Relationship between Empathizing–Systemizing Cognitive Styles and Mind Reading among Japanese Adolescents

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Objective: “Mind reading” is the ability to understand another individual’s mental states. In particular, individuals with developmental disorders, such as autism spectrum disorders, have a deficit in mind reading abilities. Similarly, individual differences in mind reading also exist among the healthy population and are often the cause of misunderstandings. Although the Empathizing and Systemizing Theory (E-S theory) has been used to explain individual developmental differences, its applicability to mind reading among Japanese adolescents has not been investigated. Therefore, the purpose of this study was to examine whether the E-S theory explains individual differences in mind reading among Japanese adolescents.

Participants: Participants were 240 Japanese university students (\(M=20.58, SD=0.51\)).

Methods: We administered questionnaires based on Japanese versions of the Empathy and Systemizing Quotients, and the Reading the Mind in the Eyes Test.

Results: Empathizing, but not systemizing, was found to be related to mind reading. Additionally, relative differences in empathizing and systemizing, rather than its combination, were associated with mind reading.

Conclusion: Since relative differences in empathizing and systemizing affect mind reading, we concluded that the E-S theory explains individual differences in mind reading among Japanese adolescents.

Key words: mind reading, empathizing–systemizing theory, cognitive style, Japanese adolescents

Introduction

The development of personal relationships and effective communication is sustained by employing various social skills including empathy and “mind reading.” Mind reading is defined as the ability to understand others’ mental states\(^1\). Individuals with developmental disorders, such as autism spectrum disorders, have difficulty in developing mind reading abilities\(^2\). This deficit is a primary diagnostic criterion for these developmental disorders\(^3\). Similarly, some variation in mind reading abilities also exists among the healthy population and is often the cause of misunderstandings. Kawata et al.\(^4\) reported that a low level of mind reading was associated with a greater number of interpersonal stress events among Japanese adolescents; low mind reading contributed to ineffective interpersonal communication\(^4\). Furthermore, poor development of mind reading was linked to the attenuation of human relationships, emphasizing the urgent need to support healthy development of mind reading.

An overview of previous studies on the development of mind reading reveals two distinct standpoints\(^5\): one suggests that environmental factors affect its development, while the other attributes it to innate factors. With regard to environmental factors, parental nurturance\(^6\), presence or absence of siblings, and educational envi-
Ronvironment (e.g., multi-age classrooms) were reported to potentially influence the development of mind reading. Specifically, studies in developmental psychology and education focused on these environmental factors to identify psychological and educational intervention strategies for supporting the healthy development of mind reading. On the other hand, studies emphasizing innate factors suggested that fetal testosterone exposure may influence mind reading development. In the same vein, several studies have suggested that females demonstrate significantly superior mind reading: this has been demonstrated across several countries such as England, Hungary, France, Turkey, Germany, and Sweden.

The Empathizing–Systemizing theory (E-S theory) suggests that cognitive styles (empathizing and systemizing) affect the development of various abilities such as social and physical causality. Social causality is the ability to deduce the cause of an agent’s action (e.g., understanding that individuals behave because of their intentions, beliefs, and motivations). This allows us to understand other’s mental states and to develop healthy human relationships and build communities. Physical causality is the ability to deduce the cause of a non-agent’s movement (e.g., understanding that objects move because of external force), allowing us to understand rules and principles in physical systems and to construct new rule-based systems. Normal children develop both abilities from infancy onward, while children with autism spectrum disorders (ASD) show considerable deficits in social causality, although they demonstrate less impairments in physical causality ability, and occasionally demonstrate superior physical causality compared to healthy children. Thus, these two causal cognitions are regarded as highly independent domains, and perhaps have independent neurocognitive underpinnings.

Empathizing is defined as the tendency to identify another individual’s emotions and thoughts and to respond to these with appropriate emotions. An individual with high empathizing is often interested in others and their emotions, intuitively understands their mental states, and treats them with kindness. Prior studies confirmed that females exhibit superior empathizing than males, and that prenatal testosterone exposure inhibits presentation of empathizing in individuals.

Thus, empathizing is regarded as at least a partially innate predisposition. Systemizing is defined as the tendency to analyze variables in a system and to derive the underlying rules that govern the behavior of the system. A person with high systemizing is often interested in concrete objects and their mechanisms, and intuitively understands the rules or principles of a system. Prior studies confirmed that males exhibit superior systemizing than females, and that testosterone exposure promotes the development of systemizing in individuals. Similarly, systemizing is also regarded as at least a partially innate predisposition.

According to the E-S theory, the relative difference in empathizing and systemizing and the magnitude of each are associated with the development of various abilities. For humans, cognitive styles can be categorized into five types according to the relative difference of empathizing and systemizing (plotted on y- and x-axes, respec-
tively), as shown in Figure-1. "Extreme Type E," indicated by a dark grey zone at the top left corner of the figure, represents a cognitive style of highly superior empathizing relative to systemizing. "Type E," indicated by a light grey zone at the top left, represents a cognitive style of slightly superior empathizing relative to systemizing. "Type B," indicated by the white zone, is a cognitive style of balance between empathizing and systemizing. "Type S," indicated by a light grey zone on the bottom right of the figure, represents a cognitive style of slightly superior systemizing relative to empathizing. Finally, "Extreme Type S," indicated by a dark grey zone at the bottom right corner, represents a cognitive style of highly superior systemizing relative to empathizing. Research confirmed that, on average, females tend to be categorized into "Extreme Type E" or "Type E," whereas males are more likely to be categorized into "Extreme Type S" or "Type S." This implies that the balance of cognitive styles (empathizing and systemizing) plays an important role in the postnatal development of various abilities, including social and physical causality.

Prior research on E-S theory has been able to provide broader perspectives that help understand individual differences in the following ways: (1) It explains gender differences in cognitive styles. Women show superior empathizing, while men show superior systemizing. In addition, women tend to show high empathizing-related abilities such as empathy and vocabulary, while, men tend to show high systemizing-related abilities such as spatial cognition and mathematical skills. Thus, individual differences in empathizing and systemizing may help us understand psychological differences in men and women. (2) It helps understand differences in orientation among adolescents (university students). Humanities students show high empathizing, while students of the natural sciences show high systemizing. This implies that empathizing students are oriented to humanities, while systemized students are oriented to natural sciences. Thus, understanding individual differences in empathizing and systemizing can help students identify areas of interest, including their educational and career choices. (3) E-S theory provides an understanding of the complex mechanisms involved with autism spectrum disorders (ASD). Individuals with ASD show extremely high systemizing and low empathizing. Baron-Cohen proposed that ASD is a phenotype with one-side development in systemizing; he termed this as "extreme male brain theory of autism." Thus, examining individual differences in empathizing and systemizing can help understand the pathology and treatment of ASD from a medical and educational perspective.

Although the E-S theory aids our understanding of human development, the applicability of the E-S theory to mind reading development has not been examined in Japanese adolescents. Therefore, the purpose of this study was to examine whether the E-S theory explains individual differences in mind reading among Japanese adolescents. If the E-S theory can predict individual differences in mind reading abilities, it could help understand the obscure underpinnings of mind reading development. This is of particular importance in Japan, because Japanese culture relies on the ability to communicate with others by inferring others’ mental states using subtle non-verbal cues and rarely any verbalization of one’s own mental states.

**Methods**

1. **Participants**

We administered a questionnaire to 278 (139 male and 139 female) Japanese university students. We calculated the minimum sample size for this study using prior sample size analysis (decided by Pearson’s product-moment correlation analysis, effect size $r = 0.20$, statistical power $(1-\beta) = 80\%$, and $\alpha = 0.05$). The minimum sample size was $n = 194$. We collected responses from 278 participants because 70% (i.e., 194) of the completed questionnaires would be valid. There were 240 valid, gender-matched respondents (120 male and 120 female, mean age $= 20.58$, $SD = 0.51$) revising the valid response rate to 86.3%. Thus, the sample size met the initial statistical power. We collected data from two universities in the metropolitan region; students were closely matched in majors with 130 (54%) participants majoring in humanities (literature, education, and social welfare), and 110 (46%) in natural sciences (architectonics, pharmacy, and health and sports science). Inclusion criteria were being Japanese university students, aged 20–22
years, and primarily living in Japan; exclusion criteria were being diagnosed with a psychiatric disorder, and having lived in a foreign country for over 6 months. This was because some psychiatric disorders may influence mind reading\(^\text{12,10,25,26}\), and the mind reading measure used non-Japanese faces in this study, implying that those with greater contact with foreign nationals would have an advantage on the mind reading test.

2. Measurement

The questionnaire consisted of demographic information including sex, age, medical history, overseas residence history, and the Japanese versions of the Empathy Quotient (EQ), Systemizing Quotient (SQ)\(^\text{27}\), and Reading the Mind in the Eyes Test (RME)\(^\text{28}\).

The EQ is a self-report questionnaire consisting of 60 items (40 scored items and 20 fillers). The original English version of EQ was developed by Baron-Cohen et al.\(^\text{19}\), and was translated into Japanese by Wakabayashi et al.\(^\text{27}\). Participants were asked to indicate whether they “strongly agree,” “slightly agree,” “slightly disagree,” or “strongly disagree” with each statement. A “strongly agree” response was given a score of 2 points and “slightly agree” was given a score of 1 point; both “slightly disagree” and “strongly disagree” responses were given no points\(^\text{19}\). The EQ score was calculated by the summation of 40 scored items, with a possible range of 0-80, from no empathizing to extremely high empathizing.

The SQ is also a self-report questionnaire consisting of 60 items (40 scored items and 20 fillers). The original English version of the SQ was developed by Baron-Cohen et al.\(^\text{20}\) and was translated into Japanese by Wakabayashi et al.\(^\text{27}\). The SQ is scored in exactly the same fashion as the EQ. Thus, the possible range of SQ scores is 0-80, ranging from no systemizing to extremely high systemizing.

The RME consists of 36 eye-region photographs with four mental state words (one target word and three foil words) presented in the corner of the photographs (see Figure-2 and Figure-3). The original English version of the RME was developed in 1997\(^\text{29}\), revised in 2001\(^\text{2}\), and translated into Japanese by Yamada\(^\text{30}\). Participants were asked to choose the best word that described the person’s feelings and thoughts exhibited in each of the photographs. Correct answers were scored 1, and incorrect answers were scored 0. All of the photographs used non-Japanese models. However, according to Kawata et al.\(^\text{28}\), 19 photographs were applicable for use with Japanese adolescents without yielding cultural differences in cognition. Thus, we used only these 19 photographs for the analysis pertaining to the objectives of this study. Nonetheless, we used the non-Japanese RME test in this study to compare our results to previous studies conducted in other cultures worldwide. The RME score was calculated by summing the number of correct answers from the 19 scored photographs. Thus, RME scores ranged from 0 to 19 (i.e. low to high mind reading).

3. Procedure

This study was approved by the Research Ethics Committee at the School of Health and Sports Science, Juntendo University (Application No.
25-14). Informed consent was obtained from all participants. Each participant was made aware of his or her right to decline cooperation at any time, without detriment, even after consenting to participate. The questionnaire was administered in a quiet classroom with enough space to ensure that the participants’ privacy was maintained.

4. Statistical analysis
All statistical analyses were carried out using SPSS 21.0 for Windows (IBM Inc.). The accepted statistical significance was set as $p < 0.05$. First, we compared the means and standard deviations of all variable scores by gender. Second, in order to examine the relationship between empathizing, systemizing, and mind reading, we calculated Pearson’s product–moment correlation coefficient between EQ, SQ, and RME scores. In order to examine the relationship between the relative difference in empathizing and systemizing, and mind reading as per the E–S theory, we calculated Pearson’s product–moment correlation coefficients between the D score (the difference score of empathizing and systemizing) and the RME score. Furthermore, to examine the relationship between the total strength of both tendencies (empathizing and systemizing) and mind reading, we calculated Pearson’s product–moment correlation coefficient between the C score (the combination score of empathizing and systemizing) and the RME score.

We calculated D and C scores using Wheelwright et al.’s method. We first normalized individual EQ and SQ scores using the following formulae:

$$\text{Normalized Individual EQ (NEQ)} = \frac{(EQ \text{ score} - <EQ \text{ score}>)}{80}$$

$$\text{Normalized Individual SQ (NSQ)} = \frac{(SQ \text{ score} - <SQ \text{ score}>)}{80}$$

That is, we subtracted the typical population mean (denoted by $<\cdots>$) from the scores in this sample, then divided this by the maximum possible score (80 for EQ and SQ). In our study, the obtained means were 35.11 (EQ) and 19.18 (SQ). For instance, in the case of an individual with an EQ score of 25 and an SQ score of 25, the normalized EQ (NEQ) score would be $-0.126$ (calculated from the formula: $25 - 35.11 / 80$) and the normalized SQ (NSQ) score would be $0.073$ (calculated from the formula: $25 - 19.18 / 80$).

To produce the two new variables, D and C, the original EQ and SQ axes were rotated by 45° and the variables were normalized by 1/2 to be appropriate for axis rotation. These D and C variables are defined as follows:

$$D = \frac{(NSQ) - (NEQ)}{2} \quad \text{(i.e., the difference between the normalized SQ and EQ scores)}$$

$$C = \frac{(NSQ) + (NEQ)}{2} \quad \text{(i.e., the sum of the normalized SQ and EQ scores)}$$

That is, we subtracted the normalized EQ (NEQ) score from the normalized SQ (NSQ) score in this sample and then divided this by 2. For instance, in the case of the above-mentioned individual, the D score would be $0.100$ (calculated from the formula: $0.073 - (-0.126) / 2$) and C score would be $-0.027$ (calculated from the formula: $0.073 + (-0.126) / 2$).

The D score is the difference between participants’ SQ and EQ scores, representing the relative difference in empathizing and systemizing for each individual. A high D score indicates attainment of

![Figure 4](image_url)

**Figure 4** D and C axes in the Empathizing–Systemizing Model, based on the E–S theory. The black diagonal line (D axis) indicates the degree of the balance between empathizing and systemizing (D score). The dotted diagonal line (C axis) indicates the degree of the combination of empathizing and systemizing (C score).
superior systemizing relative to empathizing, while a low D score indicates attainment of superior empathizing relative to systemizing. Thus, D determines participants’ cognitive styles. A positive D score indicates “Type S” or “Extreme Type S,” a negative score indicates “Type E” or “Extreme Type E,” and a score around zero indicates “Type B.” The C score theoretically refers to the total strength of both tendencies (empathizing and systemizing) for each participant. A previous study found no difference in the mean C scores between males and females. D score (on the D axis) and C score (on the C axis) are conceptually depicted in Figure-4.

Results

1. Means and standard deviations of all variables

Table-1 shows the means and standard deviations of the EQ, SQ, D, C, and RME scores of the sample. We compared all variable scores by gender using independent t-tests. Females obtained a significantly higher EQ score than did males (t(1,238) = 2.21, p < .05). Contrary to this, males obtained a significantly higher SQ score (t(1,238) = 5.72, p < .001) and D score (t(1,238) = 6.51, p < .001) than did females. For C score, there was no significant difference between males and females (t(1,238) = 1.88). With regard to RME score, females obtained a significantly higher score than did males (t(1,238) = 4.22, p < .001).

2. Relationship between empathizing and mind reading

A significant relationship between empathizing (EQ score) and mind reading (RME score) was found using Pearson’s product-moment correlation coefficient (r = 0.31, p < .001) (see Figure-5).

3. Relationship between systemizing and mind reading

The Pearson’s product-moment correlation coefficient used to examine the relationship between systemizing (SQ score) and mind reading (RME score) indicated no significant association (r = -0.12) (see Figure-6).

4. Relationship of the relative difference in empathizing and systemizing with mind reading

A significant negative relationship between the relative difference in empathizing and systemizing (D score) and mind reading (RME score) was found using Pearson’s product-moment correlation coefficient (r = -0.35, p < .001) (see Figure-7).

5. Relationship of the combination of empathizing and systemizing with mind reading

No significant relationship between the combination of empathizing and systemizing (C score) and mind reading (RME score) was found using Pearson’s product-moment correlation coefficient (r = 0.12) (see Figure-8).

Discussion

The purpose of this study was to examine whether E–S theory explains individual differences in mind reading among Japanese adolescents.

We compared EQ and SQ scores to examine gender differences, if any. The results showed that scoring patterns among Japanese adolescents were consistent with studies conducted in countries culturally different from Japan. Females obtained higher EQ scores than males, and males obtained higher SQ scores than females. This implies that females, as compared to males,

<table>
<thead>
<tr>
<th>Table-1</th>
<th>Means, standard deviations, and t-values of the five variable scores for males and females</th>
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<tbody>
<tr>
<td></td>
<td>All</td>
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<tr>
<td>EQ score</td>
<td>35.11</td>
</tr>
<tr>
<td>SQ score</td>
<td>19.18</td>
</tr>
<tr>
<td>D score</td>
<td>0.001</td>
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<tr>
<td>C score</td>
<td>0.002</td>
</tr>
<tr>
<td>RME score</td>
<td>13.72</td>
</tr>
</tbody>
</table>

M: mean, SD: standard deviation, *p < .05, **p < .01, ***p < .001
EQ: Empathy Quotient, SQ: Systemizing Quotient, D: Difference, C: Combination, RME: Reading the Mind in the Eyes test
demonstrated a greater tendency to identify with another's emotions and thoughts, and respond with an appropriate emotion. On the other hand, males demonstrated a greater tendency to analyze, understand, predict, control, and construct rule-based systems.

Gender differences in D and C scores were consistent with previous studies, that is, males obtained a higher D score than did females, and no gender difference was found for the C score. The D score represents the relative difference in empathizing and systemizing; a high D score indicates a cognitive style wherein systemizing is superior to empathizing (systemized cognitive style). Thus, the results supported the observation that females have superior empathizing skills and males have superior systemizing skills. The C score analysis suggested that the combination of empathizing and systemizing does not have a significant effect on mind reading. These results were consistent with previous studies conducted in England. We therefore considered the E-S theory, constructed based on an English population, applicable to the Japanese adolescents in this study.

A comparison of gender differences in the RME scores revealed that among Japanese adolescents,
females scored higher than males; this was identical to findings in previous studies. This result also supports the finding that biological differences may influence the development of mind reading.

Furthermore, we examined the relationship between empathizing, systemizing, and mind reading. Empathizing was found to be positively associated with mind reading, while no association was found between systemizing and mind reading. We then examined the relationships between the relative difference in empathizing and systemizing (D score), the combination of empathizing and systemizing (C score), and mind reading. The results indicated that the D score was inversely related to mind reading and the C score was not associated with mind reading, further suggesting that individuals with a superior empathizing cognitive style (empathizing > systemizing) would be much better at mind reading than individuals with a systemizing cognitive style (empathizing < systemizing). This result was consistent with the E-S theory, stating that the relative difference of empathizing and systemizing influences the development of various abilities related to social and physical causality. In particular, empathizing cognitive style was associated with mind reading ability and was regarded as a component of social causality. Moreover, a comparison of the correlations between empathizing and mind reading ($r = .31$) and between D score and mind reading ($r = .35$) reveals the latter to be slightly greater. Hence, the results suggest that a superior empathizing cognitive style—the relative superiority of empathizing to systemizing, rather than only its magnitude—has important implications in understanding mind reading ability.

This study has implications for constructing support systems for healthy individuals with low mind reading as well as individuals with ASD. By assessing both systemizing and empathizing cognitive styles in childhood, we could predict whether individuals are likely to have problems developing mind reading abilities when older. Baron-Cohen and his colleagues have developed a version of the Empathy Quotient and Systemizing Quotient for children. Although, the applicability of these questionnaires for Japanese children has not been clarified, this approach may be beneficial for initiating early detection supports, especially, since, early diagnosis and treatment adapted to individual needs is important for dealing with problems in communication and social causality among individuals with ASD.

Through this study, we found that the results consistently corresponded to the primary assertion of the E-S theory, that is, the relative difference in empathizing and systemizing has an impact on development of various abilities. Thus, the E-S theory, representing a potential or partially innate predisposition in human beings, can be applied to understand individual differences in mind reading among Japanese adolescents.

**Conclusion**

We concluded that the E-S theory explains individual differences in mind reading among Japanese adolescents.

**Limitations**

We identified at least two limitations of this study. First, the RME test used non-Japanese faces to measure mind reading. While it would have been more appropriate to use Japanese faces, an RME test using Japanese faces with sufficient reliability and validity needs to be developed. Second, the measurement of mind reading was based only on the eye region. We primarily used this test to measure the detection of subtle cues, and therefore nuanced differences in mind reading among healthy adolescents. However, in practice, mind reading occurs through other nonverbal and verbal social cues. Therefore, to corroborate our findings, further research could test mind reading using social cues besides eye regions (e.g., tone of voice). Research employing the aforementioned revisions and suggestions would lend substantial support to the findings of the present study—that is, that empathy and mind reading are key factors for effective communication, especially in Japan.

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