □	□
X-Rays	Yes □	No □	□
Prior surgery	Yes □	No □	□
Weight loss	Yes □	No □	□
Medications	Yes □	No □	□
Investigations	Yes □	No □	□
Social history	Yes □	No □	□
Age of patient	Yes □	No □	□
Cord / cauda equina questions	Yes □	No □	□
Current employment	Yes □	No □	□
Nursing student full time	Yes □	No □	□

Other Questions:

Additional Notes:

APPENDIX 5. EXPERT PARTICIPANT RECRUITMENT LETTERS

Associate Professor Darren A. Rivett
Head, Discipline of Physiotherapy

School of Health Sciences
Faculty of Health
University Drive, Callaghan
NSW 2308 Australia
Phone: +61 2 4921 7821
Fax: +61 2 4921 7902
Email: Darren.Rivett@newcastle.edu.au

Date _____

Dear _____,

A research project is currently being undertaken at The University of Newcastle titled “The exploration of the physiotherapy clinical reasoning process”. We require participants who are experts in the musculoskeletal physiotherapy field. The inclusion criteria for expert requires participants to:

- Have more than ten years physiotherapy clinical experience in the musculoskeletal field
- Be a titled member of Musculoskeletal Physiotherapy Australia (MPA)
- Have at least two years clinical experience following the postgraduate qualification enabling titled membership
- Be clinically practicing in musculoskeletal physiotherapy at present

Your details have been obtained from a search of local physiotherapists in the MPA Directory of Titled Members Handbook (2004-2005).

I would like to invite you to participate in this research project. The project requires two hours participation time on a single occasion. The study will be located at the School of Health Sciences, The University of Newcastle, at the Callaghan campus in Newcastle. The time available for participation is flexible to fit with your current work schedule.

If you meet the above criteria and would like further information about this study, please contact research higher degree student Peter Miller on peter.a.miller@newcastle.edu.au or 02 4921 6879. Your assistance will be gratefully received and will hopefully lead to a better understanding of the physiotherapy clinical reasoning process and improved professional physiotherapy education. [1]

Yours Sincerely

Peter Miller
BPhty, GC HS (Educ)
Research Student

A/Prof Darren Rivett
BAppSc(Phty), MAppSc(ManipPhty) PhD
Project Supervisor

Rosemary Isles
BPhty(Hons); GradCertEduc(Tertiary)
Project Co-supervisor

[1] **Complaints about this research:**
This project has been approved by the University's Human Research Ethics Committee (Approval No. H-149-1105). Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au

Associate Professor Darren A. Rivett
Head, Discipline of Physiotherapy

School of Health Sciences
Faculty of Health
University Drive, Callaghan
NSW 2308 Australia
Phone: +61 2 4921 7821
Fax: +61 2 4921 7902
Email: Darren.Rivett@newcastle.edu.au

Date _____

Dear _____,

This is a follow up letter relating to the research project at The University of Newcastle titled “The exploration of the physiotherapy clinical reasoning process”. We still require expert physiotherapists to complete the project and note that you have not responded to date. The inclusion criteria for expert requires participants to:

- Have more than ten years physiotherapy clinical experience in the musculoskeletal field
- Be a titled member of Musculoskeletal Physiotherapy Australia (MPA)
- Have at least two years clinical experience following the postgraduate qualification enabling titled membership
- Be clinically practicing in musculoskeletal physiotherapy at present

Your details have been obtained from a search of local physiotherapists in the MPA Directory of Titled Members Handbook (2004-2005).

I would like to invite you to participate in this research project. The project requires two hours participation time on a single occasion. The study will be located at the School of Health Sciences, The University of Newcastle, at the Callaghan campus in Newcastle. The time available for participation is flexible to fit with your current work schedule.

If you meet the above criteria and would like further information about this study, please contact research higher degree student Peter Miller on

peter.a.miller@newcastle.edu.au or 02 4921 6879. Your assistance will be gratefully received and will hopefully lead to a better understanding of the physiotherapy clinical reasoning process and improved professional physiotherapy education.

If we have not received a response from you regarding this project, a follow up phone call will be made two weeks after the above date to ensure you have received this letter. If you do not wish to be contacted please ring Shirley Parker (Discipline of Physiotherapy Administration) on 02 4921 7904 to prevent the call. [1]

Yours Sincerely

Peter Miller
BPhty, GC HS (Educ)
Research Student

A/Prof Darren Rivett
BAppSc(Phty), MAppSc(ManipPhty) PhD
Project Supervisor

Rosemary Isles
BPhty(Hons), GradCertEduc(Tertiary)
Project Co-supervisor

[1] **Complaints about this research:**
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APPENDIX 6. ADVERTISEMENT FOR NOVICE PARTICIPANTS

The exploration of the physiotherapy clinical reasoning process

(Version 2, 1.2.06)

Research study investigating clinical reasoning

Recently graduated physiotherapists are invited to participate in a research study conducted by researchers from The University of Newcastle. If you are within your first year of clinical practice after finishing an undergraduate or entry-level masters physiotherapy program, you are eligible to participate in the project titled *The exploration of the physiotherapy clinical reasoning process*. This project offers you exposure to unique clinical reasoning research and the opportunity to reflect on your own clinical reasoning during a subjective assessment (history). Your assistance will be gratefully received and will hopefully lead to a better understanding of the physiotherapy clinical reasoning process and improved professional physiotherapy education.

The study requires two hours participation time on a single occasion. The study will be conducted within the Discipline of Physiotherapy at The University of Newcastle, Callaghan Campus. The times available to participate are flexible to suit your schedule.

If you would like to know more about this study, please contact research higher degree student Peter Miller on peter.a.miller@newcastle.edu.au or 02 4921 6879.

APPENDIX 7. INFORMATION STATEMENT & PARTICIPANT CONSENT FORM

Associate Professor Darren A. Rivett
Head, Discipline of Physiotherapy

School of Health Sciences
Faculty of Health
University Drive, Callaghan
NSW 2308 Australia
Phone: +61 2 4921 7821
Fax: +61 2 4921 7902
Email: Darren.Rivett@newcastle.edu.au

Information Statement for the Research Project:
The exploration of the clinical reasoning process
(Version 2, 10/12/05)

You are invited to take part in the research project identified above which is being conducted by Peter Miller, as part of his Master of Medical Science (Physiotherapy) under the supervision of A/Prof Darren Rivett and Rosemary Isles from the Discipline of Physiotherapy at The University of Newcastle.

What is the purpose of the study?

The purpose of this research is to explore the clinical reasoning processes used by physiotherapists in clinical practice. It aims to better understand the methods of decision-making used by musculoskeletal physiotherapy clinicians with differing levels of experience. The results could further enhance educational design within undergraduate and postgraduate physiotherapy programs, in addition to further refining methods of self-directed learning and professional development for clinicians.

Who can participate?

Physiotherapists who are currently working in clinical practice are being recruited for this study. Potential expert participants have been identified via the published directory of titled members handbook for Musculoskeletal Physiotherapy Australia (2004-2005). To be eligible to participate you must meet the criteria for one of the following groups.

Expert Physiotherapists are required to:
- Have more than ten years physiotherapy clinical experience in the musculoskeletal field
- Be a titled member of Musculoskeletal Physiotherapy Australia (MPA)
- Have at least two years clinical experience following the postgraduate qualification enabling titled membership
- Be clinically practicing in musculoskeletal physiotherapy at present.

Novice Physiotherapists are required to:
- Have completed a recognised physiotherapy qualification and be registered with the NSW Physiotherapists Registration Board
- Have less than one year of clinical experience as a physiotherapist.

What choice do you have?

Participation in this research is voluntary. There is no obligation for you to participate in this research study. Only those people who give their informed consent will be included in the project. Whether or not you decide to participate, your decision will not disadvantage you in any way. If you decide to participate, you may withdraw from the study at any time. You are not required to give any reasons for withdrawal.

What will you be asked to do?

Physiotherapists agreeing to participate in this study will be asked to perform a subjective examination / history as they normally would do in clinical practice, of a trained actor simulating a real patients history. This will be videorecorded and used to facilitate your recall during a subsequent interview with the student researcher. This interview will involve watching the video of the assessment and reporting your thoughts about the case to explore the clinical reasoning processes used during the assessment. The interview will be audio recorded and transcribed without any identifying information. Your involvement in the study would take approximately 2 hours on a single occasion. This will take place at the School of Health Sciences Research Laboratory (HC35) within the Hunter Building of The University of Newcastle, Callaghan Campus.

You will be able to review the video and audio recording and / or interview transcripts from your participation. You may edit or erase your contribution and withdraw from the study at any stage.

What are the risks and benefits of participating?

Completing the study offers you the opportunity to reflect on your clinical reasoning process within a physiotherapy assessment. The results will be available on completion of the study via professional seminar locally. This will take place approximately 12 months from the commencement of data collection. You may also request a written summary of the study results.

Risks to participating in this research are minimal. The assessment involves a routine subjective examination (history) consistent with your current clinical practice. The interview process requires recall of your thoughts from the assessment and may take up to an hour. This will be conducted whilst seated at a table, however you may stand at any time during the interview.

How will your privacy be protected?

The information collected during participation will be strictly confidential. Only the researchers named on this information statement will have access to identifiable data during analysis. The interview will be professionally transcribed in its de-identified form. Following analysis the written data will be identifiable only by a study number. All data, including video and audio recordings, will be securely stored during the project. The information is required to be kept for a period of 5 years following the completion of the study, and will be destroyed after this period.

How will the information collected be used?

The results of this study will form part of the thesis of the student researcher and will be submitted for publication in scientific journals and presentation at professional conferences. Individual participants will not be identified in any reports or presentations arising from the project. Feedback on results of the study will also be presented locally at professional seminars on completion of the final data analysis.

What do you need to do to participate?

Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions regarding the project, please contact the researchers directly:

Peter Miller: Tel. 4921 6879, email Peter.A.Miller@newcastle.edu.au
A/Prof Darren Rivett: Tel. 4921 7821, email Darren.Rivett@newcastle.edu.au
Rosemary Isles: Tel. 4921 2041, email Rosemary.Isles@newcastle.edu.au

If you are willing to participate in this research, please complete the attached consent form and return it to Peter Miller at The Discipline of Physiotherapy, School of Health Sciences, The Faculty of Health, University Drive, Callaghan NSW 2308. I will then contact you to arrange a convenient time for you to participate in the study.

Thankyou for considering this invitation. [1]

Sincerely,

Peter Miller
BPhty, GC HS (Educ)
Research Student

A/Prof Darren Rivett
BAppSc(Phty), MAppSc(ManipPhty) PhD
Project Supervisor

Rosemary Isles
BPhty(Hons); GradCertEduc(Tertiary)
Project Co-supervisor

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[1] **Complaints about this research:**
This project has been approved by the University's Human Research Ethics Committee (Approval No. H-149-1105). Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au

Associate Professor Darren A. Rivett
Head, Discipline of Physiotherapy

School of Health Sciences
Faculty of Health
University Drive, Callaghan
NSW 2308 Australia
Phone: +61 2 4921 7821
Fax: +61 2 4921 7902
Email: Darren.Rivett@newcastle.edu.au

Consent Form for the Research Project:
The exploration of the clinical reasoning process
(Version 1, 21/10/05)

I have read the information on the research project "The exploration of the physiotherapy clinical reasoning process", a study that involves taking the history of a patient followed by an audio taped interview to recall my thought processes from the assessment. Peter Miller, Master of Medical Science (Physiotherapy) Research Candidate, is conducting this project under the supervision of Associate Professor Darren Rivett (Principal Supervisor) and Rosemary Isles (Co-supervisor) from The University of Newcastle.

All questions have been answered to my satisfaction. I understand that the study will be carried out as described in the information statement, a copy of which I have retained.

- I agree to participate in this investigation.
- I understand that I can access my video and audio-recorded information and transcripts at any time.
- I understand that I can withdraw from this research at any time without reason or penalty.
- All information from the project will remain confidential.
- I understand that data obtained from the study is required to be kept for 5 years following the completion of the project, and will be destroyed after this period.
- My identity will not be revealed to anyone other than the researchers named on this sheet.

Print Name: _____

Signature: _____

Date: _____

Contact Address: _____

_____

Contact Telephone: _____

APPENDIX 8. ETHICS VARIATION

The UNIVERSITY of NEWCASTLE
AUSTRALIA

Form HE2:1/05

HUMAN RESEARCH ETHICS COMMITTEE

Certificate of Approval for a research project involving humans

Applicant

Chief Investigator/Project Supervisor: (First named in application)	*Associate Professor Darren Rivett*
Co-Investigators/Research Students:	*Mr Peter Miller* *Ms Rosemary Isles*
Project Title:	*The exploration of the physiotherapy clinical reasoning process*

In approving this project, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the *National Statement on Ethical Conduct in Research Involving Humans, 1999*, and the requirements within this University relating to human research.

Details of Approval

HREC Approval No: *H-149-1105*	**Date of Approval:** *16 November 2005*
Approval valid for: *3 years, or until project ceases, whichever occurs first.*	**Progress reports due:** *Annually*

NOTE: Approval is granted subject to the requirements set out in the attached document *Approval to Conduct Human Research*, and any additional comments or conditions noted below:

16 November 2005
Approved subject to a satisfactory response to issues identified by the Committee.

12 January 2006
Response received and accepted.
Approval confirmed.

Variations to Approved Protocol:

20 September 2006
Variation to change the location of the study for two physiotherapy participants. Both participants met the criteria and gave informed consent, provided the project could be conducted in East Maitland at their place of work rather than presenting to the University of Newcastle.

Approved.
The Committee ratified the approval granted by the Chair on 15 September 2006.

Signed for the Committee: A/Professor 20/9/2006

Ms Susan O'Connor
Human Research Ethics Officer

APPENDIX 9. STUDY SETUP PROCEDURES & EQUIPMENT

Audio Equipment:

- Sony M727V microcassette recorder
- Olympus XD60 and Sanyo MC-60 microcassettes (60 minutes)
- Sanyo memo-scriber TRC-6030 (transcribing system)

Video Equipment:

- Samsung digital video recorder VP-D21i
- Canon MVX330i digital video camcorder
- Video tripod
- 5 metre fire wire cable compatible with IEEE1394 Port
- Sony & JVC mini digital video cassettes
- Verbatim external microphone

Hardware:

- Compaq 800 notebook
- Dell inspiron 6400 notebook computer
- Notebook computer compatible audio headsets (2 sets) with dual connector

Software:

- Microsoft Windows XP
- Windows Movie Maker version 5.1

Furniture:

- One metre square table available for participant to make assessment notes
- Two chairs

Simulated Patient Assessment

Procedure

1. **Preparation**

- Assessment room setup with 2 chairs and desk space if required
- Video camera setup on tripod 2 metres from chairs
- Video camera DC power supply attached
- Video camera tape check
- Microphone connected to video camera and placed 1 metre from chairs
- Connecting cable attached from notebook computer to video camera
- Laptop setup in adjacent room with DC power supply
- USB mouse attached to laptop
- Windows Movie Maker program open
- Audio recorder with tape set to 1.2cm speed and placed on desk

2. **Recording process** (once participant and simulated patient are seated)

- Audio recorder switched on to record
- Video camera set to ‘recorder’
- Record button pressed to record onto video camera cassette
- Recording commenced in Movie Maker – recording directly onto laptop computer

3. **On completion of recording**

- On completion of assessment, the laptop recording is stopped then saved as file in ‘video files’ (participant 1, 2, 3, 4, etc)
- The video camera is then stopped
- The audio recorder is then stopped
- Remove recording cassettes and label with participant number and date

Audio Taped Interview

Procedure

1. **Preparation**

- Interview room setup with two chairs and desk with notebook computer
- New micro-cassettes placed in audio and video recorders
- Audio tape recorder positioned in front of participant and researcher
- Windows Movie Maker program open
- Video clip of patient assessment opened and paused
- Video camera setup on tripod 2 metres from chairs
- Video camera DC power supply attached
- Microphone connected to video camera and placed 1 metre from chairs
- Headsets connected to notebook computer via dual adapter

2. **Interview recording process**

- Commence recording on the video recorder
- Commence recording on the audio tape recorder
- Commence the interview by stating the participant number on recording then commence play of the video clip of the recorded assessment
- Mouse control used to pause the recording at any stage
- Any stop of the video requires a time stop to be stated

3. **On completion of recording**

- The video and audio tape recording devices are stopped
- Remove recording cassettes and label with participant number and date
- The video tape of the interview downloaded onto the notebook computer
- The audio tape recording of the interview sent to the transcriptionist

APPENDIX 10. PARTICIPANT ORIENTATION SHEETS (provided separately)

Orientation to the patient assessment (Version 1, 21.10.05)

I am investigating the clinical reasoning process used in physiotherapy. I would like you to conduct a subjective assessment (or history) with this patient. You will not be required to undertake a physical examination or treat this patient. A video camera will record the assessment and the videotape will be used to help you recall your thoughts at the time of the assessment during the following discussion. Please assess the patient as normally would in your clinical practice.

Orientation to the interview (Version 1, 21.10.05)

To further explore your clinical reasoning process, I will now ask you some questions relating to the assessment you have undertaken. It is important to understand that there is no correct answer to these questions. The questions will explore your thinking at the time of the assessment.

You will be observing the video of your patient assessment to prompt recall of your thoughts at different times during the assessment. Try to describe what was going on in your mind at the actual time and not thoughts or decisions from afterwards. In other words, it is important that you try to recall your thinking at each step of the assessment and not to be influenced by information you may have obtained later.

The term hypothesis is used to refer to your understanding or explanation of the case. You may describe your hypothesis or understanding in any way that suits you.

I can pause the video whenever you would like to discuss your thoughts or observations from the assessment. There will also be times where I will pause the video to ask you what you were thinking at that point in the assessment.

APPENDIX 11. INTERVIEW PROTOCOL SHEET

The exploration of the physiotherapy clinical reasoning process
Version 1, 21.10.05

This semi-structured interview protocol utilises the following questions to prompt discussion during the interview. The video will be paused during any interview discussion.

- What were you thinking at this stage?
- Were you thinking anything else at this stage? What were you thinking?
- Did that information help you at all? How did it help?
- Did that information assist your understanding of the case at the time? How did it help?
- Why did you ask that? What information did you gain from that line of questions?

Timing of Video Stops:
The video is to be paused when requested by the participant, after each group of similar questions, or after a maximum period of 1 minute continuous play. On completion of the video observation, the following structured questions will be asked unless the information has already been provided earlier in the interview.

First Hypothesis Questions:

1. When did you first generate an understanding of the case that you would call a hypothesis?
2. How would you describe this first hypothesis?
3. What features of the case led to this first hypothesis?
4. Did you have any other hypotheses about the case at the same time? If so, what were they?

Final Hypothesis and Wind-up Questions:

5. What is your final understanding or hypothesis of the presentation based on all the information?
6. Were you thinking anything else during the assessment that we haven't discussed yet?
7. What physical examination tests are you planning to do at this stage?

Study and Method Related Questions:

8. How often on average do you see this type of patient?
9. Did the location of the assessment influence your assessment compared to normal?
10. Did the presence of the video camera influence your assessment compared to normal?
11. Was your assessment conducted more thoroughly than normal?

APPENDIX 12. FINAL CODEBOOK

Code name	Code	Sub-code	Code description
Data Collection	DC		Therapist reports collecting information in a routine manner without the data relating to a hypothesis (coded even if prompted in interview)
Hypothesis Related	H	Hypothesis categories: 1. Activity & participation 2. Patients perspective / psychosocial factors 3. Pathobiological mechanisms 4. Physical impairments & associated structure / tissue sources 5. Contributing factors 6. Precautions & contraindications 7. Management & treatment 8. Prognosis 9. Non-specific	Therapist states an understanding of the case in any of the hypothesis categories. This may be several competing possibilities or a single clear hypothesis. Any lay level of response, where no interpretation has occurred should not be coded as a hypothesis e.g. descriptive comments such as “the pain was fairly strong”
Knowledge	K		Participant refers to their knowledge in an attempt to apply it to the problem at hand.
Self Awareness	SA		Therapist verbalises awareness of their own thinking. These metacognitive reflections may relate to data, process, hypotheses, decisions or knowledge.
Planning	P	1. Examination 2. Management	Therapist verbalises their use of subjective data during the history to plan further examination or Rx procedures
Significant Case Feature	SCF		Therapist highlights the relevance / significance of data obtained to case at hand

Code name	Code	Sub-code	Examples of codes
Data Collection	DC		"just trying to gather information at this point"
Hypothesis Related	H	Hypothesis categories: 1. Activity & participation 2. Patients perspective / psychosocial factors 3. Pathobiological mechanisms 4. Physical impairments & structure / tissue sources 5. Contributing factors 6. Precautions & contraindications 7. Management & treatment 8. Prognosis 9. Non-specific	1. "she is still able to do a fair amount of activity despite being in pain" 2. "she seemed to be coping OK with the pain but is concerned about her next clinical" 3. "I was thinking along the lines of an inflammatory wind up of the neural system" 4. "the problem could be a lumbar disc or the SIJ" 5. "there is a muscle control issue" 6. "I would be careful not to leave her lying prone for extended periods" 7. "active exercise targeting the stabilising muscles will be useful" 8. "I was thinking that we weren't aiming to get pain free but back to preclinical levels of pain" 9. "I think this is an acute-on-chronic problem rather than an acute problem"
Knowledge	K		• "it's so unlikely for kids to have long standing non-specific back pain and unlikely to have a disc injury … I see enough kids to make that history unusual" • "based on the last (MPA) conference … believe disc is aggravated by sitting" • "from my experience at uni … she may need some time off ... special consideration"
Self Awareness	SA		"I was aware at that stage that I needed more information to confirm …" "that info didn't fit and could have sent me down a completely different track" "that wasn't what I was expecting to hear" ""I like to keep (the history) as open as possible"
Planning	P	1. Examination 2. Management	"I'd be testing those flexion vs extension movements" "I was using it to formulate what I'm going to do in the physical examination" "I might need to use a flexion technique"
Significant Case Feature	SCF		"that initial episode (of pain) is significant"

APPENDIX 13. PATTERN RECOGNITION IDENTIFICATION TOOLS

Time stop identification tool for pattern recognition

Participant number _____ Researcher initials _____

Time	1. Hypothesis formed	Ho. Cat.	2. SCF	3. Kn	4. Exp	5. Mx	Comments / quotes

Key for use: Interview time stops are labelled in the time column as the exact assessment time stated in transcript data.
Hypotheses formed during each time stop of the participant interview are documented and hypothesis category (Ho. Cat.) labelled relative to each hypothesis (numbered 1-9).
Information on features numbered 2 to 5 obtained via each specific code and quotations listed along with researcher comments in 'comments / quotes' column. Yes or no placed in each column (2 to 5) for each time stop.
SCF = Significant case feature Kn = Knowledge Exp = Experience Mx = Management

Overall pattern recognition scoring tool

Participant number _____ Researcher initials _____

Feature of PR	Yes / No	Evidence	Comments
1. Central hypothesis formed			
Actual time of central hypothesis formation as a percentage of the total assessment time	___ min's ___ sec's ____ % of overall time		
2. Significant case features			
3. Professional craft knowledge			
4. Prior clinical experience of this case			
5. Management stated			

Key for use: A clear predominant and central hypothesis must be formed to state pattern recognition has been used.
For each 'yes' response beside numbered (1 – 5) items a score of one is provided.
Total score is the number of 'yes' responses out of a maximum total of five.

APPENDIX 14. SELF-AWARENESS SUB-CODE EXAMPLES

These examples of the self-awareness coded text identify the sub-code name in bold text within parentheses at the end of each quotation:

Expert F: I would have expected someone with this history at that stage to say they had some stiffness in the morning **(Prediction)**

Expert B: there are some pieces of information which are just sort of like um which are there sitting in the background and others which are really channelling the flow through **(Process)**

Expert F: I just think it's interesting to how people describe pain … I don't really know whether it makes any difference but I just think its interesting **(Interesting)**

Expert J: So that doesn't really tell me what the, what the cause is, what the diagnosis is **(Diagnosis)**

Expert G: I'm perhaps a little bit surprised that she's only taking Panadol every now and then **(Surprise)**

Expert F: it hadn't really fitted and I wasn't really quite sure what I thought was wrong with her and by this stage I normally have a very clear picture of what I think's wrong with someone whether it right or wrong **(Uncertainty)**

Expert J: I usually take the history and then … at the end I really start thinking, putting it together. I usually get all the facts before I start putting it together **(Deferred integration)**

Novice N: the way that it kind of panned out made me focus a lot more on the, the structures of it as a source of the pain rather than anything else **(Direction)**

Novice S: That threw me a bit. Um with the sitting um easing it. Um but with a, a little bit more questioning I was able to sort it out a bit more. **(Uncertainty)**

Novice M: when we started going into how long standing, she can stand for and then when the pain comes on. I started thinking I really need to clarify this cause it's quite important. **(Significance)**

Novice R: I hadn't really at this staged locked myself into any sort of hypothesis. I was really just sort of pulling it all, just making a stew, just getting all that information in there and some, seeing what I thought in the end. **(Deferred integration)**

APPENDIX 15. FINAL PARTICIPANT HYPOTHESES

Participant	Summary	Evidence	Categories
Expert A	Instability	I'd expect all directions probably would be painful. With none outstanding more than other … I'm thinking instability … there's no major pathology you know untoward going on … My picture is that her disc is probably extra squashy. This is a very crude you know analogy sort of model rather than a reality. You know the disc is probably very squashy and they're sort of trying to bulge out all around and the supporting muscles just can't hold them	4 Physical impairments & associated structure / tissue sources 5 Contributing features
Expert B	Spondylolisthesis	I would still be concerned about a spondylolisthesis … it's not a sort of like a um ah a really irritable type problem	4 Physical impairments & associated structure / tissue sources 6 Precautions and contraindications
Expert C	Mechanical pelvic asymmetry	I think there's an underlying sort of asymmetry. An insidious history of the right pelvis I would expect to find on the assessment … a secondary pelvic asymmetry which is probably the underlying cause of the problem which makes it look like the pattern you're seeing here … there's a mechanical aspect to it.	4 Physical impairments & associated structure / tissue sources 5 Contributing features
Expert D	Spondylolisthesis	she's got a poor understanding of what her problem is, in fact probably virtually no understanding of her problem … my hypothesis of it being some sort of either structural instability … spondylolisthesis	2 Patients perspective / psychosocial 4 Physical impairments & associated structure / tissue sources 5 Contributing features

Participant	Summary	Evidence	Categories
Expert E	Instability	there's certainly a few directions that I'd head into … I think I'd probably go towards something sort of instability or canal stenosis or something that's central … she could have scoliosis or leg length inequality	4 Physical impairments & associated structure / tissue sources 5 Contributing features
Expert F	Nil clear stated	no I didn't (have an understanding of the case), I'm still quite confused about her. I don't thing she's typical	Nil
Expert G	Motion segment dysfunction / neurogenic / instability	I think it's um -- probably low lumbar spine, motion segment sort of I guess pathology. Um dysfunction um with a neurogenic component … with um a poor muscle, I guess poor stability system that's contributing to that	3 Pathobiological mechanisms 4 Physical impairments & associated structure / tissue sources 5 Contributing features
Expert H	Instability / joints	I think probably ah more moderate to low irritability um so I can examine it fairly fully um I think there's prob um -- there's probably an instability component that I need to address in terms of checking out her core stability um muscles. So that's, yes I'm, I'm expecting that I'll find that there's some um stiffness and painful joints at the back of her spin which I suspect I would be able to treat. Um and then maybe give her stability type exercises.	4 Physical impairments & associated structure / tissue sources 5 Contributing features 6 Precautions and contraindications 7 Management

Participant	Summary	Evidence	Categories
Expert I	Spondylolisthesis	Mechanically behaving back pain that has gone -- stemmed from an original injury as an 11 year old um that's been symptomatically managed and in a period of a lot of a lot of overload with this recent clinical placement … And structurally I'm thinking that there are enough, enough reasons to go and have it investigated, further. Um particularly looking for bony, bony changes where there was a bone injury originally … she's not getting discrete dermatomal symptoms and her aggravating factors aren't consistent with nerve root type um problems. Um certainly in the back of my mind I'm leaning strongly toward the possibility there may be some kind of bony pathology there as well (Bony pathology was stated earlier in the interview as spondylolisthesis)	3 Pathobiological mechanisms 4 Physical impairments & associated structure / tissue sources 5 Contributing features 7 Management
Expert J	Disc or joint	I couldn't say at this stage whether it's more discy or facet, and I would get back from my examination I would get more information from the examination about that. Whether it was extension, with her active movements, if it was extension that mainly brought on a pain. And if she wasn't very irritable, you know I could put her back in the quadrant position and see if it's really closing down the facet joints.	4 Physical impairments & associated structure / tissue sources 5 Contributing features 6 Precautions and contraindications
Novice K	Disc / sacro-iliac joint / postural	I'm either thinking ah discogenic, or possibly SIJ … and ah postural as well	4 Physical impairments & associated structure / tissue sources 5 Contributing features
Novice L	Disc	my yeah hypothesis is like a disc type injury which is aggravated by loading … in a like standing position … Thinking a disc injury is impacting on the nerves and therefore causing some referring type things	4 Physical impairments & associated structure / tissue sources

Participant	Summary	Evidence	Categories
Novice M	Postural	I think I've started to develop an understanding. I'm definitely thinking that there's a postural component, um to her pain and I guess I'm not really thinking about so much about structurally what's going on	5 Contributing features
Novice N	Lack of support / restriction	I'd say that she's ah she's had a history, a long history of back pain, um possibly begun with a, ah with a, a fall down the stairs. Um but I'd say she's definitely got a -- ah lack of support around the area. Um there could be some actual derangement or dysfunction in the actual structures but um I'd be thinking that there's just a lack of support for the areas that is worse when she is weight bearing. I would be expecting restriction um into flexion. Um -- and possibly … extension. I guess I would have thought that there would be some restriction … if she flexed all the way down to her toes I'd be surprised … it wouldn't fit what I was going down	5 Contributing features
Novice O	Sacro-iliac joint (SIJ)	a few ideas, nothing really specific. Um probably looking at like a, an SIJ kind of ah especially if standing for prolonged periods of time um and with the nature of having a fall as well, um with activities like netball um repeated jarring that sort of thing	4 Physical impairments & associated structure / tissue sources
Novice P	Instability	I still think it's a, a instability of the lumbar spine … there wasn't kind of any particular movement or loading strategy in a particular direction which, which um tend to flare it up. It was, there was multiple … well basically what I'm kind of getting at there is just the inability of the muscular control system to hold the, the lumbar spine within it's neutral position	5 Contributing features

Participant	Summary	Evidence	Categories
Novice Q	Instability	I guess really there's two possibilities … that sort of sit in my mind … that lumbopelvic instability in that area, um poor activation transversus abdominus, it certainly would be interested to see her ability to activate um to there and see if there was any alteration in her symptoms. Um, the other, other possibility is ah like a stenosis compression of a nerve root. Um given that her extension moments … especially with the sitting, sitting in the slouched position, the opening up of the facet joints. Um, maybe a little bit unusual in both sides at the same time	4 Physical impairments & associated structure / tissue sources 5 Contributing features
Novice R	Instability	you know she's getting this hip and lumbar spine pain and that referral could be due to um sciatic impingement through over performance or underperformance depending on her makeup. Um, so that was something that I was juggling. Um, but also there could be you know she might have other things going on. Um facet joint irritations or general instability, global instability, um that she can't control along her spine and hence is getting gross movements with her um increased load that she is putting under it	4 Physical impairments & associated structure / tissue sources 5 Contributing features
Novice S	Disc > joint	sort of chasing a lumbar disc as a possible structure. Um but also the, the referral pain down both legs and into her knee I hadn't um clearly determined whether that was, was coming from a structure in her lower back, or not. So I wanted to look at things like um her piriformis, her SIJ a little bit more with some testing, um to try and determine whether I could figure out if those all were referred pain into her buttocks and thighs and just below the knee where it related to the one area … a lumbar disc is one that is standing out um, more than others. Although it's -- just the lumbar spine specifically that is standing out some more, so I wouldn't, um, I wouldn't rule out ah some Z joint involvement um or some, some muscular involvement either	4 Physical impairments & associated structure / tissue sources