Strutt et al., *Cogent Psychology* (2014), 1: 981973
http://dx.doi.org/10.1080/23311908.2014.981973

cogent psychology

DEVELOPMENTAL PSYCHOLOGY | RESEARCH ARTICLE

High anxiety levels are associated with divergent empathising and systemising tendencies

Paul A. Strutt[1,2*], Linda Elisabet Campbell[1,2] and Darren Burke[1]

Received: 23 September 2014
Accepted: 27 October 2014
Published: 19 November 2014

*Corresponding author: Paul A. Strutt, School of Psychology, University of Newcastle, Ourimbah NSW 2258, Australia; Priority Research Centre for Translational Neuroscience and Mental Health Research, University of Newcastle, Newcastle, Australia
E-mail: paul.strutt@newcastle.edu.au

Reviewing editor:
Stefan Elmer, University of Zurich, Switzerland

Additional information is available at the end of the article

Abstract: "Systemising" and "Empathising" are two cognitive tendencies that individuals rely on to make sense of the world. Systemising involves the observation of environmental contingencies and the consequent formulation of concrete rules to predict events. Empathising is the drive to attribute affective states to others, and to guide responses based on these inferences. High Anxiety is linked to negative, and erroneous, interpretations of social information, and it is possible that the introduction of systems, and therefore predictive utility, might appeal to anxious individuals. It was hypothesised that individuals with high trait anxiety levels would report higher systemising tendencies and lower empathising tendencies than their less anxious peers. A total of 223 participants completed measures of trait anxiety, empathising and systemising tendencies, and autistic traits. Consistent with the hypotheses, individuals with higher levels of trait anxiety demonstrated high systemising tendencies and relatively low empathising tendencies, whilst their less anxious peers demonstrated balanced tendencies in both domains. The High Anxiety group also scored highest on the self-reported measure of autistic traits. This research has identified anxiety as a potential facilitator of divergence in cognitive tendencies, which will be further enhanced by studies in clinical populations.

ABOUT THE AUTHORS

Paul A. Strutt completed his undergraduate training in psychology in 2011. He is currently a PhD candidate under the supervision of Darren Burke and Linda Campbell, at the University of Newcastle, Australia. His research focuses on understanding social cognition across the general population, and the translation of this knowledge towards a better understanding of the socio-cognitive difficulties often identified within developmental disorders, e.g. autism spectrum conditions.

Linda Elisabet Campbell is a lecturer in the School of Psychology at the University of Newcastle, Australia. She is the director and chief investigator of the Family Interaction & Neurodevelopmental Disorders Lab (FINDLab). For more information, visit: findlab.net.au

Darren Burke is a senior lecturer in the School of Psychology at the University of Newcastle, Australia, and the head of the Evolutionary Cognition Lab. For more information, visit: evolutionarycognition.org

PUBLIC INTEREST STATEMENT

"Systemising" and "Empathising" are cognitive tendencies that individuals rely on to make sense of the world. Systemising involves the observation of environmental contingencies and the consequent formulation of concrete rules to predict events, and this underpins interests ranging from organising CD collections to predicting weather patterns. Empathising is the tendency to attribute emotional states to others, and to guide our behaviour based on this insight. Autism is characterised by a profile of low empathising and high systemising. Given that high anxiety is linked to negative, and erroneous, interpretations of social information, and that introducing predictability into the environment, might appeal to anxious individuals, we explored whether high anxiety levels were linked to such a profile. We found that individuals with high anxiety levels report high systemising tendencies, lower empathising tendencies and higher scores on a measure of autistic traits, when compared to their less anxious peers. The implications of these findings are discussed.

Subjects: Anxiety in Adults, Anxiety in Children & Adolescents, Autism & Aspergers, Autism & Aspergers in Children & Adolescents, Mental Health Research, Mood Disorders in Adults - Depression, Mania, Bi-Polar, Mood Disorders in Children & Adolescents, Obsessive–Compulsive Disorder in Adults, Obsessive–Compulsive Disorders in Children & Adolescents, Psychological Science

Keywords: autism, social skills, cognitive development, social development, empathy

1. Introduction

Anxiety serves a critical role in our ability to avoid potential threats in the environment (Mathews, 1990). High levels of physiological arousal, and a cognitive pattern characterised by worry, facilitate the early detection of threats (Mogg, Mathews, & Weinman, 1989) and therefore provide the opportunity to implement timely threat-management strategies. Adhering to a set of routine behaviours may reduce anxiety levels. Such an approach would increase the accuracy of outcome-expectancy predictions, and would be compatible with a cognitive profile characterised by vigilance for threat. In contrast, because anxiety levels promote self-preservation, it is possible that social and emotional reciprocity is not a priority in highly anxious individuals (Negd, Mallan, & Lipp, 2011). Important here is the divergence between social, or *Empathic* tendencies, and non-social, or *Systematic* tendencies. Fundamental to the investigation undertaken in this paper was the possibility of a link between anxiety levels and empathising–systemising tendencies.

According to empathising–systemising (E–S) theory (Baron-Cohen, 2009), the primary function of a cognitive system is either to aid our interaction with physical (non-social) properties of the environment or, alternatively, to process social information and formulate appropriate behavioural responses within social settings. E–S theory proposes two fundamental tendencies, "Empathising" and "Systemising", which underpin the development of these cognitive functions.

Empathising is defined as the tendency to take the perspective of another person (Frith & Frith, 2007; Nettle, 2007). This tendency allows an individual to make inferences about another's current emotional state, and provides a basis for understanding, and appropriately reacting to their behaviour (Baron-Cohen & Wheelwright, 2004). In contrast, the drive to establish predictive validity regarding the outcomes of everyday events results in "Systemising" behaviour (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003). Systemising occurs when an individual develops a set of rules that, when applied to a set of predetermined variables, allow him or her to *predict*, with some acceptable level of accuracy, the outcome of a specific event in their environment. There are many types of systems including technical systems (operation of a motor vehicle), natural systems (tidal changes), organisable systems (CD and photograph collections, train timetables), social systems (postal codes based on location) and abstract systems (mathematical equations) that can be governed by such rules (see Baron-Cohen et al., 2003 for a description of each). Neurodevelopmental disorders, including autism spectrum conditions and 22q11.2 deletion syndrome, include a cognitive profile characterised by impairments specific to social functioning (Campbell et al., 2011; McCabe et al., 2013). Evidence from autism research suggests that, whilst this population demonstrates social impairment, they display above average systemising tendencies (Baron-Cohen et al., 2003; Wheelwright et al., 2006). Importantly, it is the relative imbalance between an individual's empathising and systemising tendencies that is the major predictor of impairment to everyday functioning (Baron-Cohen, 2009).

High anxiety levels have been linked to limited empathic abilities (Decety & Meyer, 2008; Negd et al., 2011). One of the causes of low empathic ability may be the biasing of attention towards perceived threats when experiencing high levels of anxiety (Mogg et al., 1989). The function of these attentional biases is to ensure that potential threats are identified as early as possible, so that appropriate response strategies can be implemented (LoBue & DeLoache, 2008). For example, socially anxious individuals demonstrate a *reactive* avoidance of cues to social interaction (Moukheiber et al., 2010), first characterised by implicit attentional shifts towards perceived threats, and then by explicit attentional shifts away from these cues (Cooper & Langton, 2006). This

behaviour prevents the communication of interest in social interaction to the observer and therefore aids in the avoidance of fear-inducing interactions (Wieser, Pauli, Weyers, Alpers, & Mühlberger, 2009). The function of this anxiety, characterised by these biases, may be to enable the anxious individual to prepare, and potentially avoid, deleterious outcomes during such interactions (Mobini, Reynolds, & Mackintosh, 2012). Sustained periods of this behaviour may limit the opportunity for individuals to process social cues, and as such, will limit the development of empathic abilities. However in contrast, this avoidance of social encounters may facilitate the specialisation of alternate cognitive strategies and interests—specifically, systemising tendencies. Because the function of anxiety is to channel attention towards potential threats in the environment, highly anxious individuals are likely to develop a preference for behaviours that increase the likelihood of accurately predicting environmental contingencies. Systemising one's environment is an approach that would provide such predictive utility.

E–S theory (Baron-Cohen, 2009) has the power to explain differences in abilities, interests and behaviour in the general population (Focquaert, Steven, Wolford, Colden, & Gazzaniga, 2007; Nettle, 2007). Differences in anxiety levels experienced during human evolutionary history may have provided the catalyst for the divergent development of empathising and systemising tendencies, i.e. importance of group interaction to survival of offspring, versus the utility of responding to threats in the environment when gathering resources. There is evidence of reduced social functioning in highly anxious individuals (Moukheiber et al., 2010; Negd et al., 2011). Separately, there is also a reliance on systemising behaviours demonstrated by those with high levels of anxiety (Kim, Szatmari, Bryson, Streiner, & Wilson, 2000; Wheelwright et al., 2006). Therefore, it is possible that differences in anxiety, specifically trait anxiety, given evidence of this attribute as a heritable personality construct (Garcia et al., 2013), will explain this divergent reliance on empathising and systemising tendencies. Research to this point has not demonstrated the effects of anxiety on empathising and systemising tendencies, concurrently. The demonstration of such a relationship would suggest important avenues for research on a range of developmental disorders, for example 22q11.2 deletion syndrome, as often there is an increased prevalence of co-morbid anxiety and autism spectrum condition diagnoses within this group (Angkustsiri et al., 2013).

We hypothesised that individual differences between empathising and systemising levels (expressed as an individual difference score called "*D*") would be dependent on trait anxiety level. More specifically, we expected that a regression model would reveal that trait anxiety level would predict the magnitude of "*D*". To further illustrate the effects of different levels of anxiety on empathising and systemising tendencies, we also conducted a group-based analysis, which allowed explicit contrasts at low and high levels of anxiety to be undertaken. It was hypothesised that individuals in the High Anxiety group would score highest on the systemising quotient-revised (SQ-R) and lowest on the empathy quotient (EQ) compared to the other groups. Within-group differences between mean SQ-R and EQ scores ("*D*") were also expected to be different between groups. We expected that individuals in the High Anxiety group would score high on the SQ-R compared to their EQ scores (large "*D*"), and that the Low Anxiety group and the Medium Anxiety group would demonstrate relatively balanced EQ and SQ-R scores, characterised by "*D*" scores close to "0". Finally, given the evidence of a relationship between "*D*" and autistic traits (Wheelwright et al., 2006), and the hypothesised link between anxiety level and D-score proposed here, we expected a relationship between trait anxiety scores and scores on the autism quotient (AQ) (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001), such that those in the High Anxiety group would report significantly higher scores on the AQ compared to the other groups.

2. Method

2.1. Participants

Participants were 223 undergraduate students (167 female) aged 18–44 years ($M = 23.71$; $SD = 7.96$). Participants were enrolled in undergraduate psychology courses at the University of Newcastle, Australia. All participants were granted course credit for their involvement. To be included in the

study, participants were required to be at least 18 years of age, and to possess a level of English sufficient to understand the items in the questionnaire. Participants who reported an individual and/or family history of psychiatric illness (n = 10) were excluded from the analyses. The University's Human Research Ethics Committee granted ethics approval for the study.

2.2. Assessment

2.2.1. Trait anxiety

Trait anxiety was measured using the State-Trait Anxiety Inventory-Trait Form (STAI Form Y-2) (Spielberger, 1983). This questionnaire asks participants to report how accurately 20 statements describe them *generally* on a 4-point Likert scale. The STAI has acceptable internal consistency and reliability, and has been validated in both normal and clinical populations (for norms see Spielberger, 1983).

2.2.2. Empathising and systemising

Empathising was measured using the EQ (Baron-Cohen & Wheelwright, 2004). This scale contains 40 empathy-related items (i.e. "I really enjoy caring for other people."), and 20 filler items. Participants are asked to report how accurately each item describes them by indicating their agreement on a four-point Likert scale, ranging from 1—"Strongly Disagree" to 4—"Strongly Agree". To shorten the administration of this scale, the filler items were removed, resulting in a 40-item scale. Previous research has demonstrated that the psychometric properties of the scale are acceptable after removing these filler items (Baron-Cohen & Wheelwright, 2004; Nettle, 2007). The scale is designed to be used with individuals of normal intelligence and can be self-administered.

Systemising was measured using the SQ-R (Wheelwright et al., 2006). The SQ-R contains 75 items (i.e. "I am fascinated by how machines work."), and requires respondents to indicate their agreement with each statement using the four-point Likert scale.

2.2.3. Autistic traits

Dimensional ratings of sub-clinical autistic traits were measured using the AQ (Baron-Cohen et al., 2001). This scale measures traits of autism in five sub-domains, which include social skill, attention to detail, attention switching, communication and imagination. Respondents complete the scale by indicating their agreement with each of the 50 statements on a four-point Likert scale. The scale has good test re-test reliability, and has been documented to accurately discriminate between individuals with an autism spectrum condition and their typically developing peers (Baron-Cohen et al., 2001).

2.3. Procedure

The survey was completed via the Internet, either within a lab session at the Ourimbah Campus of the University of Newcastle, or externally (e.g. on participant's home computer) using the web-host SurveyMonkey™. Upon obtaining informed consent, each participant completed the survey, which contained each of the scales described previously. The order of questionnaire completion was randomised between subjects, whilst to maintain scale validity, the item order within each questionnaire was standardised according to the original scales.

2.4. Analysis

Preliminary analyses revealed sex differences on overall scores for the EQ and SQ-R (see Results). Therefore, "Sex" was used as a covariate in the analyses. Multiple regression analysis was undertaken to determine whether, after accounting for Sex, levels of trait anxiety predicted individual differences between empathising and systemising tendencies ("*D*"). A between-group Multiple Analyses of Covariance was used to establish whether group-based differences in anxiety produced differences in scores on the EQ and SQ-R measures. Group allocation was based on the sample mean and standard deviation on the trait anxiety measure (STAI Form Y-2). The sample was divided into three groups, where participants scoring more than one standard deviation either side of the sample mean were allocated to the "Low Anxiety" or "High Anxiety" groups, whilst the remainder of the participants, who scored within one standard deviation of the sample mean, were assigned to the "Medium Anxiety" group.

2.4.1. Calculation of "D"

To quantify any bias towards empathising or systemising, a normalised difference score was computed (see Wheelwright et al., 2006 for details). Standardised SQ-R and EQ scores were calculated using the following formulae: S = [(SQ-R − <SQ-R>)/150] and E = [(EQ − <EQ>)/80]. The sample population mean (denoted by <...>) was subtracted from individual scores on each measure, and then divided by the maximum possible score (150 for SQ-R and 80 for EQ). We then used the formula: [(S − E)/2] to obtain the difference between the two measures, which resulted in a new variable, referred to as "*D*".

3. Results

3.1. Sample demographics

Of the 223 participants, 10 were excluded due to reports of psychiatric illness, and 5 were excluded due to incomplete responses. Of the remaining 208 participants, 187 (90%) self-identified as Caucasian, 11 as Asian (5%), 2 as African (1%), 2 as Polynesian (1%), 1 as Greek, 1 as Mexican, and 1 participant's ethnicity was not reported. Preliminary analyses revealed that participants who completed the survey during a lab session were significantly older (M = 27.14, SD = 1.33) than those who completed the survey externally (M = 23.07, SD = .62), F (1, 203) = 7.67, p < .01. Neither age nor type of testing session (lab session or external setting) had a significant effect on STAI, EQ or AQ scores; however, age did have an effect on SQ-R scores, F (28, 179) = 2.34, p < .01, which was no longer observed once D-scores were calculated (p > .46).

3.2. Anxiety level predicts "D" score

Before interpreting the model, assumptions of linearity, homogeneity, normality, and collinearity were checked and satisfied. Using the Enter method, the two-factor model (Sex; Trait Anxiety) was significant, F (2, 205) = 19.94, p < .001. The model predicted 16% of the variance in "D" scores (Adjusted R^2 = .159). Trait anxiety significantly accounted for variance in "D" scores (β = .22), and this was strengthened slightly (β = .23), after accounting for sex differences (β = .34).

3.3. Anxiety group characteristics

Participants were classified into groups of either "High" (n = 38), "Medium" (n = 135) or "Low" (n = 35) levels of trait anxiety based on the sample population mean and standard deviation (M = 45.13,

Table 1. Descriptive statistics for each key measure within each anxiety group

	Descriptive statistics														
	Low Anxiety					Medium Anxiety					High Anxiety				
	(*n*)	Min	Max	Mean	SD	(*n*)	Min	Max	Mean	SD	(*n*)	Min	Max	Mean	SD
Age		18	59	25.74	11.60		17	54	23.40	7.52		18	44	23.05	5.76
Sex (% female)				85.70	.36				76.30					81.60	
Trait anxiety**[a]		21	33	29.51	3.14		34	56	44.42	6.24		57	73	62.05	3.90
SQ-R*[b]		26	104	59.29	16.98		19	103	51.29	17.84		21	142	58.61	21.41
SQ-R (Adjusted)		−.19	.33	.04	.02		−.23	.33	−.02	.01		−.22	.59	.03	.02
EQ**[c]		18	67	51.80	12.43		19	72	43.61	12.03		16	69	42.29	13.29
EQ (Adjusted)		−.34	.28	.09	.03		−.33	.34	−.02	.01		−.36	.30	−.03	.03
AQ		3	26	14.36	5.72		6	39	17.18	5.89		10	39	22.93	7.00
D-score**[d]		−.18	.25	−.02	.10		−.20	.20	<.01	.08		−.17	.48	.03	.13
Group (*n*)	35					135					38				

[a]All group comparisons were significant.

[b]Medium Anxiety group scored significantly lower on SQ-R than either comparison group.

[c]Low Anxiety group scored significantly higher on EQ than either comparison group.

[d]High Anxiety group "*D*" Score was significantly larger than any other group.

**Significant at .01 level (two-tailed).

*Significant at .05 level (two-tailed).

SD = 11.12). As expected, there were significant differences between these groups in levels of trait anxiety, F (2, 205) = 326.57, $p < .001$ (see Table 1). Groups did not differ significantly on age ($F = 1.34$, $p > .20$) or sex distribution ($x^2 = 1.68$, $p > .40$) (see Table 1 for descriptive statistics).

3.4. Anxiety and E–S strategies

Males ($M = 59.48$, SD = 19.39) scored higher than females ($M = 52.50$, SD = 18.25) on the systemising quotient, F (1, 206) = 4.95, $p < .05$, whilst females ($M = 46.63$, SD = 12.25) scored significantly higher than males ($M = 37.75$, SD = 11.96) on the EQ, F (1, 206) = 18.41, $p < .001$ across groups. Therefore, "Sex" was included as a covariate in the following analyses.

3.4.1. Group differences on EQ and SQ-R

After adjusting for Sex, there was a significant main effect of anxiety group on EQ scores, F (2, 204) = 6.56, $p < .01$. Planned contrasts, revealed that the Low Anxiety group scored significantly higher ($M = 51.8$, SD = 12.43) on the EQ compared to both the Medium Anxiety group ($M = 43.61$, SD = 12.03), t (206) = 3.50, $p < .001$ and the High Anxiety group ($M = 42.29$, SD = 13.29), t (206) = 3.29, $p < .001$, whilst the Medium and High Anxiety groups did not perform significantly differently from one another ($p > .50$). ANCOVA also revealed a significant effect of anxiety group on systemising behaviours, F (2, 206) = 4.83, $p < .01$, where both the Low Anxiety group and the High Anxiety group scored significantly higher on the SQ-R than the Medium Anxiety group (Low: t (206) = 2.29, $p < .05$; High: t (206) = 2.17, $p < .05$).

3.4.2. "D" scores

When adjusted for Sex, "*D*" was significantly different between groups, F (2, 206) = 4.24, $p < .02$. "*D*" was significantly larger in the High Anxiety group when compared to both the Low Anxiety group, t (206) = 2.68, $p < .01$, and the Medium Anxiety group, t (206) = 2.12, $p < .05$. There was no significant difference in the magnitude of "*D*" between the Low Anxiety and Medium Anxiety groups.

3.5. Autistic traits

There was a significant positive correlation between "*D*" and AQ score, r (208) = .57, $p < .001$. Positive correlations were also identified at the group level: Low Anxiety, r (35) = .74, $p < .001$; Medium Anxiety, r (135) = .47, $p < .001$; High Anxiety, r (38) = .63, $p < .001$. As well, there was a positive correlation between anxiety level and AQ score, r (208) = .47, $p < .001$. AQ scores were significantly different when anxiety groups were compared, F (2, 204) = 18.52, $p < .001$. Planned comparisons showed that the High Anxiety group reported significantly higher levels of autistic traits than both the Low Anxiety group, t (206) = 5.90, $p < .001$, and the Medium Anxiety group, t (206) = 4.72, $p < .001$.

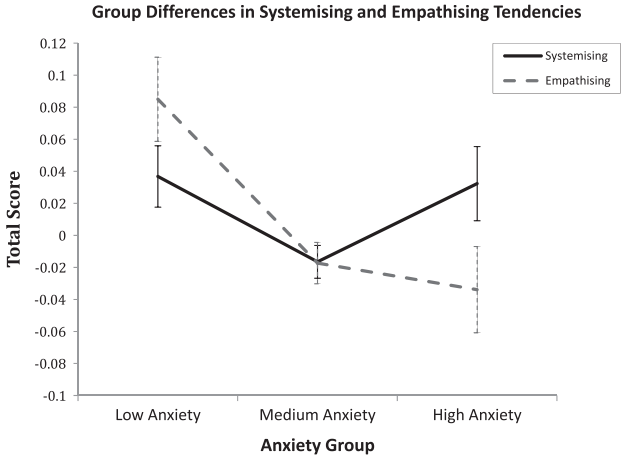

Figure 1. Standardised scores for EQ and SQ-R within each anxiety group.

Notes: Systemising behaviours were reported significantly less by the Medium Anxiety group, whilst empathising significantly decreased as anxiety level increased. "D" was significantly different between groups. Larger "D" scores were positively correlated with scores on the AQ.

4. Discussion

Research investigating the genesis of broad developmental trajectories is important as it can provide a deeper understanding of cognitive functions in both the general population and, potentially, in populations of individuals with neurodevelopmental disorders. The primary aim of the study was to establish a link between anxiety levels and cognitive tendencies across two broad domains—empathising and systemising. A biased reliance on systemising is argued to underpin the development of ritualistic behaviour and, in extreme cases, leads to the social impairments demonstrated by individuals with an autism spectrum condition (Baron-Cohen et al., 2003; Wheelwright et al., 2006). Conversely, high empathy levels have been linked to increased social skills (Negd et al., 2011). Given the utility of increased anxiety levels in identifying potential threats in the environment (LoBue & DeLoache, 2008), and the motivation for a predictable environment that might occur as a consequence, as well as recent empirical evidence demonstrating that highly anxious individuals are less socially skilled (Ishikawa & Sakano, 2006; Negd et al., 2011), it was proposed that anxiety levels may be linked to the development of empathising and systemising tendencies.

It was predicted that individuals who scored high in trait anxiety would adopt a tendency towards systemising and would report less frequent empathising tendencies. The results from both the regression and group-based analyses were consistent with this hypothesis. When explored in more detail, the High Anxiety group reported the lowest scores on the EQ, and the "*D*" score obtained by this group indicated the greatest relative bias towards the use of systemising tendencies, when compared to the other groups. The low EQ scores for the High Anxiety group are not unexpected given previous reports of the link between social skills and anxiety, where research has found that participant's ability to empathise with others was impaired in situations where their anxiety levels were manipulated, in both adult (Negd et al., 2011) and child samples (Ishikawa & Sakano, 2006). Interestingly, there was no significant difference between the Low and High Anxiety groups on the systemising measure, with both groups recording significantly higher scores than the Medium Anxiety group. This finding underscores the central role of imbalance between empathising and systemising tendencies as the primary driver for impairment, rather than one specific cognitive tendency, per se. Of note is the potential bias to empathise rather than systemise in the Low Anxiety group, a reversal of what was observed in the High Anxiety group. This profile is negatively correlated with scores on the AQ, and suggests no functional impairment. However, given that this study was conducted within a typically developing sample, and the significantly smaller D-score relative to the High Anxiety group, it is difficult to form conclusions without further exploring groups with "hyper-empathic" tendencies. At this point, it is not clear whether such a group exists.

According to the theory proposed within this paper, systemising strategies should appeal to anxious individuals. An evolutionary perspective suggests that the functional role of anxiety is to bias attentional processes towards threat (LoBue & DeLoache, 2008). Indeed, there is behavioural evidence of this bias towards threat processing (Mogg et al., 1989), and evidence that ambiguous information is interpreted negatively (Mogg, Bradley, Millar, & White, 1995). It may be that the predictive utility offered by systemising one's environment is of particular appeal to anxious individuals. The development of rule-based systems offers the opportunity to determine the outcome of an event when the individual is confronted with predetermined threat inputs. Examples of such behaviour might be the compulsions some individuals with obsessive–compulsive disorder have to wash their hands repeatedly at specific times during the day, or the strict patterns of ritualistic behaviour demonstrated by those with an autism spectrum condition. It is already known that there is a role for anxiety in both conditions, given that obsessive–compulsive disorder is accepted as a manifestation of clinically significant anxiety issues (American Psychiatric Association, 2000), and the increased rate of co-morbid anxiety diagnoses in the autism population relative to the general population (Kim et al., 2000)

Based on the evidence of a negative relationship between anxiety levels and empathic abilities (Angelico, Crippa, & Loureiro, 2010; Hunter, Buckner, & Schmidt, 2009; Negd et al., 2011), we proposed that those who were lower in anxiety would demonstrate high levels of empathy and

relatively low levels of systemising. Those in the Low Anxiety group scored significantly higher on the EQ than both the Medium Anxiety group and the High Anxiety group. However, the Low Anxiety group performed against expectations on the SQ-R. Contrary to expectations, there was no difference between the Low Anxiety group and the High Anxiety group on the measure of SQ-R. One potential reason for this is the therapeutic effect that systemising may have on anxiety levels. It may be that individuals, who adopt systemising behaviours, for example, through the development of daily routine, feed a fundamental need for predictability in their environments and, consequently, reduce their feelings of anxiety. Notably, within this group, "*D*" was significantly smaller than the High Anxiety group, and may reflect a relative balance of empathising–systemising abilities.

For the Low Anxiety group, we hypothesised high scores on the EQ measure, and low scores on the SQ-R. However, this group demonstrated a relative balance of both empathising and systemising (small "*D*"). While scoring differently on each measure compared to the other groups, the Medium Anxiety group also obtained balanced scores on both measures. In contrast, for the High Anxiety group, the magnitude of the "*D*" score was significantly larger than either of the comparison groups, reflecting a bias towards a systemising cognitive profile. Importantly, this cognitive profile is argued to underpin autistic traits (Baron-Cohen, 2009). Consistent with this proposal, when the presence of autistic traits was examined across the anxiety groups, the High Anxiety group reported significantly higher scores on the AQ when compared to each of the comparison groups.

The fundamental difference between the Low Anxiety Group and the High Anxiety group was not the scores on the SQ-R, but the relatively low level of empathising (see Figure 1). It is likely true that well-adjusted individuals will rely on both systematic and empathic tendencies to navigate the world on a day-to-day basis, indeed that is what is suggested by the pattern of results here. If it is true that balance reflects appropriate tendencies, one may also expect impairment in a sample that demonstrates a bias towards empathising over systemising, but again, it is not yet clear whether such a group exists.

5. Conclusions and future directions

We demonstrated a link between anxiety and E–S tendencies; however, what is not clear from the results of this study is a direction of causation. The theoretical position offered here is that systemising behaviours can be adaptive in the presence of typical empathising levels due to the remediating effects that these strategies may have on anxiety levels. We argue for a *post hoc* adoption of systemising behaviours that occurs as a consequence of high anxiety levels. Conversely, it may be that there are innate mechanisms that render a "systematic" cognitive profile less malleable and relatively predetermined. One might expect individuals with such profiles to develop high levels of anxiety, specifically social anxiety, due to relative difficulties in empathic understanding, which underpins the ability to appreciate events in the environment from another's perspective. This is problematic in a world that requires appreciation of both empathic and systematic interactions.

Future investigations exploring the effects of anxiety manipulations on choice behaviour towards empathising or systemising tasks could provide valuable insights into the nature of causation. Research in clinical groups known for hyper-empathic or hyper-systematic tendencies, such as Williams Syndrome and autism spectrum conditions, will also provide valuable comparisons between clinical samples and the general population. Ultimately, this avenue of research will greatly contribute to the investigation of anxiety as a precursor for cognitive divergence and, potentially, clinical diagnoses.

Funding
The authors received no direct funding for this research.

Conflict of interest
The authors declare that they have no conflict of interest.

Author details
Paul A. Strutt[1,2]
E-mail: paul.strutt@newcastle.edu.au
Linda Elisabet Campbell[1,2]
E-mail: linda.e.campbell@newcastle.edu.au
Darren Burke[1]
E-mail: darren.burke@newcastle.edu.au
[1] School of Psychology, University of Newcastle, Ourimbah NSW 2258, Australia.
[2] Priority Research Centre for Translational Neuroscience and Mental Health Research, University of Newcastle, Newcastle, Australia.

Citation information
Cite this article as: High anxiety levels are associated with divergent empathising and systemising tendencies, P.A. Strutt, L.E. Campbell & D. Burke, *Cogent Psychology* (2014), 1: 981973.

References

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., Text Rev.). Washington, DC: Author.

Angelico, A. P., Crippa, J. A. S., & Loureiro, S. R. (2010). Social anxiety disorder and social skills: A critical review of the literature. *International Journal of Behavioral Consultation and Therapy, 6*, 95–1110. Retrieved from http://0-ovidsp.ovid.com.library.newcastle.edu.au/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=psyc6&AN=2010-18460-002

Angkustsiri, K., Goodlin-Jones, B., Deprey, L., Brahmbhatt, K., Harris, S., & Simon, T. J. (2013). Social impairments in chromosome 22q11.2 deletion syndrome (22q11.2DS): Autism spectrum disorder or a different endophenotype? *Journal of Autism and Developmental Disorders, 44*, 739–746. doi:10.1007/s10803-013-1920-x

Baron-Cohen, S. (2009). Autism: The empathizing-systemizing (E–S) theory. *Annals of the New York Academy of Sciences, 1156*, 68–80. doi:10.1111/j.1749-6632.2009.04467.x

Baron-Cohen, S., Richler, J., Bisarya, D., Gurunathan, N., & Wheelwright, S. (2003). The systemizing quotient: An investigation of adults with asperger syndrome or high-functioning autism, and normal sex differences. *Philosophical Transactions of the Royal Society B: Biological Sciences, 358*(1430), 361–374. doi:10.1098/rstb.2002.1206

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34*, 163–175. http://dx.doi.org/10.1023/B:JADD.0000022607.19833.00

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ): Evidence from asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*, 5–17. Retrieved from http://dx.doi.org/10.1023/A:1005653411471

Campbell, L., Stevens, A., McCabe, K., Cruickshank, L., Morris, R., Murphy, D., & Murphy, K. (2011). Is theory of mind related to social dysfunction and emotional problems in 22q11.2 deletion syndrome (velo-cardio-facial syndrome)? *Journal of Neurodevelopmental Disorders, 3*, 152–161. doi:10.1007/s11689-011-9082-7

Cooper, R. M., & Langton, S. R. (2006). Attentional bias to angry faces using the dot-probe task? It depends when you look for it. *Behaviour Research and Therapy, 44*, 1321–1329. doi:10.1016/j.brat.2005.10.004

Decety, J., & Meyer, M. (2008). From emotion resonance to empathic understanding: A social developmental neuroscience account. *Development and Psychopathology, 20*, 1053–1080. doi:10.1017/S0954579408000503

Focquaert, F., Steven, M. S., Wolford, G. L., Colden, A., & Gazzaniga, M. S. (2007). Empathizing and systemizing cognitive traits in the sciences and humanities. *Personality and Individual Differences, 43*, 619–625. doi:10.1016/j.paid.2007.01.004

Frith, C. D., & Frith, U. (2007). Social cognition in humans. *Current Biology, 17*, R724–R732. doi:10.1016/j.cub.2007.05.068

Garcia, S. E., Tully, E. C., Tarantino, N., South, S., Iacono, W. G., & McGue, M. (2013). Changes in genetic and environmental influences on trait anxiety from middle adolescence to early adulthood. *Journal of Affective Disorders, 151*, 46–53. doi:10.1016/j.jad.2013.05.046

Hunter, L. R., Buckner, J. D., & Schmidt, N. B. (2009). Interpreting facial expressions: The influence of social anxiety, emotional valence, and race. *Journal of Anxiety Disorders, 23*, 482–488. doi:10.1016/j.janxdis.2008.10.004

Ishikawa, S.-I., & Sakano, Y. (2006). The investigation on the relationship between social skills and anxiety symptoms in children by the self-report method. *Japanese Journal of Counseling Science, 39*, 202–211. Retrieved from http://0-ovidsp.ovid.com.library.newcastle.edu.au/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=psyc5&AN=2007-01972-004

Kim, J. A., Szatmari, P., Bryson, S. E., Streiner, D. L., & Wilson, F. J. (2000). The prevalence of anxiety and mood problems among children with autism and asperger syndrome. *Autism, 4*, 117–132. doi:10.1177/1362361300004002002

LoBue, V., & DeLoache, J. S. (2008). Detecting the snake in the grass: Attention to fear-relevant stimuli by adults and young children. *Psychological Science, 19*, 284–289. doi:10.1111/j.1467-9280.2008.02081.x

Mathews, A. (1990). Why worry? The cognitive function of anxiety. *Behaviour Research and Therapy, 28*, 455–468. doi:10.1016/0005-7967(90)90132-3

McCabe, K., Melville, J., Rich, D., Strutt, P., Cooper, G., Loughland, C., & ... Campbell, L. (2013). Divergent patterns of social cognition performance in autism and 22q11.2 deletion syndrome (22q11DS). *Journal of Autism and Developmental Disorders,* 1–9. doi:10.1007/s10803-012-1742-2

Mobini, S., Reynolds, S., & Mackintosh, B. (2012). Clinical implications of cognitive bias modification for interpretative biases in social anxiety: An integrative literature review. *Cognitive Therapy and Research, 37*, 173–182. doi: 10.1007/s10608-012-9445-8

Mogg, K., Bradley, B., Millar, N., & White, J. (1995). A follow-up study of cognitive bias in generalized anxiety disorder. *Behaviour Research and Therapy, 33*, 927–935. http://dx.doi.org/10.1016/0005-7967(95)00031-R

Mogg, K., Mathews, A., & Weinman, J. (1989). Selective processing of threat cues in anxiety states: A replication. *Behaviour Research and Therapy, 27*, 317–323. http://dx.doi.org/10.1016/0005-7967(89)90001-6

Moukheiber, A., Rautureau, G., Perez-Diaz, F., Soussignan, R., Dubal, S., Jouvent, R., & Pelissolo, A. (2010). Gaze avoidance in social phobia: Objective measure and correlates. *Behaviour Research and Therapy, 48*, 147–151. Retrieved from http://dx.doi.org/10.1016/j.brat.2009.09.012

Negd, M., Mallan, K. M., & Lipp, O. V. (2011). The role of anxiety and perspective-taking strategy on affective empathic responses. *Behaviour Research and Therapy, 49*, 852–857. doi:10.1016/j.brat.2011.09.008

Nettle, D. (2007). Empathizing and systemizing: What are they, and what do they contribute to our understanding of psychological sex differences? *British Journal of Psychology, 98*, 237–255. doi:10.1348/000712606X117612

Spielberger, C. (1983). *Manual for the state-trait anxiety inventory* (Rev ed.). Palo Alto, CA: Consulting Psychologists Press.

Wheelwright, S., Baron-Cohen, S., Goldenfeld, N., Delaney, J., Fine, D., Smith, R., & ... Weil, L. (2006). Predicting autism spectrum quotient (AQ) from the systemizing quotient-revised (SQ-R) and empathy quotient (EQ). *Brain Research, 1079*, 47–56. doi:10.1016/j.brainres.2006.01.012

Wieser, M. J., Pauli, P., Weyers, P., Alpers, G. W., & Mühlberger, A. (2009). Fear of negative evaluation and the hypervigilance-avoidance hypothesis: An eye-tracking study. *Journal of Neural Transmission, 116*, 717–723. Retrieved from http://dx.doi.org/10.1007/s00702-008-0101-0

Cogent Psychology **(ISSN: 2331-1908) is published by Cogent OA, part of Taylor & Francis Group.**