

Short Communication

## Empathizing and systemizing cognitive traits in the sciences and humanities

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### Abstract

For several decades, cognitive research on personality and individual differences has focused on psychological traits other than general intelligence. Here we present data on empathizing and systemizing cognitive traits in science and humanities students. In view of existing data on autistic traits in scientists, we hypothesized that the science students would show higher systemizing than empathizing and that the humanities students would show the opposite pattern. Our findings suggest that individuals in the sciences possess a cognitive style that is more systemizing-driven than empathizing-driven, whereas individuals in humanities possess a cognitive style that is much more empathizing-driven than systemizing-driven. Both type of major and gender independently and highly significantly contribute to this effect. Within the sciences, the systemizing pattern is especially pronounced in engineering and physics. Men and women have been found previously to differ in their systemizing–empathizing cognitive style, with men being stronger in systemizing and women being stronger in empathizing. We find the same gender differences within each type of major. © 2007 Elsevier Ltd. All rights reserved.

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## 1. Introduction

The empathizing–systemizing theory of psychological sex differences claims that whereas the female brain is predominantly hard-wired for empathy, the male brain is predominantly hard-wired for understanding and building systems (Baron-Cohen, 2002, 2003; Baron-Cohen, Knickmeyer, & Belmonte, 2005). Systemizing is defined as the drive to analyze a system in terms of the rules that govern the system, in order to predict its behavior (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003; Baron-Cohen et al., 2005). Empathizing is defined as the drive to identify others' mental states in order to predict their behavior and respond with an appropriate emotion (Baron-Cohen & Wheelwright, 2004; Baron-Cohen et al., 2005).

There is evidence to suggest that male and female brains are wired differently from birth. Prenatal androgens appear to produce sex differences in the neural structure and function of the brain that might last a lifetime (Baron-Cohen et al., 2005; Kimura, 2004). Men appear to score higher on spatial navigation, mental rotation (Collins & Kimura, 1997; Voyer, Voyer, & Bryden, 1995) and mathematical problem solving tasks (Kimura, 2002a, 2002b; Benbow, Lubinski, Shea, & Eftekhari-Sanjani, 2000), whereas women appear to score higher on verbal memory, landmark memory retrieval and emotional recognition tasks (Kimura, 2002a, 2002b; McClure, 2000). These differences reflect patterns of ability that are related to specific cognitive traits and do not explain themselves in terms of differences in overall levels of intelligence, such as IQ (Kimura, 2002a). Men and women on average do not differ in general intelligence (Baron-Cohen et al., 2005). Some of these differences, for example mathematical problem solving skills and emotional recognition abilities, might explain themselves in terms of empathizing and systemizing differences (Baron-Cohen, 2003; Hoffman, 1977).

According to the Empathizing–Systemizing (E–S) theory, individuals can possess three particular 'brain types': (E) an individual's level of empathy can be higher than his or her level of systemizing ( $E > S$ ), (S) an individual's level of systemizing can be higher than his or her level of empathizing ( $S > E$ ) or (B) an individual can have comparable levels of empathizing and systemizing skills ( $E = S$ ). Type S is more common in males, whereas type E is more common in females (Baron-Cohen et al., 2005). Individuals with extreme  $E > S$  cognitive patterns are deemed "system-blind" ( $E \gg S$ ), whereas individuals with extreme  $S > E$  cognitive patterns are deemed "mind-blind" ( $S \gg E$ ). The "extreme male brain theory" (EMB) posits that Autism Spectrum Conditions (ASCs), such as Asperger Syndrome, represent an extreme of the male brain type S (reduced empathy and enhanced systemizing) (Asperger, 1944; Baron-Cohen, 2002, 2003; Baron-Cohen et al., 2005). Reduced empathy or "mind blindness" (Baron-Cohen, 1995) is a feature of ASCs and may lie at the heart of the social difficulties individuals with ASCs experience. Baron-Cohen, Wheelwright, Skinner, Martin, and Clubley (2001) showed that science students, e.g. computer science, math, engineering, biology and physics, score higher on the Autism-Spectrum Quotient (AQ) than humanities students and social science students. Moreover, within science students, students in such areas as math, computer science and engineering scored higher than students in more human or life-centered sciences such as medicine and biology. Overall, males scored significantly higher than females on the AQ questionnaire. These findings further validate the link

Baron-Cohen et al. (1998, 2001) found between ASCs and occupations/skills in math, physics and engineering. Although not all studies have found (inverse) correlations between empathizing and systemizing skills (Lawson, Baron-Cohen, & Wheelwright, 2004; Carroll & Yung, 2006), casting some doubt on possible trade offs between both abilities in normal individuals, the combination of high systemizing skills with low empathizing skills does reflect an Asperger-type cognition (Baron-Cohen, Wheelwright, Lawson, Griffin, & Hill, 2002; Baron-Cohen, 2003). Indeed, individuals with Asperger Syndrome are more likely to have an extreme brain type S (Baron-Cohen et al., 2005).

If the EMB theory (Baron-Cohen, 2003) is valid, and autistic traits are indeed more common in science students compared to humanities and social science students (Baron-Cohen et al., 2001), then individuals in mathematics, engineering, computer science and the natural sciences should be more likely to have a brain type S (or extreme brain type S), whereas individuals in humanities and the social sciences might show the opposite pattern. However, since autistic traits and brain type S are both more common in males, whereas brain type E is more common in females, possible empathizing–systemizing differences might merely reflect differences in male/female ratio in the sciences versus humanities and the social sciences (Achter, Lubinski, Benbow, & Eftekhari-Sanjani, 1999).

The aim of our study is to directly investigate these different cognitive patterns as related to natural science, mathematics and engineering students versus humanities students. From now on, for reasons of brevity, we will use the term ‘science(s)’ to refer to mathematics, engineering and the natural sciences (physics and chemistry in particular). We compared 214 first-year science students (math, engineering, physics and chemistry) to 137 first and second year humanities students (French and English) on the Empathy Quotient (EQ) and Systemizing Quotient (SQ) questionnaires (Baron-Cohen, 2003). We hypothesized that the science students would show a systemizing-driven cognitive pattern, whereas the humanities students in comparison would show an empathizing-driven cognitive pattern. The crucial questions we are asking are (1) do individuals in the sciences show a different empathizing–systemizing pattern as compared to individuals in humanities and if so, (2) is this effect merely attributable to gender differences in empathizing and systemizing?

## 2. Participants

A total of 351 college students from Ghent University in Belgium participated in this study. The sciences group consisted of 214 participants of which 162 were males and 52 females. The humanities group consisted of 137 participants of which 27 were males and 110 females. All the participants were between 18 and 25 years of age.

## 3. Method

In order to avoid any language-related difficulties, both the EQ and SQ were translated into Dutch by the first author and double-checked by an English–Dutch expert from Ghent University. The English EQ and SQ were obtained from Baron-Cohen (2003). The questionnaires were administered in hard-copy format in classrooms at the mathematics, engineering, physics,

chemistry and language departments of Ghent University. This was done during the same week for the engineering, math, physics, chemistry and language department. Participants were given 30 min to fill out both questionnaires. The EQ was given before the SQ. The EQ contains 40 empathy items and 20 control items. The SQ contains 40 systemizing items and 20 control items. On each item an individual can score 2, 1 or 0, so the maximum score on each scale is 80 and the minimum score is zero. To create the scale scores we followed the instructions indicated in [Baron-Cohen \(2003\)](#). All questionnaires were anonymous and participants were asked to reply truthfully.

#### 4. Results

Participants occasionally left one or more items blank on one or both of the two scales. In all, 40 participants were missing at least one item on the EQ scale and those 40 left an average of 2.37 items blank. Twenty-six participants left one or more items blank on the SQ scale and those 26 left an average of 1.66 items blank. There was complete data on 289 of the 351 participants. Because of the missing data, we carried out the various analyses in two ways: We analyzed the data on the participants with complete data by creating scale scores as recommended by [Baron-Cohen \(2003\)](#). Those scale scores would be misleading for subjects missing an occasional item so we also computed mean scale scores based only on completed items. Analyses based on the regular scale scores had 289 participants and analyses based on mean scale scores had all 351 participants. There were no differences between the two types of analyses, so we report only those analyses based on participants with complete data.

The mean score of the science students is 30.25 on the SQ scale and 34.88 on the EQ scale. The mean score of the humanities students is 17.27 on the SQ scale and 41.70 on the EQ scale.

The primary analysis was a  $2 \times 2$  analysis of variance using the difference between the EQ score and the SQ score as the dependent measure. Type of major (sciences versus humanities) and gender were the two independent variables. Type of major was highly significant ( $F(1, 285) = 65.37$ ,  $p < .001$ , partial  $\eta^2 = .187$ ). Gender was also highly significant ( $F(1, 285) = 51.27$ ,  $p < .001$ , partial  $\eta^2 = .152$ ). The interaction was not significant ( $F(1, 285) = 2.86$ ,  $p < .092$ ). The results are shown in [Fig. 1](#).

Within the sciences, there are significant differences as a function of particular majors showing that the systemizing pattern is especially pronounced in physicists and engineers ( $F(3, 173) = 5.33$ ,  $p < .002$ , partial  $\eta^2 = .085$ ). These differences are shown in [Fig. 2](#).

#### 5. Discussion and conclusion

Our data reveal that on average (1) individuals in the sciences are more systemizing-driven, whereas individuals in humanities are more empathizing-driven and (2) men are more systemizing-driven whereas women are more empathizing-driven. The gender differences on the SQ and EQ questionnaires that were previously found by [Baron-Cohen et al. \(2003\)](#) and [Baron-Cohen and Wheelwright \(2004\)](#) are replicated in our study within each type of major. Considering that the interaction between gender and major is non-significant, the effect of gender and the effect of major are additive. Both gender and major contribute independently to the differences found in

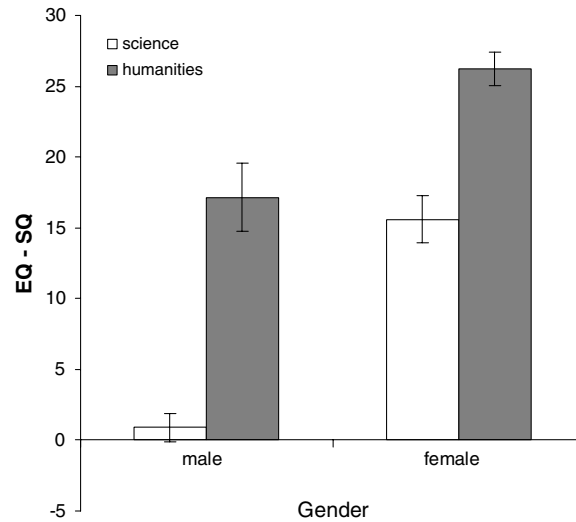


Fig. 1. Empathizing versus systemizing as a function of major and gender.

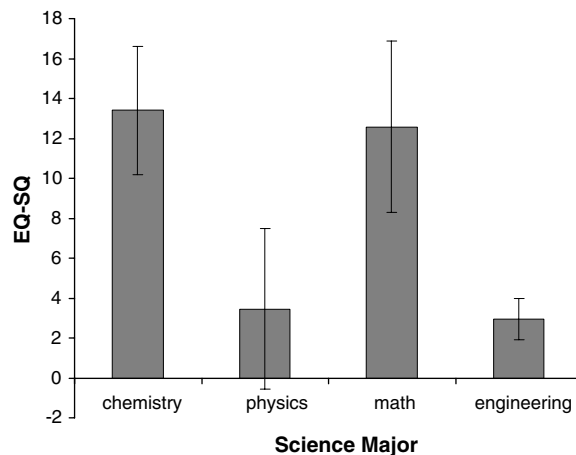


Fig. 2. Empathizing versus systemizing as a function of specific science major.

empathizing and systemizing cognitive traits in the sciences versus humanities (Fig. 1). Thus our finding indicates that the fact that the science students are more systemizing-driven than the humanities students is not solely attributable to gender. It is important to note that the mean score of the science students on SQ lies in the middle section of the average range (20–39), whereas their mean score on EQ lies in the lower section of the average range (33–52) and beneath the scores of most women (EQ = 47) and most men (EQ = 42) (see Baron-Cohen, 2003 for averages). The mean EQ score in the sciences is much closer to the low range (0–32) than to the average score of men and women (see Baron-Cohen, 2003). Therefore, individuals in the sciences can be said to have a more systemizing-driven cognitive style as compared to individuals in humanities that

have a more empathizing-driven cognitive style. Within the sciences this effect appears to be especially strong for engineering and physics as opposed to math and chemistry (Fig. 2).

Our data strongly suggest that in the sciences versus humanities, both gender and major independently contribute to the assessment of an individuals' systemizing and empathizing cognitive style. The main conclusions from our study are that on average (1) men are more systemizing than women, and (2) science students are more systemizing than humanities students.

We believe that these differences are at least to a certain extent accounted for by differences in the type of brain an individual possesses. In agreement with Baron-Cohen et al. (2005), we suggest that differences in neural structure and functioning might underlie the differences in systemizing and empathizing cognitive styles found in normal individuals (Baron-Cohen et al., 2005). We hypothesize that these differences might be in line with certain ASCs related anatomical differences (Baron-Cohen et al., 2005) such as a reduction of the posterior part of the corpus callosum (Barnea-Goraley et al., 2004; Courchesne, 1997) in normal individuals with an extreme type S ( $S \gg E$ ). Likewise, fMRI might show differences in medial prefrontal cortex, orbitofrontal cortex, temporal lobe and amygdala functioning between individuals with brain type S ( $S > E$ ) and individuals with brain type E ( $E > S$ ). The aim of our work in progress is to (1) investigate on a functional and brain connectivity level if an Asperger-type cognitive style ( $S \gg E$ ) indeed reflects an extreme of a normal brain type S ( $S > E$ ) and (2) look at individual differences in brain functioning and connectivity in normal individuals as related to empathizing and systemizing cognitive traits.

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