



## Empathizing and systemizing: What are they, and what do they contribute to our understanding of psychological sex differences?

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Empathizing and systemizing have recently been put forward as two important individual-difference dimensions, whose different mean levels in men and women are argued to account for many psychological sex differences. This paper presents a series of studies designed to investigate the reliability and validity of the empathizing and systemizing quotients (EQ & SQ), to relate them to existing personality constructs, and to replicate reported sex and sexual orientation-related differences. Correlations with interests and social behaviour suggest the two measures are valid. However, empathizing appears essentially equivalent to agreeableness in the five-factor model of personality. Systemizing cannot be reduced to established personality dimensions, though it is moderately correlated with conscientiousness and openness. Men have higher levels of systemizing than women, and non-heterosexual women higher than heterosexuals. However, no differences were found between heterosexual and non-heterosexual men. Although systemizing and empathizing account for a number of observed sex differences, there are others they do not explain.

Simon Baron-Cohen and colleagues have recently proposed an 'empathizing-systemizing' theory of psychological sex differences (Baron-Cohen, 2003; Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003; Baron-Cohen & Wheelwright, 2004). Empathizing and systemizing are two individual-difference dimensions that can be measured by self-report questionnaire, the former being defined as the drive to identify another person's emotions and thoughts and the latter as the drive to analyse or construct systematic relationships in non-social domains. Both sexes show a range of variation on both dimensions, but on average women are higher than men in empathizing, and men higher than women in systemizing, as measured by the empathy quotient (EQ) and systemizing quotient (SQ), respectively (Baron-Cohen *et al.*, 2003; Baron-Cohen & Wheelwright, 2004).

The intellectual origins of the empathizing and systemizing dimensions lie in research on autism spectrum disorders (Baron-Cohen, Leslie, & Frith, 1985;

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Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). In such conditions, social reasoning and theory-of-mind are strongly impaired, but there can be islands of ability in non-social domains. Autism spectrum disorders are much more common amongst men than women, and autistic traits are common amongst mathematicians, scientists, engineers and their families (Baron-Cohen *et al.*, 1998, 2001). Such evidence has led Baron-Cohen and colleagues to suggest that high-functioning autism is simply the high-systemizing, low-empathizing extreme of the population distribution for the two traits.

This paper presents a series of investigations of the empathizing and systemizing dimensions, using the empathizing quotients (EQ) and systemizing quotients (SQ) questionnaires (Baron-Cohen *et al.*, 2003). The purposes are several-fold. First, as empathizing and systemizing are such new concepts, they have not been extensively assessed for reliability and validity. The current studies therefore seek to replicate the sex differences observed by Baron-Cohen *et al.*, and moreover to examine the validity of the dimensions by them relating to patterns of interests and social behaviour which their formulation suggests they should predict.

Second, empathizing and systemizing are presented by Baron-Cohen *et al.* without reference to well-established notions within differential psychology, such as the Big Five personality factors. The Big Five framework is the most widely used and validated general framework in personality psychology, and has been shown to capture the majority of the variation recorded by a large number of alternative personality taxonomies (Costa & McCrae, 1992a, 1992b; De Raad & Perugini, 2002; Saucier & Goldberg, 1998). Given that there are sex differences in several of the big five (Costa, Terraciano, & McCrae, 2001), it remains to be established that empathizing and systemizing are measuring something new. The second aim of this paper is therefore to relate empathizing and systemizing to the existing constructs of the five-factor model.

Third, in his book *The essential difference*, Baron-Cohen argues that the empathizing-systemizing model has the explanatory power to explain most if not all psychological sex differences (Baron-Cohen, 2003). Many psychological sex differences have been documented and an investigation of all of them would be beyond the scope of any single paper. This paper therefore focuses on one domain – the domain of interests – where clear sex differences have been observed, and can plausibly be related to sex-typed patterns of cognition and affect (Twenge, 1999). I investigate the extent to which the observed sex differences can be explained by differences in empathizing and systemizing. This is a strong test of whether empathizing and systemizing really constitute *the* essential difference between men and women or merely one difference amongst many.

Finally, homosexual males have been found to have higher levels of empathy than heterosexual males by two studies (Salais & Fischer, 1995; Sargeant, Dickins, Davies, & Griffiths, 2006), the second of which uses Baron-Cohen's EQ scale as its empathy measure. The interpretation given for this difference is that, first, empathizing and systemizing are organized by sex-patterned developmental factors, principally exposure to prenatal androgens; and second, that exposure to prenatal androgens is sex-atypical in those who will go on to develop a same-sex sexual preference. There is a fair amount of indirect evidence for the first proposition. Individuals with autism spectrum disorders have digit ratio patterns suggestive of elevated levels of prenatal testosterone (Manning, Baron-Cohen, Wheelwright, & Sanders, 2001). Moreover, a recent study by the same group measured prenatal testosterone levels by amniocentesis and correlated

them with measures of social communication and restricted interests when the children were 4 years old (Knickmeyer, Baron-Cohen, Raggatt, & Taylor, 2005). Foetal testosterone levels were positively associated with restricted interests, which is a possible childhood marker for systemizing and autistic traits, and negatively associated with social communication abilities, which are a possible indicator of empathizing. As for the second proposition, it too is supported by a large quantity of mainly indirect evidence (see Rahman & Wilson, 2003, for a review). A further aim of the present research was therefore to seek to replicate the homosexual-male advantage in empathizing found by Sargeant *et al.* (2006), and moreover, to extend the analysis to cover systemizing, and also homosexual females, neither of which are included in their study.

The three studies reported herein investigate the issues outlined in the foregoing paragraphs. Study 1 relates the EQ and SQ to the dimensions of the five-factor model of personality. Study 2 relates the EQ and SQ to patterns of interests and social behaviour, both as a validity check for the measures and to examine whether observed sex differences in interests are reducible to differences in empathizing and systemizing. Finally, Study 3 looks at the EQ, SQ, interests and social behaviour in groups of non-heterosexuals as opposed to heterosexuals. All of the research reported here uses data gathered via the internet. Previous personality studies have shown that data gathered in this way can have satisfactory reliability and validity (Buchanan, Johnson, & Goldberg, 2005), and that internet and pencil-and-paper administrations of the same questionnaires produce very similar norms and factor structures (Gosling, Vazire, Srivastava, & John, 2004; Salgado & Moscoso, 2003).

## STUDY 1

Empathizing is described by Baron-Cohen *et al.* as 'the drive to identify another person's emotions and thoughts, and to respond with the appropriate emotion' (2003, p. 361). There are some potentially similar constructs within personality theory. The dimension of agreeableness in the five-factor model is a continuum of prosociality, with facet descriptors including trust, altruism and tender-mindedness (Costa & McCrae, 1992b). Agreeableness is higher in women than men (Budaev, 1999; Costa *et al.*, 2001), just as the EQ is. Several of the items from the IPIP five-factor inventory agreeableness scale (Goldberg, 1999) closely resemble items found in the EQ (e.g. agreeableness: 'Am interested in other people's problems', 'Feel others' emotions', EQ: 'Friends usually talk to me about their problems as they say that I am very understanding', 'I tend to get emotionally involved with a friend's problem').

Extraversion could also be related to empathizing. Though the extraversion dimension may ultimately be explained in terms of sensitivity to reward (Depue & Collins, 1999), it has a facet to do with sociality and the enjoyment of social interactions (Costa & McCrae, 1992b). Thus we can hypothesize that the empathizing quotient will be positively correlated with five-factor agreeableness and extraversion. Some support for this hypothesis came from an earlier study of professional actors, who completed a battery of psychometric instruments include the EQ, SQ and a five-factor personality inventory (Nettle, 2006). Agreeableness and extraversion were indeed correlated positively and significant with EQ. However, actors, who as a group are high in agreeableness and extraversion, represent a restriction of sampling range, and thus the correlations need replicating with a general population sample.

Systemizing is defined as ‘the drive to analyse the variables in a system, to derive the underlying rules that govern the behaviour of a system’ (*sic*, Baron-Cohen *et al.*, 2003, p. 361). There is no immediately obvious candidate counterpart of such a tendency in the five-factor model. Openness has been related to intellectual interests and interest in abstraction, whereas conscientiousness has a desire for order as one of its components. Thus, it is possible that there will be positive relationships between the SQ and five-factor openness and conscientiousness, though examination of the items in the SQ and five-factor model suggest a weaker or less obvious relationship than for EQ. The purpose of Study 1 was to examine the relationships between EQ and SQ and the five factors of personality, with a view not just to testing the hypotheses outlined above, but also discovering how much unique variance the EQ and SQ capture.

## Methods

An online study was published on the internet, containing the SQ and EQ questionnaires (Baron-Cohen *et al.*, 2003). For the present purposes, the non-scored filler items were omitted and the items of the two scales were intermingled. This presentation has been used in a previous study with satisfactory results (Nettle, 2006). The second section of the questionnaire contained the 50-item IPIP five-factor personality scales (Goldberg, 1999). These scales are publicly available for research use, and have been shown to exhibit internal consistency, appropriate factor structure, and high correlations with the reference five-factor instrument, the NEO-PI (Gow, Whiteman, Pattie, & Deary, 2005). Basic demographic information was also collected.

The questionnaire was set up so that non-response could be distinguished from selecting the first response option. Multiple submissions from the same IP address were deleted, as were responses that did not complete all items on the SQ and EQ. However, a small number of responses with one or two incomplete items in the personality scales have been retained, leading to up to 10 missing values for the five factor dimensions.

Participants were recruited through online advertising on a large number of websites across the USA. All the websites were newspapers or community information pages aimed at residents of particular towns or cities without specialism as regards age-group or any other special characteristic or interest. Advertisements were carried in ‘what’s on’, voluntary activities, or community information sections. In addition, a few participants found the study through general internet searches. The sample contains 277 individuals (104 male, 173 female), with a mean age of 31.75 years (standard deviation 10.31 years). Of the participants, 258 were based in North America, 10 in Europe, and nine in other locations.

## Results

Table 1 shows the sample size, descriptive statistics, and Cronbach’s  $\alpha$  for the SQ, EQ and five personality dimensions. Scale reliability was excellent in all cases. Significant sex differences (Table 2) were found in the EQ, agreeableness, and neuroticism (women higher), and the SQ (men higher). The EQ and SQ were weakly negatively correlated with each other ( $r = -.13$ ,  $df = 276$ ,  $p < .05$ ).

Correlations of SQ and EQ with the five personality dimensions are shown in Table 3. EQ is very strongly correlated with agreeableness ( $r = .75$ ,  $df = 266$ ,  $p < .01$ ; Figure 1), and less strongly so with extraversion ( $r = .37$ ,  $df = 270$ ,  $p < .01$ ). As agreeableness

**Table 1.** Descriptive statistics and Cronbach's  $\alpha$  for the SQ, EQ and five-factor personality dimensions (Study 1)

	N	Mean	SD	$\alpha$
SQ	277	31.29	12.92	.88
EQ	277	45.34	12.90	.88
Extraversion	271	31.57	9.67	.92
Agreeableness	267	40.42	6.97	.87
Conscientiousness	267	34.24	7.17	.81
Neuroticism	272	30.86	8.93	.89
Openness	271	40.71	5.34	.76

**Table 2.** Comparison by sex for the SQ, EQ and five personality dimensions. Where difference is significant, Cohen's  $d$  (absolute value) is shown

	Men		Women		$d$
	Mean (SD)		Mean (SD)		
SQ	34.74 (12.29)		29.22 (12.89)		.44*
EQ	40.47 (12.93)		48.26 (12.01)		.63*
Extraversion	34.74 (9.02)		29.22 (9.98)		<i>ns</i>
Agreeableness	37.81 (6.86)		41.98 (6.57)		.60*
Conscientiousness	34.44 (6.74)		34.13 (7.44)		<i>ns</i>
Neuroticism	28.50 (8.38)		32.30 (8.97)		.44*
Openness	40.78 (5.19)		40.67 (5.43)		<i>ns</i>

\* $p < .01$ .

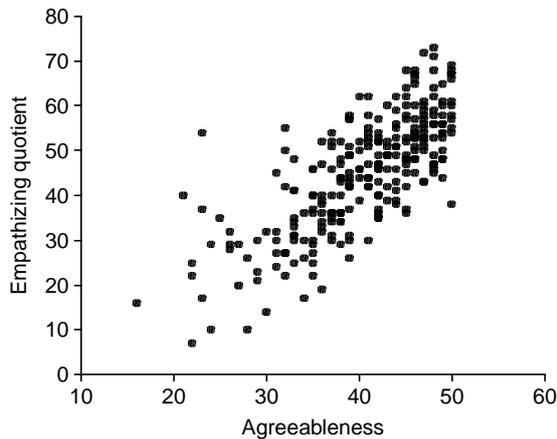
**Table 3.** Correlations between the SQ, EQ and the five personality factors, for the whole sample, and the two sexes separately

	Whole sample		Men		Women	
	SQ	EQ	SQ	EQ	SQ	EQ
Extraversion	-.01	.37*	.19	.33*	-.08	.37*
Agreeableness	-.11	.75*	.00	.74*	-.09	.71*
Conscientiousness	.30*	.06	.42*	.16	.24*	.01
Neuroticism	-.19*	.02	-.11	-.27*	-.18†	.10
Openness	.37*	.09	.18	.22†	.48*	.03

\* $p < .01$ ; † $p < .05$ .

and extraversion are correlated with each other ( $r = .37$ ,  $df = 261$ ,  $p < .01$ ), the two relationships may be a consequence of the same covariance, and indeed, in a partial correlation with agreeableness controlled for, the association between EQ and extraversion is reduced in strength, though still significant ( $r = .15$ ,  $df = 259$ ,  $p < .05$ ).

SQ is moderately positively correlated with conscientiousness ( $r = .30$ ,  $df = 266$ ,  $p < .01$ ) and openness ( $r = .37$ ,  $df = 270$ ,  $p < .01$ ), and moderately negatively correlated with neuroticism ( $r = -.19$ ,  $df = 270$ ,  $p < .01$ ). There are no significant



**Figure 1.** Scatterplot of empathizing quotient against agreeableness score (Study I).

correlations amongst conscientiousness, openness and neuroticism, and so their associations with SQ are independent.

Some of these correlations may be an artefact of comparing across sexes, given that there are known sex differences in the EQ and SQ, and also in several personality dimensions. The correlations were therefore repeated in the two sexes separately (Table 3). The correlations between EQ and agreeableness, and EQ and extraversion, hold essentially identically in each sex as they do in the overall sample (this is also true of the partial correlation between EQ and extraversion controlling for agreeableness). Similarly, the correlations between SQ and conscientiousness, and SQ and openness, are found in both sexes separately. For neuroticism, there is less consistency across the sexes, since it is correlated negatively with SQ in the women and the sample overall, but negatively with EQ in the men.

To determine the amount of variance in EQ and SQ captured by the Big Five, multiple linear regressions were run with EQ and SQ as dependent variables and the five personality factors as predictors. The model with all five factors entered accounted for 57.5% of variation in the EQ ( $F(5, 240) = 67.31, p < .001$ ). The two predictors whose weights differed significantly from zero at  $p < .05$  were agreeableness ( $\beta = .71$ ) and extraversion ( $\beta = .12$ ). For SQ, the regression with the five factors as predictors accounted for 24.7% of the variation ( $F(5, 240) = 17.69, p < .001$ ). The predictors differing significantly from zero ( $p < .05$ ) in this regression were openness ( $\beta = .37$ ), conscientiousness ( $\beta = .29$ ), neuroticism ( $\beta = -.16$ ) and agreeableness ( $\beta = -.13$ ).

## Discussion

The sex differences in SQ and EQ found by Baron-Cohen and colleagues were also found here and were similar in magnitude (EQ: Baron-Cohen *et al.*, 2003; Cohen's  $d = .76$ , here,  $d = .63$ ; SQ: Baron-Cohen *et al.*, 2003,  $d = .59$ ; here,  $d = .44$ ). Means for the SQ in the present study were around half a standard deviation higher here than in Baron-Cohen *et al.* (men: 34.74 vs. 30.3; women: 29.22 vs. 24.1). This may reflect the effects of internet sampling, which will attract those interested in technology, or differences between the British and US population. Means for the EQ were similar in the two studies.

The EQ was, as predicted, correlated with the personality dimension agreeableness. The correlation is found identically in both sexes, and is so strong (Figure 1) that EQ and

agreeableness should basically be considered as measures of the same trait. However, there is a small amount of extra variance in EQ captured by the personality dimension of extraversion. This is also as predicted, since extraversion has a facet of sociality. Positive correlations between EQ and agreeableness and extraversion were also found in the earlier study of professional actors (Nettle, 2006), but the correlations are stronger here. This may be due to the fact that the actors represent a restriction of range compared to the general population.

Most of the variation in EQ was explained by agreeableness. The SQ is less obviously explicable within the five-factor framework. It is moderately positively correlated with openness. Openness has been shown to be positively related to intelligence (Moutafi, Furnham, & Crump, 2003), and so it is possible the SQ may be capturing some aspect of intelligence rather than personality. However, openness is most consistently related to verbal intelligence (Moutafi, Furnham, & Paltiel, 2005), whereas male advantage is more often evident in non-verbal (particularly spatial) tasks (Kimura, 1999). Moreover, intelligence scores have generally been found to be negatively related to conscientiousness (Moutafi *et al.*, 2005), whereas the SQ has a moderate positive association. The relationship between neuroticism and SQ is weaker, and inconsistent in the two sexes.

One of the most consistently observed sex differences in personality, namely higher agreeableness in women (Costa *et al.*, 2001), can thus be seen as essentially equivalent to the empathizing-systemizing model's female empathizing advantage. The other recurrent sex difference in personality, elevated neuroticism in women, is not captured by the empathizing-systemizing framework (see General discussion).

Study 1 shows that EQ can be fitted fairly easily into the prevailing constructs of personality psychology. This does not of course mean that the development of the EQ model has not been useful. This is because Baron-Cohen *et al.* (2003) attribute the origins of empathizing to sexually-dimorphic cognitive abilities in domains such as theory-of-mind. Personality differences, by contrast, are usually explained in terms of affective systems. Though female advantage is already documented on many socially related cognitive abilities, such as 'mind-reading' accuracy (Thomas & Fletcher, 2003), higher-order theory-of-mind (Kinderman, Dunbar, & Bentall, 1998), and facial emotion processing (McClure, 2000), the link between these abilities and equally well-documented sex differences in agreeableness has apparently not been made.

The place of SQ within the conventional constructs of individual differences is less clear. Though it is associated with some personality factors, it has abundant unique variation. It may be that it is more fruitfully compared to those aspects of non-verbal intelligence that tend to show a male advantage (Kimura, 1999). This is hypothesis that again merits further exploration.

## STUDY 2

Study 2 was an investigation of the relationships of SQ and EQ to patterns of interests and social behaviour. To recap, interests and social behaviour were chosen for two reasons. First, the formulation of EQ and SQ suggests that they should relate to aspects of interpersonal relationships, and interests in the non-social world, respectively. Thus, Study 2 is partly a face validity test for the scales. Second, sex differences have previously been found, in interests in particular, with a greater male interest in mechanical and technological domains, and a greater female interest in aesthetic domains and

socially based activities (Twenge, 1999). An interesting test of the explanatory power of the EQ/SQ model of sex differences is whether EQ and SQ scores are sufficient to explain these differences.

Measures of social networks were obtained, following Stiller and Dunbar (in press). The measures were an estimate of the participant's sympathy group or core social network, which equates essentially to close friends and their support clique, the smaller group of individuals to whom they could turn in a time of major personal problems (Dunbar & Spoor, 1995; Hill & Dunbar, 2003). In addition, participants were asked to rate their degree of interest in a list of activities or fields. These were chosen from a survey of previous work (Hansen & Scullard, 2002; Twenge, 1999) to produce a reasonably concise set where all items would have a roughly equal frequency of being endorsed.

## Methods

An online questionnaire was published on the internet, containing the SQ and EQ as in Study 1. In addition, the questionnaire contained a range of demographic information, and two further sections. The first of these asked the participant to rate their degree of interest in 14 different domains: music, poetry, science, novels, theatre, visual arts, computers, technology, politics, travel, sport, the outdoors, plants and making things with one's hands. These ratings were on five-point scales from 'not at all interested' to 'very interested'. The second section examined social networks and behaviour, through two items. In the first, the participants were asked to list all the individuals that they had contacted for social reasons in the past month (by initials or some other anonymous coding scheme of their choice). In the second, they were asked to list all those individuals to whom they felt they could turn in the event of a serious personal crisis. The two items were designed to provide an estimate of the individual's sympathy group and support clique, respectively (Dunbar & Spoor, 1995; Hill & Dunbar, 2003; Stiller & Dunbar, in press).

Participants were visitors to an online research page that is part of the University of Newcastle's website. This page was publicized within the University by announcements in lectures, and in a newsletter to staff. In addition, the page has been publicized externally in local media, through online journals and community groups, and by word of mouth. It is thus estimated that participation was roughly 50% students and staff of the university and 50% external. Incomplete submissions and multiple submissions from the same IP address were deleted.

Participants in Study 2 were 63 men and 132 women. Non-heterosexual participants were filtered for Study 3. One hundred fifty-seven participants (80.5%) were from the UK, with the bulk of the remainder from North America. The age distribution was as follows: 15-24 years, 30.3%; 25-34 years, 34.4%; 35-44 years, 22.1%; 45-54 years, 10.3% and over 55 years, 3.1%.

## Results

Mean scores for the EQ were very similar to those in Study 1 (men: mean 38.10, *SD* 11.17; women: 48.27, *SD* 12.59). SQ scores were lower than in Study 1, closer to the means in Baron-Cohen *et al.* (2003) (men: mean 33.94, *SD* 11.41; women: 23.74, *SD* 9.74). The sex differences were as predicted, but of greater magnitude in this study

(EQ:  $d = .86$ ; SQ:  $d = .96$ ). Cronbach's  $\alpha$  was similarly high as in Study 1, being .85 for the SQ and .89 for the EQ.

### Interests

An exploratory factor analysis (EFA) was carried out to investigate the covariance structure of different interests. With Varimax rotation, and accepting factors with an Eigenvalue greater than 1.5, three factors were produced. The loadings of the individual interests on these factors are shown in Table 4. Two interests (music and politics) did not load substantially on any of the three factors.

**Table 4.** Rotated factor loading plot for the interests (Study 2). Loadings with an absolute value less than .3 are suppressed

Interest	Factor 1	Factor 2	Factor 3
Visual arts	.79		
Poetry	.74		
Novels	.63		
Theatre	.59		
Handwork	.46	.39	
Plants	.43	.30	
Technology		.83	
Computers		.76	
Science		.66	
Outdoors			.85
Sport	-.47		.70
Travel			.53

Factor 1, with strong loadings from visual arts, poetry, novels and theatre, can be interpreted as a dimension of aesthetic interests. Factor 2, with loadings from technology, computers and science, is a dimension of technological interests. Factor 3, with loadings from sport, travel and the outdoors, can be interpreted as a dimension of exploratory or physical interests. Women scored significantly more highly than men on factor 1 ( $t(180) = 6.99, p < .001$ ), and men significantly more highly than women on factor 2 ( $t(180) = 5.39, p < .001$ ). There was no significant sex difference for factor 3 ( $t(180) = 0.35, ns$ ).

Correlation matrices between the three interests factors and EQ and SQ are shown in Table 5. SQ is strongly and significantly related to technological interests. EQ is moderately positively related to aesthetic interests, and moderately negatively related to technological interests. However, these correlations could arise from the fact that there are sex differences in interests and unrelated sex differences in SQ and EQ. To explore this further, the sample was broken down into men and women and the correlations repeated (Table 5). SQ is strongly correlated with technological interests within each sex as well as in the whole sample. In the sexes considered separately, the negative relationship between EQ and technological interests disappears, and positive moderate correlations between SQ and aesthetic interests appear in both men and women.

To consider the critical question of whether EQ and SQ are sufficient to explain sex differences in interests, hierarchical regressions were carried out entering EQ and SQ in the first block of independent variables, and sex in the second. For factor 1

**Table 5.** Correlations between SQ, EQ and the interests factors, in the whole sample, and within men and women separately (Study 2)

	Whole sample		Men		Women	
	SQ	EQ	SQ	EQ	SQ	EQ
Factor 1 (aesthetic)	.01	.26*	.35*	.20	.18†	.08
Factor 2 (technological)	.61*	-.21*	.47*	.01	.59*	-.12
Factor 2 (physical)	.08	.09	.12	.28†	.16	.01

\* $p < .01$ ; † $p < .05$ .

(aesthetic interests), the adjusted  $r^2$  is .07 in the model with just EQ and SQ and rises to .26 with the addition of sex (significance of the  $r^2$  change:  $F(1, 178) = 48.85$ ,  $p < .001$ ). For factor 2 (technological interests), the adjusted  $r^2$  is 0.38 in both the model with just SQ and EQ, and the model with sex as well (significance of the  $r^2$  change:  $F(1, 178) = 2.89$ , *ns*). Thus, EQ and SQ are sufficient to account for sex differences in interest in technology, but not in interest in aesthetic domains.

### Social networks

The social contacts variable (contacts) yielded a mean of 13.66 individuals ( $SD 7.57$ ). As there were only 25 spaces to list individuals on the questionnaire, there may have been some truncation at the top of the range, since 28 individuals listed 25 contacts. The social support variable gave a mean of 7.39 individuals ( $SD 4.71$ ). Truncation effects were less likely here, as only four individuals used all 25 spaces. However, this item was not completed by 29 of the 195 participants, which suggests that they interpreted the rubric to mean that they should only list individuals to whom they should turn who were not listed in the previous item. Inspection of the data suggests that most participants did not interpret the instructions this way, since they often listed the same individuals in both responses. The contacts and support variables were positively correlated ( $r = .48$ ,  $df = 154$ ,  $p < .001$ ).

There were no significant sex differences in either variable (contacts:  $t = 0.42$ ,  $df = 188$ , *ns*; support:  $t = 0.31$ ,  $df = 164$ , *ns*), but as contacts and support are likely to be affected by age, age group was included as an independent variable in subsequent analyses. In a general linear model with contacts as the dependent variable, age group as a fixed factor and SQ and EQ as covariates, there was a significant main effect of age group ( $F(4, 183) = 6.27$ ,  $p < .001$ ,  $\eta^2 = .12$ ). The number of individuals contacted was highest amongst the young, dropping amongst those in early middle age and then rising again later in life (estimated marginal means: 15–24 years, 16.96; 25–34 years, 13.38; 35–44 years, 10.24; 45–54 years, 11.33; 55+ years, 17.61). There was also a significant main effect of EQ ( $F(1, 183) = 9.08$ ,  $p < .005$ ,  $\eta^2 = .05$ ,  $B = 0.12$ ). There was no effect of SQ ( $F(1, 183) = 0.25$ , *ns*). For support, there was a significant effect of EQ ( $F(1, 159) = 5.25$ ,  $p < .05$ ,  $\eta^2 = .04$ ,  $B = 0.06$ ), but not of SQ ( $F(1, 159) = 0.65$ , *ns*) or age group ( $F(4, 159) = 1.54$ , *ns*).

### Discussion

The interests questions yielded a factor structure of interests similar to those found elsewhere (Hansen & Scullard, 2002), with one factor relating to the arts and aesthetics,

another related to technology and another relating to physical pursuits and the outdoors. Women had stronger aesthetic interests and men stronger interests in technology, in accordance with previous findings (Twenge, 1999). SQ is a strong predictor of technological interests, both across and within sexes. The hierarchical regression shows that the observed sex difference in interest in technology is entirely accounted for by the greater SQ in men. However, the greater female interest in aesthetic domains is not explicable in terms of either the female advantage on EQ or the male advantage on SQ, so some other sex-related differences must be at work. Indeed, within the sexes, aesthetic interest is moderately positively correlated with SQ.

The social contacts and social support items elicited social network sizes which appear to correspond to what have been called the sympathy group (here 13.66, in previous studies 12–15) and the support clique (here 7.39, previous studies around 4–7), respectively (Dunbar & Spoors, 1995; Hill & Dunbar, 2003). The EQ (but not SQ) was shown to be a predictor of social network characteristics, with higher EQs being associated with a larger sympathy group and a larger support clique. The effect sizes are fairly small, with an increase in EQ of one standard deviation raising the number of social contacts by 1.56 individuals, and the size of the support clique by 0.78 individuals.

Despite the relationships between the EQ and the social network variables, there were no sex differences observed in social networks. This is in conformity with other studies using a similar method (Dunbar & Spoors, 1995). It may be a product of the simple numerical lists used in these items. A focus on quality of social relationships, or connectedness and empathy within them, may have revealed sex differences, as are found for example using the friendship questionnaire (Baron-Cohen & Wheelwright, 2003). However, such an approach was not used here because of concerns about item overlap with the EQ. Since the objective was to validate the EQ against something more objective, the friendship questionnaire, with its focus on quality and empathy within relationships, did not seem appropriate.

This study, then, produced a predictable pattern of external correlates for SQ and EQ. SQ emerges as a cognitive style drawn to understanding causal relationships in non-social domains and as such explains the greater male interest in science and technology. EQ has no correlates amongst cognitive interests, but is associated with the maintenance of larger numbers of social relationships. SQ and EQ are nearly orthogonal, so SQ produces no negative relationships in the social domain, and EQ produces no negative relationships in non-social interests.

The findings are not particularly surprising, but they do provide important validity checks for the EQ and SQ. If SQ did not predict an interest in systematic non-social domains, or EQ did not predict rich social networks, doubt would be cast on their validity. However, it is clear from the study that although the empathizing-systemizing model is sufficient to explain some sex differences (e.g. men's greater interest in technology), it is not sufficient to explain others (e.g. women's greater interest in the arts or men's in sports). This issue is considered further in the General discussion.

### STUDY 3

Study 3 examines EQ, SQ, interests, and social networks in non-heterosexual as compared to heterosexual men and women. It has been suggested that systemizing and empathizing, in common with many other sex differences, are established by

prenatal exposure to androgens (Knickmeyer *et al.*, 2005; Manning *et al.*, 2001), see General introduction), whose levels differ by sex of the foetus. It has also been hypothesized that same-sex sexual preference is established by sex-atypical exposure to such androgens (Ellis & Ames, 1987), a hypothesis that has considerable empirical support (see Rahman & Wilson, 2003, for a full review).

If the development of systemizing and empathizing is organized by prenatal androgens and if the levels of such androgens is atypical in individuals who will go on to have same-sex sexual preferences, then a clear prediction follows. Non-heterosexual men should be shifted towards greater empathizing and reduced systemizing, whilst non-heterosexual women should be shifted towards greater systemizing and reduced empathizing. Sargeant *et al.* (2006) have shown that a sample of homosexual men score more highly than matched heterosexuals on the EQ. This is consistent with previous findings using other measures that have shown homosexual men to be less physically aggressive than heterosexuals (Ellis, Hoffman, & Burke, 1990) and to score higher on an 'empathy' scale that measures prosociality and altruism (Salais & Fischer, 1995). However, Sargeant *et al.* include neither the SQ nor a sample of homosexual women. Study 3 used the same questionnaires as Study 2, but recruited groups of non-heterosexual participants to investigate the hypotheses described above.

## Methods

Non-heterosexual participants were recruited through the internet using community mailing lists and bulletin boards, to be compared with the heterosexual participants of Study 2. The questionnaire was as in Study 2. Participants described themselves as heterosexual, bisexual or homosexual. As sample sizes are small, the sample is collapsed into heterosexual and non-heterosexual groups. There were 54 non-heterosexual men and 22 non-heterosexual women, to be compared to the 63 men and 132 women of Study 2.

## Results

### SQ and EQ

Table 6 shows the means for SQ and EQ for heterosexuals and non-heterosexuals of each sex, along with *d* values for heterosexual versus non-heterosexual participants. Whilst non-heterosexual men do not differ significantly from heterosexuals, the non-heterosexual female mean for SQ is 0.7 standard deviations above heterosexual mean. This difference is statistically significant ( $t(152) = 3.24, p < .005$ ). In fact, the non-heterosexual women do not differ significantly from the heterosexual men on SQ ( $t(83) = 0.95, p = .34$ ). Non-heterosexual women also scored less highly than heterosexuals on EQ. Though the effect size was 0.37, the difference only approached statistical significance ( $t(152) = 1.61, p = .11$ ), due to the small female sample size.

### Interests

A factor analysis identical that used in Study 2, but with the extra participants included, produced an identical three-factor structure (data not shown). Mean scores on these factors for heterosexual and non-heterosexual men and women were calculated (Table 7). As the table shows, there are a number of significant differences related to

**Table 6.** Heterosexual vs. non-heterosexual comparisons for SQ and EQ. Cohen's *d* (absolute value) is shown, and standard deviations are in parentheses

	Male			Female		
	Het.	Non-het.	<i>d</i>	Het.	Non-het.	<i>d</i>
SQ	33.94 (11.41)	36.81 (11.39)	.25	23.74 (9.74)	31.23 (11.68)	.70*
EQ	38.10 (11.19)	37.74 (12.48)	.03	48.27 (12.59)	43.59 (12.52)	.37

\* $p < .01$ .**Table 7.** Heterosexual vs. non-heterosexual comparisons for the three interests factors (Study 3)

	Male			Female		
	Het.	Non-het.	<i>d</i>	Het.	Non-het.	<i>d</i>
Factor 1 (aesthetic)	-.75	-.19	.66*	.34	.55	.23
Factor 2 (technological)	.25	.62	.42†	-.42	.26	.82*
Factor 3 (physical)	.07	-.31	.40†	.15	-.36	.51†

\* $p < .01$ ; † $p < .05$ .

sexual orientation. For the aesthetic factor, non-heterosexual men differ significantly from heterosexual men, being shifted around half the way to the female mean. Non-heterosexual women do not differ from heterosexual women on factor one. For the technological factor, non-heterosexual men actually score significantly more highly than heterosexuals. Non-heterosexual women show a strong effect, scoring significantly higher than heterosexual women, and, indeed, higher than heterosexual men. For factor three, the physical factor, non-heterosexuals among both the men and the women have significantly reduced levels of interest.

To consider whether EQ and SQ can explain the observed sexual orientation differences in interests, hierarchical regressions were carried separately amongst the men and the women, out entering EQ and SQ in the first block of independent variables, and sexual orientation in the second.

The results for men are as follows. For factor 1 (aesthetic interests), the adjusted  $r^2$  is .04 in the model with just EQ and SQ and rises to .13 with the addition of sexual orientation (significance of the  $r^2$  change:  $F(1, 106) = 10.94$ ,  $p < .01$ ). For factor 2 (technological interests), the adjusted  $r^2$  is .26 in the model with just SQ and EQ and .28 with sexual orientation added (significance of the  $r^2$  change:  $F(1, 106) = 3.78$ ,  $p = .06$ ). For factor 3 (physical interests),  $r^2$  is .06 in the model with just EQ and SQ and rises to .10 with the addition of sexual orientation (significance of the  $r^2$  change:  $F(1, 106) = 5.65$ ,  $p < .05$ ).

The results for the women are as follows. For factor 1 (aesthetic interests), neither SQ and EQ, nor SQ, EQ and sexual orientation are significant predictors of level of interest. For factor 2 (technological interests), the adjusted  $r^2$  in the model with just EQ and SQ is .38 and that with sexual orientation added .39 (significance of the  $r^2$  change:  $F(1, 140) = 2.15$ , *ns*). Finally, for factor 3 (physical interests),  $r^2$  is .01 in the model with just EQ and SQ, and rises to .06 with the addition of sexual orientation (significance of the  $r^2$  change:  $F(1, 140) = 6.54$ ,  $p < .05$ ).

### Social networks

In a general linear model with contacts as the outcome variable and age and sexuality, there were no significant effects of age or sexual orientation for men (age group:  $F(4, 101) = .74$ , *ns*; sexual orientation:  $F(1, 101) = 2.81$ , *ns*), or for women (age group:  $F(4, 142) = 1.09$ , *ns*; sexual orientation:  $F(1, 142) = 2.75$ , *ns*). With support as the dependent variable, there were also no significant effects of age or sexual orientation for men (age group:  $F(4, 85) = 1.10$ , *ns*; sexual orientation:  $F(1, 85) = 2.10$ , *ns*), or for women (age group:  $F(4, 130) = .48$ , *ns*; sexual orientation:  $F(1, 130) = 3.43$ , *ns*). However, with the sexes pooled in this expanded sample, there are still overall effects of age group and EQ on contacts (age group:  $F(4, 255) = 6.00$ ,  $p < .001$ ,  $\eta^2 = .09$ ; EQ:  $F(1, 255) = 10.64$ ,  $p < .005$ ,  $\eta^2 = .04$ ,  $B = .11$ ), and on support (age group:  $F(4, 227) = 2.68$ ,  $p < .05$ ,  $\eta^2 = .05$ ; EQ:  $F(1, 227) = 8.63$ ,  $p < .005$ ,  $\eta^2 = .04$ ,  $B = .07$ ).

### Discussion

The results show that whilst the non-heterosexual men in this sample do not depart significantly from the SQ-EQ profile of heterosexuals, the non-heterosexual women have sharply increased SQ scores. A  $d$  score of .7 is considered a medium-large effect size (Cohen, 1988) and indicates that the mean non-heterosexual woman stands at the 76% percentile of the heterosexual distribution. The non-heterosexual women did not differ significantly from heterosexual men on the SQ. There was also a trend towards lower EQ amongst non-heterosexual women, whose lack of significance may be due to small sample size. These results are discrepant with those of Sargeant *et al.* (2006) for non-heterosexual men. It remains to be seen whether this is simply an artefact of sampling or statistical power.

As predicted, non-heterosexual men and women differ from heterosexuals in their interests in certain ways that shift them toward the opposite sex. Thus, non-heterosexual men have greater interest in aesthetic domains than heterosexuals, whilst non-heterosexual women have increased interest in technology and computers. The latter differences are largely explained by the increased SQ of non-heterosexual women. The former difference, however, like the greater female interest in the arts in general, cannot be explained by SQ or EQ differences and must be due to some other factor. There are also differences between the sexual orientation groups that are not expressions of sex atypicality. Thus, non-heterosexual men have increased interest in technology and non-heterosexuals of both sexes have reduced interest in sport. These differences are not related to SQ or EQ and it remains to be seen if they are artefacts of sampling.

Social network sizes did not differ by sexual orientation, just as they do not differ by sex. However, the positive relationships between EQ and social network sizes are maintained with roughly unchanged slopes in this expanded sample as compared to Study 2.

Some of the results of Study 3 are thus consonant with the hypothesis that psychological sex differences are organized by sexually patterned neurodevelopmental factors, such as prenatal androgen levels, and that non-heterosexuality is also a result of atypical exposure to such factors (Ellis & Ames, 1987). However, other predicted patterns (such as increase EQ in homosexual males) were not found here, and some of the differences in interests (the reduced interest in sports amongst homosexuals) cannot be explained in this way.

## GENERAL DISCUSSION

The studies presented here confirm the reliability of the SQ and EQ, and find the same sex differences reported by Baron-Cohen *et al.* (2003). They also allow additional insight into the nature and distribution of empathizing and systemizing. The following general discussion briefly reviews some of the main issues raised and those that remain to be solved.

### **What are empathizing and systemizing?**

The studies reported here suggest that empathizing is essentially equivalent to the agreeableness dimensions of the five-factor model of personality. Its essence is attention to the needs and situations of others, as evidenced by perspective-taking, altruism and cooperativeness. Women have an advantage of between one half and one whole standard deviation on this trait as compared to men. High scorers on empathizing, regardless of their sex, have slightly larger circles of friends and more individuals they can turn to for social support, as compared to low scorers.

Though the empathizing dimension would not seem to represent an empirical advance, since it captures essentially the same variation as the agreeableness dimension, the fact that such different approaches as cognitive research on autism and theory-of-mind and personality descriptors, have converged on such a similar construct is interesting. It suggests, for example, that a cognitive correlate of agreeableness will be performance on theory-of-mind tasks, a novel hypothesis that would not have been generated from within personality theory alone. It further suggests that prenatal androgen levels may contribute to the organization of this aspect of personality, again a novel prediction.

Systemizing is a cognitive style that predicts interests in science, technology, computers and the natural world. It is not easily reducible to existing personality constructs. Though it correlates weakly with openness and conscientiousness, much of its variation is not captured by the five-factor model. It may be better related to aspects of intelligence, most obviously those non-verbal components where a male advantage tends to be observed (Kimura, 1999), though this remains a hypothesis to be investigated. Men have an advantage in systemizing of around half to one whole standard deviation compared to women.

### **Origin of sex differences**

Baron-Cohen suggests strongly that the origin of sex differences in empathizing and systemizing is biological (Baron-Cohen, 2003). No cross-cultural research has yet been undertaken on this point and such research would be desirable to reinforce any conclusions drawn about biological or evolutionary origins of the observed differences. Nonetheless, the sexual orientation differences observed here are consonant with a role for biological factors in organizing cognitive styles.

Why there should be sex differences in empathizing and systemizing is an interesting question that deserves more detailed investigation. Social relationships are important to survival and reproductive success in primates of both sexes and this creates a selection pressure for social intelligence (Dunbar, 1998). Sexual dimorphism suggests that, though useful for both sexes, the fitness payoff from the attribute is greater for one sex than the other. The fact that females often have dependent offspring creates several

possible reasons for social relationships being especially important to them. Not only do they nurture young, but the consequences of social conflict may be more serious for them, as their young may be endangered by aggression, and young limit females' opportunities to disperse to new social groups in the event of relationships breaking down. Moreover, females may rely on social alliances, whether with males or other females, to provision and guard their young, an activity that is particularly extended and costly in humans. Clearly, within human cultures, there is a great diversity of gender roles and men as well as women invest time in care of offspring. Nonetheless, a basic difference in the importance of sociality may be part of our evolutionary heritage.

As for systemizing, it would also appear to be a characteristic useful for both sexes. However, it is possible that is a side-effect of a specialization for technology or tool-use that has tended to have a greater impact on reproductive success for males than females, either because ancestral males could free more time for such innovatory activity, or because the males could gain in relative status by mastery of technologies, for example of hunting.

#### **What empathizing and systemizing do and do not explain**

The observed sex differences in empathizing and systemizing appear sufficient to explain men's greater interest (on average) in science and technology and women's greater social skill. However, Baron-Cohen implies that the empathizing-systemizing model is sufficient to explain all psychological sex differences (Baron-Cohen, 2003; Baron-Cohen *et al.*, 2003). This claim is not supported by the present results. There are a number of observed sex differences which are independent of differences in the EQ and SQ.

First, women are higher than men in the personality dimension of neuroticism. Neuroticism relates to the activation of harm-avoidance mechanisms, such as anxiety. There are several reasons why it might be adaptive for women to have these mechanisms uprated compared to men (see also Budaev, 1999). For one, when a female is pregnant or has dependent young, the consequences of undetected threats may be more damaging to inclusive fitness than they would be to a man, which would lead to an uprating of the sensitivity of threat-detection mechanisms. Second, as the variation in reproductive success is greater in males than females, men are likely to be selected to take greater risks than females, and this would lead to a tuning down of harm-avoidance mechanisms in men. Whatever the reason, the observation of greater neuroticism in women is unrelated to their greater empathizing/agreeableness.

It is also clear from the present studies that the greater female interest in the arts and aesthetic domains is not reducible to greater empathizing or reduced systemizing. Geoffrey Miller has suggested that women in particular are interested in these domains as they are an arena for males to display their phenotypic qualities as potential mates (Miller, 2001). The test of such a hypothesis is obviously beyond the scope of the present study. Nonetheless, it is of interest that women have a greater interest in aesthetic domains that is not a side effect of their greater sociality.

#### **Sexual orientation and sexually-patterned psychology**

The results for non-heterosexual women in Study 3 add a further finding to the impressively large list of characteristics where non-heterosexuals show a shift in the cross-sex direction (see Rahman & Wilson, 2003, for a review). For the present

purposes, the finding is of double interest. On the one hand, if the relationship between systemizing and empathizing and prenatal androgens (Knickmeyer *et al.*, 2005) is taken as a given, it lends support to the prenatal androgen hypothesis of same-sex sexual preference (Ellis & Ames, 1987). On the other hand, if that hypothesis is taken as given, then the finding lends support to the organization of systemizing and empathizing by prenatal androgen levels. Clearly, the findings cannot simultaneously be used for both of these purposes. However, at the very least, the findings add to an expanding array of self-consistent findings that suggest biological origins for psychological sex differences, via the pathway of prenatal androgens, which are atypical in non-heterosexual individuals.

The lack of an effect here of homosexuality on empathizing and systemizing in men is surprising, given previous results in this area (Sargeant *et al.*, 2006). It is hoped that future research will examine whether some oddity of sampling or recruitment is responsible for this null finding.

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