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The short forms of the Empathy Quotient (EQ-short) and the Systemizing Quotient (SQ-short)

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Abstract

The empathizing–systemizing (E–S) theory has previously been tested using the Empathy Quotient (EQ) and the Systemizing Quotient (SQ). This study tested n = 1761 students with these instruments, to determine if short versions of these scales could be constructed. This would be desirable both for faster assessment and to establish which are the key items on each scale. Principal component analysis and factor analysis suggested that a 23 item version of each instrument was highly correlated with the full scale versions. The reliability of each short scale was reasonable. Results showed that females scored significantly higher than males on the EQ-Short, whilst males scored higher than females on the SQ-Short. Additionally, scores were analyzed according to the degree the student was studying. On the EQ-Short, students studying humanities scored higher than students studying sciences, whereas on the SQ-Short, the results were the opposite. Finally, distributions of the population who showed 'brain types' based on the scores on two scales were examined. The pattern of distribution of the brain types was consistent with the E-S theory. These results suggest that the EQ-Short and SQ-Short are useful instruments for measuring fundamental cognitive styles.

Key words: Empathizing, systemizing, E-S theory, EQ-Short, SQ-Short, cognitive style

1. Introduction

1.1. The empathizing-systemizing theory

Understanding (*intentional*) agency and understanding non-agentive (*causal*) events appear to be two fundamental aspects of human cognition (Tomasello, 1999). Baron-Cohen (2002) proposed the Empathizing–Systemizing (E-S) theory that consists of two psychological dimensions. This theory was developed from the folk psychology–folk physics model, which corresponded to two fundamental causal cognitions. The concept of empathizing extends the scope of folk-psychology, or theory of mind, by including an emotionally reactive dimension. Similarly, the concept of systemizing includes a wider range of systems, such as *mechanical* (e.g., machines), *abstract* (e.g., mathematics), *organizable* (e.g., taxonomy) and so on. Empathizing is used for making sense of an agent's behaviour, and systemizing is used for predicting the behaviour of non-agentive events or objects. Empathizing is defined as the drive to identify emotions and thoughts in others and to respond to these with an appropriate

emotion. Systemizing refers to the drive to construct systems, which allows people to predict the behaviour of a system, and to control it. According to the E-S theory, there are certain individual differences in both empathizing and systemizing, for example, sex differences in the mind are found in empathizing (stronger in females) and systemizing (stronger in males). A growing body of evidence suggests males spontaneously systemize to a greater degree than do females, whilst females spontaneously empathize to greater degree than do males (for example, Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003; Lawson, Baron-Cohen, & Wheelwright, 2004).

1.2. The Empathy Quotient (EQ) and the Systemizing Quotient (SQ)

The Empathy Quotient (EQ) and the Systemizing Quotient (SQ) were constructed as instruments with which to test the E-S theory (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004). The EQ was developed as a new measure of empathy because several instruments that purport to measure empathy only tap part of empathy. Empathy has an affective component (for example, feeling an appropriate emotion triggered by

another's emotion), a cognitive component (for example, understanding and/or predicting what someone else might think, feel, or do), and a mixed component (cognitive and affective). The SQ was constructed by using examples from everyday life in which systemizing is used. The assumption was that an individual with high systemizing would be drawn to use their systemizing skills across the range of examples more often than an individual with low systemizing. Systemizing involves figuring out the rules of a system and is held to involve monitoring input-operation-output relations (e.g., If I do A, then X occurs).

According to the E-S theory, it is possible to plot on two dimensional coordinate, which is constructed by empathizing and systemizing. Baron-Cohen et al. (2003) have used the terms "brain types" to describe the three basic cognitive types which are generated from this theory. Individuals in whom empathizing is at a higher level than their systemizing are referred to as having a brain of type E (the Empathizing brain type: E>S). Individuals in whom systemizing is at a higher level than their empathizing are said to have a brain of type S (the Systemizing brain type: S>E). Individuals in whom

empathizing and systemizing are equally balanced are said to be type B (the Balanced brain type: E=S). It could be said that these brain types are kinds of cognitive styles. On average, more males than females have a brain of type S, and more females than males have a brain of type E (Goldenfeld, Baron-Cohen, Wheelwright, Ashwin, & Chakrabarti, in press). Evidence supporting these sex differences in the E-S theory includes the findings that mathematics, physics and engineering (which all require a high degree of systemizing) are largely male in sex ratio (for example, Benbow, 1988; Geary, 1996), and that women are better at decoding non-verbal communication, picking up subtle nuances from tone of voice or facial expression, or judging a person's character (for example, Hall, 1978). However, a fundamental problem is remained, that is, it is not clear whether all items in each scale are needed to measure the hypothesized two constructs.

The aims of the present study are: (1) To examine the psychometric properties of the EQ and SQ as instruments. (2) To produce short versions of the EQ and SQ for increasing their reliabilities, based on the results of item analyses, and to compare with those

original scales. (3) To test if the EQ-Short is independent of the SQ-Short. (4) To examine the sex differences and the differences between students in the humanities and students in the sciences on the E-S theory. (5) To test the hypotheses about the postulated types of brain, using these short versions of the scales.

2. Method

2.1. Participants

Participants consisted of 1,761 students of Cambridge University, comprising 723 males and 1,038 females. Their mean age was 21.0 yrs (*SD* = 2.58, range = 18.2 – 26.3). They were recruited via several routes including e-mail, post, newspaper adverts and notices around the university. An incentive to participate was offered, in that everyone who completed all questionnaires was entered into a draw to win a prize. Only participants who replied to all items were included in the final analysis. Participants indicated their undergraduate degree subject and these were classified as sciences and humanities.

2.2. Procedure

All participants completed the EQ and SQ online, using a custom-designed website. After registering on the website and providing some basic information, such as sex, age and their degree/area of study, participants were invited to fill out the two questionnaires. For each questionnaire, participants were instructed to read each statement carefully and judge how strongly they agreed or disagreed by selecting the appropriate option of each item.

2.3. Instruments

The EQ and SQ have a forced-choice format, and are self-administered. Both the EQ and SQ comprise 60 questions, 40 assessing empathizing or systemizing respectively, and 20 filler items. Approximately half the items are worded to produce a “disagree” response, and half an “agree” response, and items are randomized to avoid a response

bias. An individual scores 2 points if they strongly display a systemizing/empathizing response, and 1 point if they slightly display a systemizing/empathizing response (i.e., each item being scored 2,1,0,0) (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004).

3. Results

3.1. Psychometric properties of the original 40-item EQ and SQ

The *mean* EQ scores and *mean* SQ scores and their *SD*s of the participants are shown in Table 1. The *skewnesses* and *kurtosis* were calculated. On the EQ, *skewness* = - 0.149 and *kurtosis* = - 0.284. On the SQ, *skewness* = 0.426 and *kurtosis* = - 0.081. Pearson's product moment correlation coefficients between EQ score and SQ score was r = - 0.171 (p<0.01). To examine the internal consistency of the EQ and SQ, Cronbach's alphas were calculated, these being 0.884 for the EQ and 0.881 for the SQ.

Table 1 about here

3.2. Constructing the short versions of the EQ and SQ

It is unclear whether all items in each scale are needed to measure the hypothesized two constructs. No statistical item analyses for each scale were reported in the earlier studies using the EQ and SQ, so the two scales might contain some unnecessary items. Therefore, we carried out multivariate analyses on the two scales to confirm their factorial consistency, and to construct short versions of the EQ and SQ to measure each cognitive style.

First, we applied a principal component analysis to both scales respectively, because the EQ and SQ were originally conceptualized as being independent of each other. The 40 items of the EQ were considered via principal component analysis, and the scree plot suggested that the EQ scale consisted of one-component (Eigenvalues were 8.46, 3.01, 1.96, etc.) but the first principal component showed that 22 of 40 items loaded above

0.40. In the SQ, the scree plot of PCA also suggested one-component (Eigenvalues were 7.92, 2.54, 1.82, etc.), and the first component showed that 25 of 40 items loaded above 0.40 (Table 2). The internal consistencies (Cronbach's alpha) of these high loaded items were 0.900 in the EQ (22 items) and 0.894 in the SQ (25 items).

Table 2 about here

In order to confirm the validities of these high loaded items as the shortened versions of the EQ and SQ, the correlations between original 40-item versions of the EQ/SQ and the EQ-Short/SQ-Short were calculated. The correlations between scores in the 40-item EQ and 22-item EQ-Short was r = 0.932 (r =0.927 in males, and r = 0.926 in females). The correlation between scores in the 40-item SQ and 25-item SQ-Short was r = 0.953 (r = 0.942 in males, and r = 0.950 in females).

Then, we administered a factor analysis by combining the original EQ and SQ (80 items) in order to confirm the validity of the EQ/SQ-Short and independence of two

scales. A principal factor analysis was carried out on the inter item correlation matrix obtained from 1761 students' responses to the 80 items. The result of the initial factor analysis revealed that three factors had Eigenvalues greater than one. However, the scree plot showed that the two factor solution was adequate (Eigenvalues: Factor I was 7.88, Factor II was 5.65, and Factor III was 1.31). The result of the Varimax rotated two factor solution showed that the highly loaded items of each factor were perfectly identical with the items of each short version. These items are shown in Table 3.

Table 3 about here

The *mean* EQ-Short scores and *mean* SQ-Short scores and their *SD*s of the participants are shown in Table 4. The *skewnesses* and *kurtosis* of them were calculated. On the EQ-Short, *skewness* = - 0.110 and *kurtosis* = - 0.448. On the SQ-Short, *skewness* = 0.364 and *kurtosis* = - 0.536. These results suggest that the score distributions of the two scales are not skewed, and the kurtoses show that the distributions are slightly platykurtic but not so problematic. Pearson's product moment correlation coefficients

between EQ-Short score and SQ-Short score was r = - 0.149 (p<0.01) (r = 0.031, p = *n.s.* in males and r = - 0.069, p<0.05 in females).

Table 4 about here

3.3. Investigating the E – S theory by using the EQ-Short and SQ-Short

The results obtained in multivariate analyses and internal consistencies suggest that the EQ-Short and the SQ-Short are reliable and adequate to measure individual differences in empathizing and systemizing.

In addition to testing for sex differences, we analyzed the results according to degree/area of study to compare students between studying humanities vs. sciences, using definitions from former studies (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Wakabayashi et al., in press) in order to examine the validity of the E–S

theory. [1]

Mean EQ-Short and SQ-Short scores for each degree type are also shown in Table 4. Comparing groups using an ANOVA on the EQ-Short score by Sex and Degree, there was a main effect of Sex (F (1, 1757) = 177.623, p<0.001), female students scoring higher than male students. There was also a main effect of Degree (F (1, 1757) = 53.669, p<0.001), the students studying humanities scoring higher than students studying sciences. There was no Degree by Sex interaction. Similarly, comparing groups using an ANOVA on the SQ-Short score by Sex and Degree, there was a main effect of Sex (F (1, 1757)= 472.649, p<0.001), male students scoring higher than female students. There was again a main effect of Degree (F (1, 1757) = 388.156, p<0.001), the sciences students scoring higher than the humanities students. There was no interaction of Sex by Degree on the SQ-Short either.

3.4. Brain types

[1] Footnote

Finally, we examined the differences of numbers in each ‘brain type’ in terms of males and females, and humanities vs. sciences students. We transformed the raw EQ-Short and SQ-Short scores from each participant into standard (*T*) scores. Then we subtracted the standard EQ-Short (*T*) score from the standard SQ-Short (*T*) score for each participant. We call this difference score ‘D’. A high D score can be attained either by a high SQ-Short score with a low EQ-Short score, or vice versa. A low D score means the difference between scores in the EQ-Short and SQ-Short is small. The greater the D score in a positive direction, the stronger is one’s systemizing, and the greater the D score in a negative direction, the stronger one’s empathizing.

A D score falling below plus/minus ten (-10<D<10: within plus/minus 1 *SD*) is termed a brain of *type B* (Balanced brain), from ten to below twenty (10<D<20) is *type S*, and twenty and over (D>20) is the *extreme type S*. A D score falling from minus ten to above minus twenty (-10>D>-20) is a brain of *type E*, and minus twenty and below (D<-20) is an *extreme type E*. The percentages of participants fitting each brain type are shown in

Table 5. The distribution of *extreme type E* and *type E* was greater in females than in males, whilst the proportion of *extreme type S* and *type S* was greater in males than in females. The proportion of *extreme type E* and *type E* were greater in students studying humanities than among students studying sciences, whilst the proportion of *extreme type S* and *type S* were greater in sciences students than those studying humanities. These results were confirmed by a chi-square by sex (*chi-square* = 46.131, *df* = 4, $p<0.001$), and by degree (*chi-square* = 24.203, *df* = 4, $p<0.001$).

Table 5 about here

4. Discussion

In this study, we examined the psychometric properties of the EQ and SQ, and shortened the scales in order to reduce them to their essential items. Then, we tested the E-S theory of sex differences (Baron-Cohen, 2002) using the revised EQ (EQ-Short) and SQ (SQ-Short). Results of principal component analyses suggested that about half

the items were adequate to measure empathizing and systemizing respectively. The EQ-Short and SQ-Short were therefore constructed from 22 items and 25 items respectively. The internal consistency of each scale rose compared with their original 40-item scales, suggesting that the original scales contained some unnecessary items. The result of factor analysis by combining the EQ-Short and SQ-Short revealed that two factors corresponded to the empathizing and systemizing, and confirmed their independence.

As expected from the E–S theory, females scored significantly higher than males on the EQ-Short, and males scored significantly higher than females on the SQ-Short. This result replicates other studies using the original EQ and SQ (Baron-Cohen et al., 2003; Lawson, Baron-Cohen & Wheelwright, 2004). Regarding the area of study among the students, students in the humanities scored higher than students in the sciences on the EQ-Short, and reverse was shown on the SQ-Short. Although the EQ-Short and SQ-Short were inversely correlated (r = - 0.149), the size of the correlation coefficient was very low, suggesting the two scales are almost independent of each other. In support

of this view, the correlations between the two scales calculated in males and females separately were close to zero (r = 0.031 in males, and r = - 0.069 in females). However, there may be some trade-off between these two cognitive styles. This is suggested from the results comparing the degrees of the students participating. Students in the humanities scored significantly higher on the EQ-Short, and significantly lower on the SQ-Short, compared with the students in the sciences.

There were also clear sex differences, and effects of degree type, on the 5 brain types. 41% of females showed *types E* (*type E* or *extreme type E*) and 12% of females showed *types S* (*type S* or *extreme type S*). In contrast, 47% of males showed *types S* whilst about 7% of males showed *types E (type E or extreme type E)*. 38% of humanities students showed *types E* and 13% of them showed *types S*. In contrast, 17% of science students studying sciences showed *types E*, and 40% of them showed *types S*. These patterns of distribution are very similar to those found in the original EQ and SQ (Goldenfeld, et al., in press).

It might be suggested that empathizing has been amply investigated under the name of "emotional intelligence" and shares large parts of variance with this concept, and systemizing relates to the mental capacity of reasoning as measured by many intelligence tests. However, the SQ is uncorrelated with the Raven's Matrices as an index of IQ (Billington, Wheelwright, Baron-Cohen, Parekh, & Hoxley, submitted). We plan to test the relationship between the EQ and emotional intelligence measures in future studies.

This study suggests that it is important to investigate individual differences in cognitive styles as well as those in personality. Future studies will need to test the external validity for the EQ and SQ, such as comes from the relation between the SQ and mathematical ability or mental rotation and between the EQ and the theory of mind task. These studies have been proceeding in our lab. We conclude that the EQ-Short and the SQ-Short may be more useful methods for testing such individual differences in cognitive styles.

Finally, some limitations are remained. This study has been administered within

university students, and Cambridge University students could not be the representative sample as normal population. It would need further investigation in different populations.

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Footnote 1

Sciences included Physical Sciences (mathematics, physics, chemistry, computer science, engineering, etc.) and Biological Sciences (biology, neuroscience, physiology, medicine, genetics, pharmacology, etc.). Humanities included Humanities (classics, languages, education, law, history, philosophy, etc.) and Social Sciences (economics, commerce, social and political sciences, archaeology, etc.). We acknowledge that some Humanities (such as law or linguistics) or Social Sciences (such as economics) involve more systemizing than others, but these ways of dividing degree subjects may still capture some important differences between the highly lawful physical sciences and less lawful domains.

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Table 1 Mean scores (and *SD*s) of the EQ and SQ in original items

	N	EQ	SQ
All participants	1761	44.3 (12.23)	27.5 (12.43)
Males	723	39.0 (11.56)	33.1 (11.78)
Females	1038	48.0 (11.28)	23.7 (11.37)

Table 2 Loadings of PCA of the EQ and SQ

EQ-item	loadings	SQ-item	loadings
34	*0.751*	*8*	*0.736*
14	*0.711*	*10*	*0.642*
22	*0.702*	*22*	*0.623*
28	*0.642*	*12*	*0.602*
36	*0.634*	*3*	*0.599*
15	*0.633*	*39*	*0.588*
35	*0.613*	*5*	*0.584*
13	*0.605*	*14*	*0.580*
26	*0.582*	*35*	*0.568*
12	*0.579*	*34*	*0.558*
29	*0.566*	*25*	*0.554*
1	*0.557*	*6*	*0.530*
11	*0.552*	*27*	*0.523*
38	*0.534*	*23*	*0.508*
31	*0.517*	*28*	*0.504*
4	*0.505*	*30*	*0.490*
8	*0.505*	*21*	*0.483*
9	*0.460*	*32*	*0.480*
3	*0.449*	*9*	*0.479*
18	*0.448*	*16*	*0.443*
21	*0.427*	*20*	*0.434*
39	*0.419*	*37*	*0.416*
7	0.377	*33*	*0.412*
20	0.364	*7*	*0.410*
27	0.359	*24*	*0.410*
19	0.329	25	0.340
33	0.327	15	0.328
32	0.312	38	0.317
40	0.306	36	0.309
16	0.296	13	0.277
30	0.269	11	0.260
2	0.264	1	0.254
5	0.253	2	0.232
24	0.249	29	0.215
23	0.226	40	0.191

17	0.166	4	0.145
10	0.156	26	0.128
37	0.137	12	0.102
25	0.112	17	0.100
6	0.042	31	0.051

The items of the EQ-Short and SQ-Short were shown in italics

Table 3 Rotated factor loadings of the items in the EQ-Short and SQ-Short

Item	Factor I	Factor II
EQ 1	**0.564**	0.082
EQ 3	**0.441**	- 0.097
EQ 4	**0.509**	0.030
EQ 8	**0.499**	- 0.028
EQ 9	**0.459**	- 0.003
EQ11	**0.567**	0.104
EQ12	**0.566**	- 0.150
EQ13	**0.603**	- 0.028
EQ14	**0.711**	- 0.022
EQ15	**0.639**	0.036
EQ18	**0.434**	- 0.082
EQ21	**0.429**	0.040
EQ22	**0.705**	- 0.014
EQ26	**0.594**	0.118
EQ28	**0.641**	- 0.043
EQ29	**0.576**	0.077
EQ31	**0.499**	- 0.115
EQ34	**0.754**	0.006
EQ35	**0.617**	0.005
EQ36	**0.644**	0.042
EQ38	**0.541**	0.121
EQ39	**0.406**	- 0.167
SQ14	- 0.091	**0.570**
SQ33	- 0.026	**0.404**
SQ 3	- 0.027	**0.601**
SQ10	- 0.060	**0.634**
SQ25	- 0.080	**0.544**
SQ39	- 0.140	**0.564**
SQ28	- 0.109	**0.492**
SQ23	- 0.145	**0.491**
SQ 7	- 0.091	**0.406**
SQ 8	- 0.224	**0.702**
SQ16	0.007	**0.446**

SQ21	- 0.074	**0.463**
SQ37	- 0.019	**0.407**
SQ 5	- 0.161	**0.567**
SQ 6	- 0.142	**0.507**
SQ34	- 0.063	**0.556**
SQ27	- 0.045	**0.524**
SQ30	0.011	**0.492**
SQ12	- 0.122	**0.587**
SQ24	0.107	**0.420**
SQ27	- 0.062	**0.615**
SQ32	0.001	**0.477**
SQ 9	- 0.159	**0.451**
SQ20	0.057	**0.448**
SQ35	- 0.117	**0.548**
Cont.	8.747	8.213

Table 4 Mean score (and SDs) of the EQ-Short and SQ-Short

Group (*N*)	N	EQ-Short	SQ-Short
All participants	1761	23.8 (8.75)	19.0 (10.05)
Males	723	20.7 (8.46)	24.1 (9.55)
Females	1038	26.0 (8.27)	15.4 (8.77)
Humanities	867	25.3 (8.32)	15.0 (8.84)
Sciences	894	22.4 (8.92)	22.8 (9.68)

Males: 304 Humanities and 419 Sciences; Females: 563 Humanities and 475 Sciences.

Table 5 The distribution of the five cognitive styles (brain types) (%)

	Extreme E	Type E	Type B	Type S	Extreme S
Males	1.4	5.8	45.9	24.1	22.8
Females	15.4	25.9	46.6	8.5	3.6
Humanities	14.8	22.8	49.7	9.5	3.2
Sciences	4.7	12.6	43.1	20.1	19.5

Appendix: List of items of EQ-Short and SQ-Short

Empathy Quotient

1. I can easily tell if someone else wants to enter a conversation.
3. I really enjoy caring for other people.
4. I find it hard to know what to do in a social situation.*
8. I often find it difficult to judge if something is rude or polite.*
9. In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking.*
11. I can pick up quickly if someone says one thing but means another.
12. It is hard for me to see why some things upset people so much.*
13. I find it easy to put myself in somebody else's shoes.
14. I am good at predicting how someone will feel.
15. I am quick to spot when someone in a group is feeling awkward or uncomfortable.
18. I can't always see why someone should have felt offended by a remark.*
21. I don't tend to find social situations confusing.
22. Other people tell me I am good at understanding how they are feeling and what they are thinking.
26. I can easily tell if someone else is interested or bored with what I am saying.
28. Friends usually talk to me about their problems as they say that I am very understanding.
29. I can sense if I am intruding, even if the other person doesn't tell me.
31. Other people often say that I am insensitive, though I don't always see why.*
34. I can tune into how someone else feels rapidly and intuitively.
35. I can easily work out what another person might want to talk about.
36. I can tell if someone is masking their true emotion.
38. I am good at predicting what someone will do.
39. I tend to get emotionally involved with a friend's problems.

Systemizing

3. If I were buying a car, I would want to obtain specific information about its engine capacity.
5. If there was a problem with the electrical wiring in my home, I'd be able to fix it myself.
6. I rarely read articles or web pages about new technology.*
7. I do not enjoy games that involve a high degree of strategy.*
8. I am fascinated by how machines work.
9. In math, I am intrigued by the rules and patterns governing numbers.
10. I find it difficult to understand instruction manuals for putting appliances together.*

12. If I were buying a computer, I would want to know exact details about its hard disc drive capacity and processor speed.
14. I find it difficult to read and understand maps.*
16. When I look at a piece of furniture, I do not notice the details of how it was constructed.*
20. I find it difficult to learn my way around a new city.*
21. I do not tend to watch science documentaries on television or read articles about science and nature.*
22. If I were buying a stereo, I would want to know about its precise technical features.
23. I find it easy to grasp exactly how odds work in betting.
24. I am not very meticulous when I carry out D.I.Y.*
25. When I look at a building, I am curious about the precise way it was constructed.
27. I find it difficult to understand information the bank sends me on different investment and
saving systems.*
28. When travelling by train, I often wonder exactly how the rail networks are coordinated.
30. If I were buying a camera, I would not look carefully into the quality of the lens.*
32. When I hear the weather forecast, I am not very interested in the meteorological patterns.*
33. When I look a mountain, I think about how precisely it was formed.
34. I can easily visualize how the motorways in my region link up.
35. When I'm in a plane, I do not think about the aerodynamics.*
37. I am interested in knowing the path a river takes from its source to the sea.
39. I am not interested in understanding how wireless communication works.*

Nos. of items are in original versions. * reversal items