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Empathising and Systemising in Adults with and without Asperger Syndrome

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An experiment was devised to test the empathising–systemising (E–S) theory of autism. Three groups of participants took part in the study: males with Asperger Syndrome (AS) ($n = 18$), males without AS, ($n = 44$) and females from the general population ($n = 45$). Each participant completed two tasks: one that involved empathising and another that involved systemising. On the empathising task, females scored significantly higher than control males who in turn scored higher than males with AS. Conversely, females scored significantly lower than both male groups on the systemising task, who did not differ significantly from each other. These results are in line with both the E–S theory of autism and the 'extreme male brain' theory of autism. Alternative explanations of the results are also explored, including an interpretation through the idea of open and closed systems.

KEY WORDS: Empathising; systemising; autism; asperger syndrome; theory of mind.

INTRODUCTION

Asperger Syndrome (AS) is a neurodevelopmental condition first described some 50 years ago (Asperger, 1944). Hans Asperger identified in a group of young males a pattern of distinguishing behavioural features including a lack of empathy, difficulty in forming friendships, one–sided conversation, intense interest in specific topics and clumsy physical movement. Asperger's work was largely ignored until about 20 years ago when Lorna Wing drew wider attention to the condition (Wing, 1981). The current diagnostic criteria for AS include social interaction impairments, unusually intense, circumscribed interests and restricted, repetitive and stereotyped patterns of behaviour and interest (ICD-10, 1994). There is a clear similarity between AS and autism (Kanner, 1943). In terms of diagnostic criteria, the key difference is the absence, in AS, of any significant delay in language or cognitive development. For this reason some theorists have argued that AS and autism can be seen as the same condition differing only in terms of associated learning and language difficulties (Schopler, 1985). It makes sense therefore to see the two conditions as being situated on an autism spectrum.

The last 20 years have seen a rapid growth of research into autism spectrum conditions (ASCs). Much of this has involved attempts to discover the defining characteristics of these conditions. Some theorists have conceptualised ASCs as involving cognitive deficits in executive function (Ozonoff, Pennington, & Rogers, 1991; Russell, 1997). Others have focused on an impairment in the ability to use context and integrate information at different levels, the weak central coherence model (Frith, 1989; Happe, 1996). Others still have explored whether ASCs are best characterised as involving a theory of

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mind (ToM) deficit (Baron-Cohen, Leslie, & Frith, 1985). More recently, an approach has emerged from within the ToM paradigm that focuses on empathising and systemising skills (Baron-Cohen, Wheelwright, Lawson, Griffin, & Hill, 2002). Findings of a sex difference in empathising (females performing better) have led theorists to investigate the possibility that ASCs may constitute an extreme version of a pattern of cognitive difference that extends across the entire population (Baron-Cohen, 2002). This idea has become known as the extreme male brain theory of autism (EMB) and is discussed below. The aim of the research presented here is to explore and test further both the empathising–systemising models and the EMB theory.

THE EMPATHISING–SYSTEMISING MODEL

The E–S model proposes there are two psychological dimensions. These have evolved from the concepts of folk psychology and folk physics (Baron-Cohen, 1997). The model also retains the proposed asymmetry of ability present in ASCs hypothesised in the EMB theory of autism.

Empathising is defined as the drive to identify emotions and thoughts in others and to respond to these appropriately (Baron-Cohen, 2002). It is not simply about inferring what someone else is thinking or feeling, though this is an important part of empathising. Rather, it includes an appropriate spontaneous emotional reaction. Empathising provides a way of making sense of other's behaviour and a natural way of responding to others.

Systemising is defined as the drive to analyse and build systems, with the aim of understanding and predicting non-agentive events (Baron-Cohen, 2002). Systems can be technical (e.g., the workings of a machine), natural (e.g., the process of coastal erosion), abstract (e.g., mathematics), motoric (e.g., a guitar playing technique), taxonomic (e.g., a criteria for ordering compact discs) or social (e.g., a taxation system). When confronted with systems such as these we don't analyse them in terms of emotions and mental states. Rather, we examine relationships between components and correlations between events which then allow us to understand any underlying rules that may be relevant. By identifying regularities between the input, operations, and output of a system it becomes possible to predict the behaviour of a system.

Table I. Possible Cognitive Styles

Cognitive style	Description
Balanced	Aptitude in empathising and systemising is at a similar level
Empathising bias	Empathising skills are greater than systemising skills by a small but significant amount
Systemising bias	Systemising skills are greater than empathising skills by a small but significant amount
Extreme empathising bias	Empathising skills are much greater than systemising skills
Extreme systemising bias	Systemising skills are much greater than empathising skills

The concepts of empathising and systemising have been developed in an attempt to address problems and limitations with the previous "folk" categories model. For example, there is some disagreement over how folk-psychology is supposed to operate. According to Dennett it is explained through the idea of intentional strategies underpinned by rules (Dennett, 1987) whereas folk-psychology in the "mindreading" literature is more clearly mentalistic and has a greater tacit, "feel-based" quality. Simultaneously, empathising extends beyond the scope of folk-psychology by including an emotionally reactive dimension. Similarly, while folk-physics only concerns intuitive knowledge about physical bodies, systemising incorporates the wider range of systems outlined above.

Theoretically, a person's aptitude in empathising could be independent of their systemising. Alternatively, the two domains might be weakly or strongly, positively or negatively correlated. The different cognitive biases or styles that arise from these hypothetical permutations are summarised in Table I.

THE EXTREME MALE BRAIN THEORY

Questions concerning cognitive differences between the sexes have been investigated for over 50 years (Halpern, 1992). Research exploring these differences has often focused on certain broad areas of ability, namely verbal, spatial and mathematical reasoning (Kimura, 1999; Richardson, 1997). This has led to certain theorists to refer to a "holy trinity" of sex differences in cognition (Hyde, 1990). Of these, a number are particularly significant here. First, female superiority has been reported in the

areas of social judgement (Argyle & Cook, 1976; Halpern, 1992), accurate decoding of non-verbal communication (Hall, 1985), sensitivity to emotional expression (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997) and some aspects of empathy (Eisenberg & Lennon, 1983). In terms more specific to theory of mind, similar sex differences have been found in the ability of adults to mindread (Baron-Cohen & Hammer, 1997). Female superiority has also been found with children in such areas as predicting and explaining false beliefs (Cutting & Dunn, 1999), assessing the motives and feelings of characters in a story (Bosacki & Astington, 1999), distinguishing between the appearance and reality of emotion (Banerjee, 1997), and false belief development (Charman, Ruffman, & Clements, 2002). One study has even identified a female preference for social stimuli just 24 hours after birth (Connellan, Baron-Cohen, Wheelwright, Ba'tki, & Ahluwalia, 2001). Second, male superiority has been reported in tasks involving mathematical reasoning (Kimura, 1999), mental rotation (Halpern & Wright, 1996; Voyer, Voyer, & Bryden, 1995), mechanical reasoning (Stanley, Benbow, Brody, Dauber, & Lupkowski, 1991), and spatial visualisation (Kimura, 1999). In other words, male superiority has been found on tasks that involve systemising skills and female superiority has been found on tasks that draw on empathising skills. In terms of the different styles summarised in Table I, males on average can be said to have a *systemising* cognitive style, and females to have an *empathising* cognitive style (Baron-Cohen, 2002).[3]

Due to the sex ratio in AS (10:1 male:female (Gillberg, 1989)), certain theorists have started to examine the relationship between having AS and being male (Baron-Cohen & Hammer, 1997). The question has been raised as to whether ASCs should be regarded as an extreme form of the systemising style or male brain type. This idea of an asymmetry of ability that gradually becomes more extreme fits well both with Asperger's initial description of the condition as an extreme variant of male intelligence (Asperger, 1944). It is also in line with the high level of variability, in terms of severity, that exists within the AS population. One corollary of this suggestion is the possible existence of a borderline AS group. These individuals may posses the systemising or even the extreme systemising cognitive profile but their empathising skills might be just high enough to avoid many of the social difficulties typically associated with ASCs.

If the E–S model is combined with the idea of cognitive styles as summarised in Table I we arrive at a model that is summarised graphically in Fig. 1.

This model represents one view of how empathising and systemising may be associated. As this model suggests, it is possible for a person's performance to be balanced at all levels of skill. For example, someone may be highly skilled at both empathising and systemising, or they might have very little ability in either domain. In both cases however they would be balanced in terms of cognitive style (Type B). Alternatively, there may be a discrepancy between the level of a person's empathising and systemising abilities. The issue of how large this discrepancy should be to qualify as being biased is, of course, completely arbitrary. For this reason we have borrowed from standard statistical conventions to sketch our initial definitions. As a result, in this

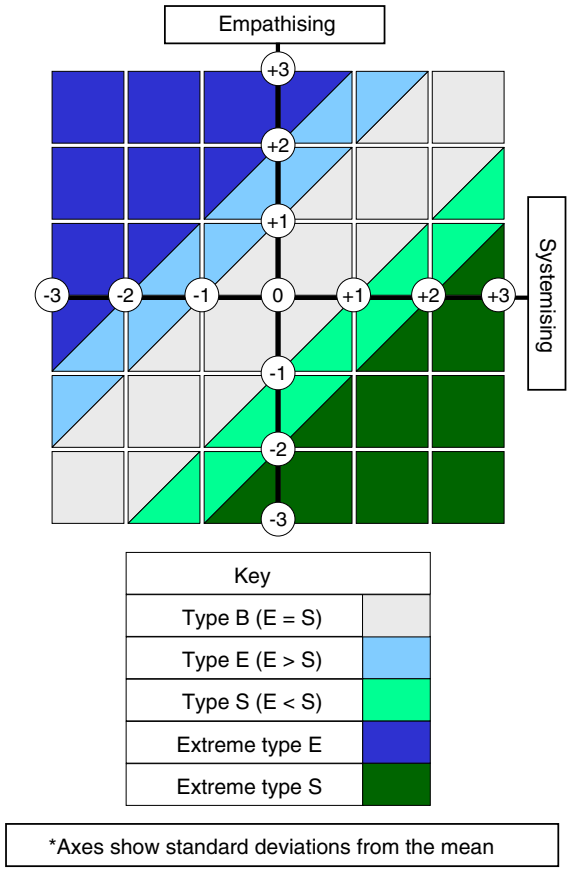

Fig. 1. Empathising and systemising associations.

[3] It is worth emphsising that this model does not make any claim about individuals, only about the average male and female.

model Type E is defined as having empathising abilities that are between one and two standard deviations higher than systemising skills. The Extreme Type E style is defined as empathising abilities being more than two standard deviations higher than systemising abilities. The same sizes of discrepancy in favour of systemising skills are used to define Type S and Extreme Type S styles. This model assumes that empathising and systemising are normally distributed across the population and independent of each other. These assumptions may need to be revised as more data become available. The key issue in this model is the possible existence of asymmetries of ability.

THE EXPERIMENTS

In order to test the model in Fig. 1 and further explore the EMB theory of ASCs, empathising and systemising abilities were examined in three population groups: males with AS, males without AS, and females without AS. Females with AS were not possible to recruit in sufficient numbers. It was hypothesised that on the empathising measure the females would perform better than the non-AS-males, who in turn would perform better than the males with AS. On the systemising task it was unclear exactly what we would find. If empathising and systemising were to show symmetrically opposite patterns, then the non-AS-males would perform better than the females but worse than the males with AS. However, previous literature suggests that while both male groups would perform better than the female group the AS group would not necessarily perform better than the non-AS-males.

Although systemising can be applied to a range of possible content areas, understanding rules concerned with causality in physical systems is a good example as these rules make it possible to predict outcomes. For example, in playing snooker or pool, some basic, intuitive understanding of the rules of inertia and trigonometry is needed to predict correctly where to send the cue ball in order to achieve the desired result. One previous test found that children with ASCs were superior to controls in such folk physics (Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001) and results from a recent questionnaire (the Systemising Quotient or SQ) also found that adults with ASCs have a stronger drive to systemise (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003). The experiment below is the first to examine systemising performance, in relation to understanding physical systems in adults with ASCs. The Physical Prediction Questionnaire (PPQ) involves understanding physical systems but was designed to be challenging enough so as to reveal individual differences. It comprises 40 items taken from the Vincent Mechanical Diagrams Test (NIIP, n.d.) in which participants study mechanical diagrams and predict the movement of two levers or bobs in response to the movement of a connected lever. The test was in multiple-choice format where participants had to choose one of five possible outcomes. The likelihood of choosing the correct outcome by chance is therefore $p = .2$ on any given item.

Like systemising, empathising can be applied to a number of possible content areas. However, to balance the first test, we developed a measure that evaluated people's understandings of *social* outcomes. One approach to this problem in the past has been to examine children's ability to identify "faux-pas" in a conversation and ask if anyone said anything they should not have said (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999). Although an adult version of this has been used with neurological patients (Stone, Baron-Cohen, & Knight, 1998) a much more sophisticated test had to be developed, containing more discreet *faux pas*, in order to examine subtle sex differences in normal adults and to avoid ceiling effects. The test developed was the Social Stories Questionnaire (SSQ).

The SSQ contains 10 short stories and involves utterances made by one character that could upset another character in the story. Each story is divided into three sections making 30 sections overall with at least four utterances in each section. Ten of the sections contained a blatant target utterance, 10 contained a subtle target utterance and 10 contained no target utterance. Each section contained several questions for the participant to answer. First, they had to judge whether the section contained a potentially upsetting utterance and where relevant underline the text in question (the probability of identifying a target by chance alone is therefore $p = .5 \times .25 = .125$). Second, they had to judge whether this utterance (if present) would have upset the character concerned. Each of the 10 stories also included a control question and only those participants who answered all of these correctly were included in the analysis. Participants were scored according to the number of targets correctly identified. The erroneous identification of non-targets was

not included in this paper although it is worth mentioning that no participants consistently answered yes to every question. Decisions concerning whether specific utterances were blatant or subtle in nature were made by a mixed sex panel of six judges, and only those in which there was unanimous agreement were included.

METHOD

Participants

A total of 107 adult participants (over the age of 18 years) took part in the study: Group 1 contained 18 males with AS (AS-males) diagnosed according to internationally recognised criteria (APA, 1994; ICD-10, 1994). Group 2 contained 44 males without AS (non-AS-males) and group 3 contained 45 females also without AS (non-AS-females). Age and IQ information is summarised in Table II.

IQ in Group 1 was measured using either the WASI (Wechsler, 1999) or the short form WAIS-R (Wechsler, 1997) and in the other groups by the NART (Nelson & Willison, 1991). Although the use of different IQ scales is not ideal it has been argued that the two tests are highly comparable (Crawford, Stewart, Parker, Besson, & DeLacy, 1989). These test results serve as an index that all had an IQ in the normal range.

Group 1 consisted of individuals on a research database at the Autism Research Centre in Cambridge University. They came from varied socio-economic and educational backgrounds. Groups 2 and 3 were respondents to a newspaper advertisement requesting "volunteers for research into thinking styles". The groups did not differ in terms of socio-economic and educational background.

Procedure

Participants were sent the two test booklets by post, along with a covering letter. As there was no way to control task order, they were asked to complete the two booklets in which ever order they preferred. Participants were also instructed to take as long as was needed and to ensure that they were not helped in any way by anyone else. Completed booklets were then returned in person at which time IQ measurements were taken.

Analysis

Results from the SSQ were distributed in an approximately Gaussian way. The PPQ results however, showed a bi-modal distribution that appeared to be caused by the differences between male and female scores. As the skewness and kurtosis statistics both fell within the standard "acceptable range" (−2 to +2), no transformations of the data were carried out.

RESULTS

In response to the slight deviation from normality and the low numbers in the AS group, the results were first examined with a Mann–Whitney test. On the SSQ the non-AS-females scored significantly higher than non-AS-males ($z = -2.4$, $p < .02$) who scored higher than the AS-males ($z = -3.6$, $p < .002$). On the PPQ the non-AS-females scored significantly lower than their nearest group, the non-AS males ($z = -4.7$, $p < .001$) but the AS-males did not score significantly higher than the non-AS-males ($z = -.161$, $p < .87$). The SSQ and PPQ scores were then examined using a multivariate analysis of covariance (MANCOVA) and post hoc test (Tukey HSD). In order to examine any possible role of age and IQ these variables were entered as covariates but were found to be non-significant (age, $p > .171$ and IQ, $p > .918$). These data were also examined to see whether scores on the two tests were correlated but no significant correlation was found overall or within each group (all groups $r = .046$, $p > .63$, females $r = .136$, $p > .37$, non-AS males $r = .174$, $p > .25$, AS males $r = .33$, $p > .19$). The results from the tests are summarised in Table III.

Table II. Summary of Participant Information

	n	Mean age	*SD*	Mean *IQ*	*SD*	Range
AS-males	18	36	11.26	117	6.68	47
Non-AS-males	44	30	14.20	113	10.28	36
Non-AS-females	45	28	13.06	112	8.31	36

Table III. SSQ and PPQ Means and Standard Deviations (*SD*)

	PPQ		SSQ	
	Mean	*SD*	Mean	*SD*
AS-males	28.18	11.78	9.22	3.08
Non-AS-males	28.00	10.86	12.02	2.98
Non-AS-females	16.18	9.30	13.62	2.37

The SSQ—A Measure of Empathising

Results from the SSQ are shown graphically in Fig. 2. Significant score differences were found between the three groups ($F = 12.21$, df2, $p < .001$). Examination with *post hoc* tests indicated significant differences between each of the groups. AS-males performed significantly worse than non-AS-males ($p < .016$) who in turn performed worse than non-AS-females ($p < .017$).

The Physical Prediction Questionnaire—A Measure of Systemising

Results from the PPQ are shown in Fig. 3. Once again significant differences were found between the three groups ($F = 15.31$, df2, $p < .001$). Examination with *post hoc* tests indicated a significant difference between only two of the groups. Non-AS-females performed significantly worse than non-AS-males ($p < .001$) and AS-males ($p < .006$). The males groups did not differ significantly from each other ($p > .853$).

If the SSQ and PPQ results for all groups are combined and standardised, it becomes possible to examine whether people's scores are associated with respect to the model illustrated in Fig. 1. In other words, it becomes possible to look at what percentage of each group in the sample have a Type B (balanced) cognitive style, a Type E (empathising) cognitive style and so on. The resulting distribution (summarised in Table IV), is statistically significant (Fisher's exact = 40.33, $p < .001$) suggesting a significant association between group and cognitive style. An analysis of adjusted residual suggests that all cells in the analysis are contributing significantly towards the overall effect. In other words, the effect is not limited to just one group or just one cognitive style.

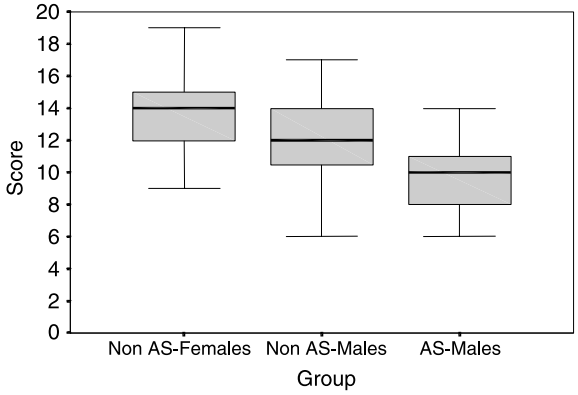

Fig. 2. Box and whisker plots showing results for the three groups on the SSQ (empathising).

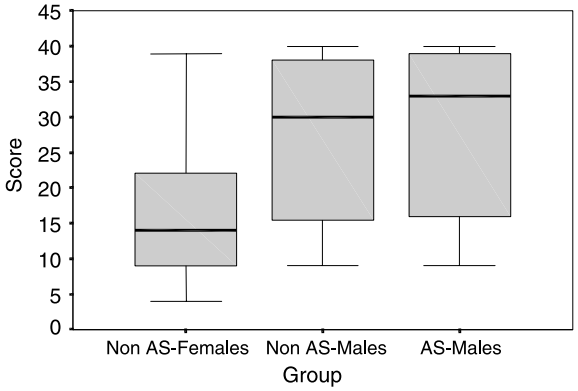

Fig. 3. Box and whisker plots showing results for the three groups on the PPQ (systemising).

Table IV. Table Showing the Distribution of Each Group Across the Five Cognitive Styles Discussed in Fig. 1

	Type B (%)	Type S (%)	Type E (%)	Extreme Type S (%)	Extreme Type E (%)	Total (%)
AS males	35	35	0	30	0	100
Non-AS males	55	25	9	11	0	100
Non-AS females	40	7	42	0	11	100

DISCUSSION

This study employed two measures to test predictions from the E–S and EMB models. On the empathising task (SSQ), non-AS-females, on average performed better than non-AS-males who in turn performed better than AS-males. On the

systemising task (PPQ) the female group, on average, performed worse than both of the male groups. The two male groups did not differ significantly from each other on this task. These results support the idea that people with autism spectrum conditions demonstrate an empathising deficit whilst having a level of systemising skills that is, at least, in the normal range. They are also consistent with the EMB theory of autism (Baron-Cohen, 1999).

The distribution summarised in Table IV suggests that a bias, towards either empathising or systemising exists not only in the AS group, but also in the general population with 55% of the sample falling into one of the non-balanced groups. The distribution is also congruent with the possibility that distinctive empathising and systemising styles may be associated with specific population groups. For example, the ASCs group aside, Type E is more often associated with females (42% vs. 9% f:m) and Type S is more often associated with males (7% vs. 25% f:m). Likewise, 11% of females fell into the extreme Type E compared with none from the other groups. However, the absence of significant correlation between SSQ and PPQ scores both overall and within each group suggests that empathising and systemising are independent abilities. In other words, as a person's empathising ability increases, their systemising ability does not necessarily decrease. Other research has found significant (inverse) correlation between empathising type tasks and systemising type tasks (Baron-Cohen *et al*., 2003; Jarrold, Butler, Cottington, & Jimenez, 2000). The apparent contradiction between these studies might be due to small sample size and may also suggest that other factors are involved.

Alternative Explanations of the Results

Executive Dysfunction

Within this framework the relatively poor performance of the ASC group on the SSQ (empathising) could be explicable in terms of demands placed on working memory and general attention. Simultaneously, higher performance on the PPQ (systemising) might be explained by the greater overall simplicity of the task. However, no time limits were placed on the participants and everyone was able to refer to "hard" (paper) copies of the tasks. As a result, demands on working memory were minimal. Furthermore, the idea that executive demands would cause decreased performance when being asked about feelings (e.g., how will the utterance affect x) but not about factual detail (e.g., at what street number was the dinner party being held) seems problematic. It is also unclear whether the PPQ really does involve fewer executive demands than the SSQ. In some of the more complex diagrams in the PPQ, the interactions of several cogs and pulleys had to be considered concurrently. The Executive Dysfunction model therefore seems unable to account for the specific pattern of results found.

Weak Central Coherence

It has been suggested that theory of mind ability may be inversely associated with performance on central coherence tasks (Jarrold, Butler, Cottington, & Jimenez, 2000). The central coherence framework therefore seems to offer a promising explanation of the results. This framework would explain the findings of the SSQ in terms of the distinction between the local and global processing. While an utterance said to person x in context x would cause no offence, it may do so to person y in context y, or even person x in context y. In other words, the lower scores on the SSQ result from ignoring the wider context. Success with the control questions might be said to occur because they only require an analysis of surface meaning rather than global context (e.g., the street number of the party doesn't alter according to who is in the room etc.). The results from the PPQ are however slightly more problematic for this model. A network of levers and pulleys might appear to be a straightforward local processing task. However, to predict a specific outcome in terms of lever movements, a person must achieve a wider contextual view of the entire system. While attention to detail would inform about localised outcomes, completing the PPQ requires drawing these local outcomes together holistically. Despite this, the mean score of the ASC group on the PPQ is higher than the other groups. Thus, the Central Coherence model also cannot easily account for the specific pattern of results.

Levels of Difficulty

One possible explanation of why people with ASCs score lower on the SSQ is simply that it is a harder task than the PPQ. However, it seems problematic to argue that either task is significantly more challenging than the other. If it were simply a

matter of difficulty, why is the female group scoring lower than the other two groups on the *easi*er of the tasks? Rather than one being quantitatively harder than the other, the two tasks seem to require qualitatively different approaches.

Socialization

Many theorists have shown that male and female infants are socialised differently in a variety of ways. Some have suggested that girls are raised to be more caring and sensitive towards the feelings of others than boys are (Gilligan, 1982). Likewise, educational experience and the expectations of parents and teachers could result in males being better equipped to solve certain types of problems like those in the PPQ. Thus, the pattern of results across the three groups could simply be reflecting differential gender socialization. While socialization undoubtedly has a significant influence on people's abilities, some studies suggest there is more to these differences than socialization. Differential attention towards social and non-social stimuli has been found among males and female infants just 24 hours after birth (Connellan, *et al*., 2001). The implication from that study is that females, on average, possess a "hard-wired" preference for social phenomena. In a similar vein, levels of eye contact, a possible early component of empathising, have been shown to be inversely correlated with levels of foetal testosterone (Lutchmaya, Baron-Cohen, & Raggett, 2002). This implies that biological factors may also contribute to a female superiority in empathising.

Open and Closed Systems

Another possibility is that empathising and systemising might be specific abilities that have developed in response to qualitatively different kinds of phenomena that exist in our world. According to Bhaskar (Bhaskar, 1978) our worlds contain different combinations of object and context that in turn give rise to qualitatively different kinds of event: *open* and *closed* systems. We attempt to understand these events and phenomena by considering a host of issues such as properties, relationships with other phenomena and so on. According to deductivism an event is explained when a universal law is formulated from which the event can be deduced. The basic form of this law is "if x then y", in other words, whenever a given event x occurs, event y will *always* follow. However, Bhaskar argues that this kind of conjunction of events only occurs when a *closure* is achieved; isolating all of the mechanisms involved in that event and creating a closed system. For a system to become closed, two different types of closure condition must be achieved: extrinsic and intrinsic. Extrinsic closure refers to the isolation of the target phenomena from any external confounding mechanism that could influence outcomes. Intrinsic closure concerns the internal structure of the target phenomenon. That is, despite an identical context and extrinsic closure, whether there is anything that could give rise to different outcomes on subsequent occasions, e.g., people making differing choices or having different desires. An open system is therefore any in which it is not possible to obtain a closure. It may be that empathising and systemising are human adaptations to a crucial environmental distinction. When appropriate, we systemise, apply rules, and think in terms of event regularities. In other situations, we empathise, demonstrate greater flexibility, and think in terms of contingencies. Current research is examining whether the open–closed distinction extends the empathising–systemising theory, or whether it actually represents an alternative model of understanding ASCs altogether (Lawson, 2003).

In sum, we have reported two tasks which show that, as predicted, males on average have better systemising skills than females, females on average have better empathising skills than males, and that people with ASCs have an extreme of the male style (lower empathising alongside intact or superior systemising). These results are compatible with the E–S and EMB models. We have also discussed these results with reference to several alternative models most of which seem unable to explain the findings fully. Future studies will need to test this pattern of results across a larger sample, as well as across a wider set of tests. Future work also needs to focus on females with ASCs and explore their empathising and systemising abilities.

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