



# Development and sex differences in social communication from primary school to adolescence : Formulation of an advanced test of theory of mind, Japanese version

Itoh, Masako

Takada, Satoshi

---

(Citation)

Bulletin of health sciences Kobe, 19:63-79

(Issue Date)

2004-03-25

(Resource Type)

departmental bulletin paper

(Version)

Version of Record

(JaLCD0I)

<https://doi.org/10.24546/00391936>

(URL)

<https://hdl.handle.net/20.500.14094/00391936>



# **Development and sex differences in social communication from primary school to adolescence : Formulation of an advanced test of theory of mind, Japanese version**

Masako ITOH<sup>1,2,\*</sup>, Satoshi TAKADA<sup>1</sup>

**Backgrounds and Methods:** Children exhibiting high functioning autism (HFA) and Asperger's disorder (AS) are generally characterized by poor social communication. To develop a method to evaluate their skills, we devised a new advanced test of theory of mind, modified and adaptable to Japanese cultural traits, comprised of ten tasks, based on Happé's test<sup>1)</sup>. This study covers normal 1,204 children and 55 young adults and is intended to clarify age and sex differences in social communication of children ranging from primary school to adolescence.

**Results:** The probability of succeeding in the tasks increases with subject age. The 50% passing rate for tasks evaluating the subject's grasp of lies, simile, pretending, appearance / reality, and contrary emotion was achieved by first graders. Similarly, a 50% success rate for the tasks evaluating understanding of white lies and metaphor was achieved by second graders; joke and persuasion by fourth graders; and sarcasm by fifth graders. With respect to sex differences, the five tasks of appearance / reality, whitelies, metaphor, joke, and persuasion were accomplished by female subjects one year before male counterparts. For the two tasks evaluating understanding of sarcasm and persuasion, male students are unable to achieve an 80% success rate even in the ninth grade. Even for young adults, the probability of succeeding in the task of persuasion is significantly higher with female subjects.

**Conclusions:** The results of our study indicate that in handling problems in interpersonal relations, we must recognize developmental differences in social communication with respect to age and sex before attempting interventions.

## **Key Words**

Theory of mind,  
social communication,  
development,  
sex differences,  
primary school to adolescence.

## **Introduction**

Children demonstrating high functioning autism (HFA) and Asperger's disorder (AS) are generally poor at understanding jokes, sarcasm, and other implicit meanings, and tend to experience difficulty in interpersonal communications when they reach the fourth to sixth grade<sup>2)</sup>. However, no method for evaluating social communication has been devised in Japan.

An advanced test of theory of mind<sup>1)</sup> was developed to ascertain the understanding of implicit meanings. In order

---

1 Division of Health Sciences, Graduate School of Medicine, Kobe University, Kobe, Japan

2 Osaka College of Rehabilitation, Osaka, Japan

to develop a method for evaluating social communication of children with HFA/AS, we conducted preliminary studies to modify the advanced test of theory of mind to make it suitable for Japanese cultural traits<sup>3-5)</sup>. The results indicate that while the probability of normal children succeeding in the tasks increases with age, HFA/AS subjects generally exhibit impairment in this area.

While research into the "Theory of Mind" has drawn much attention since 1978<sup>6)</sup>, most studies have focused on the years of early childhood (3–6 years of age). There have been relatively few standard materials on development and sex differences with respect to the faculty of understanding the minds of others, specifically, classmates and adults.

Based on the results of our preliminary study, this study is intended to clarify 1) the likelihood of succeeding in the tasks classified by age and 2) sex differences in the development of social communication of children from primary school to adolescence, utilizing a modified advanced test of theory of mind consisting of newly devised tasks, based

on Happé's test<sup>1)</sup>.

## Subjects and Methods

We secured informed consent from all 1,204 (597 male and 607 female) students in ordinary classes of two primary schools and one junior high school in Hyogo Prefecture (Table 1), and from 55 young adults (24.5±6.2 years).

We used ten tasks involving the understanding of lie, white lies, simile, metaphor, pretending, appearance/reality, contrary emotion, joke, sarcasm, and persuasion in settings calling for social communication settings. These tasks were compiled in workbook format, with two illustrations for each (Fig.1).

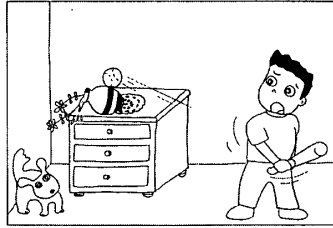
The tasks were actually implemented during the course of a single lesson period (45–60 min.) by a homeroom teacher delivering workbooks to subjects. Subjects read two sets of questions (Q 1 and Q 2) composed for each task and selected their answers. Q 1 was "Is what the character said true?" The point of this question was to ascertain whether the subject understood the objective facts described in each task. Subjects were to select one of the following options "Yes," "No," or "I don't know." Q 2 was "Why did the character say that?" Subjects were to write free form responses. Necessary precautions were taken by briefing each teacher in advance to ensure that the subjects would not discuss the questions among themselves, and that assistance would be provided only to those having difficulties reading the text or writing out their answers.

To ensure reliability, the analyses focused on answers to Q 2 for subjects

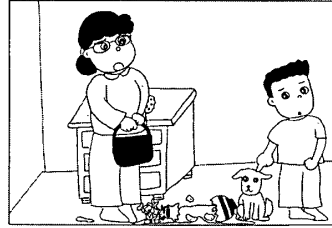
**Table 1.** Number, grade and sex of subjects

| Grade | Male | Female | Total |
|-------|------|--------|-------|
| 1 st  | 76   | 73     | 149   |
| 2 nd  | 70   | 84     | 154   |
| 3 rd  | 71   | 80     | 151   |
| 4 th  | 79   | 80     | 159   |
| 5 th  | 90   | 85     | 175   |
| 6 th  | 88   | 75     | 163   |
| 7 th  | 53   | 37     | 90    |
| 8 th  | 30   | 47     | 77    |
| 9 th  | 40   | 46     | 86    |
| Total | 597  | 607    | 1204  |

Lie

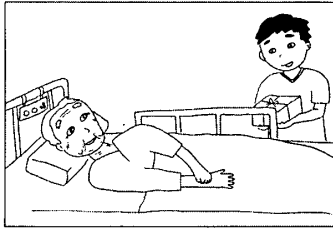


While his mother is away, Goro breaks her favorite vase playing ball.

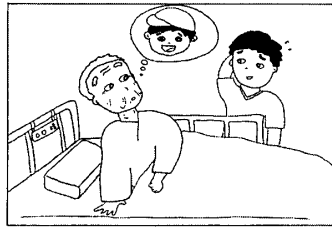


When his mother comes home and asks him: "What happened to the vase?" he said: "I didn't do it, the dog did it."

White lie

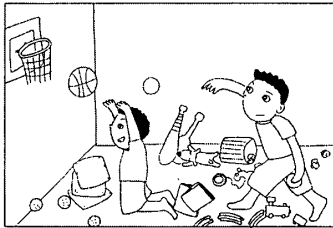


While his younger brother goes outside to play, Mitsuo dutifully heads to the hospital to visit his grandfather.

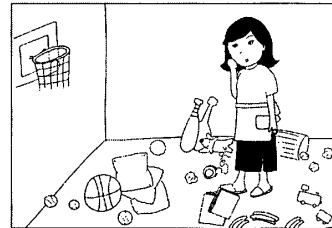


When his grandfather asks him: "Where is your brother?" he says: "He's home sick."

Simile

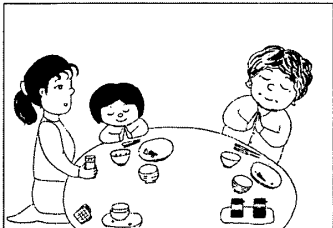


Two brothers are playing basketball in their room.

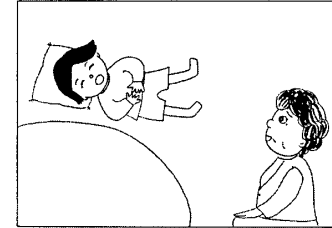


They then go outside, leaving the room a mess. Their mother says: "It looks like a storm just passed through here."

Metaphor

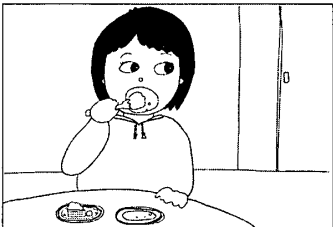


Asami has dinner at her grandmother's house.

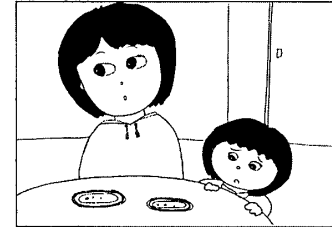


Feeling full, she lies down. Her grandmother says to her: "You'll turn into a cow if you lie down right after eating."

Pretending



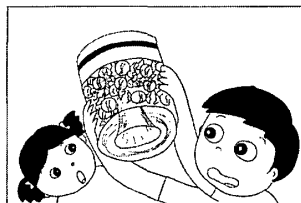
Sachiko eats her younger sister's cake.



The sister appears sad and says: "My cake is gone." Sachiko says: "I don't know anything about your cake."

Fig. 1-1. All tasks 1

Appearance/  
reality



A novelty bottle appears to contain more candy than it holds.

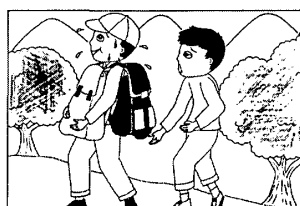


The store clerk says, "There are plenty of candies in it."

Contrary  
emotion

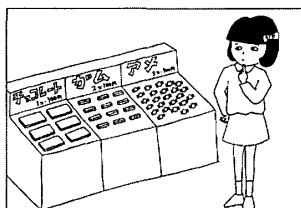


Two good friends, Taro and Jiro, go hiking together.

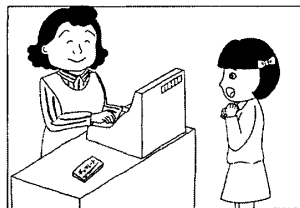


As Jiro is suddenly struck with stomach pains, Taro carries both his friend's bag and his own. Jiro asks Taro: "I'm so sorry. Aren't both bags too heavy for you?" Taro responds: "Not at all."

Joke



Megumi goes to the store to buy sweets.

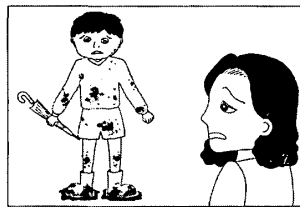


At the counter, as she gets ready to pay for a chocolate bar that costs one hundred yen, the store clerk tells her: "That will be one million yen."

Sarcasm

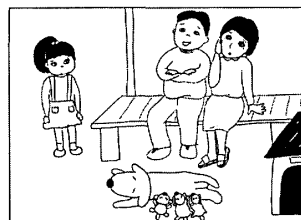


Satoru plays in a muddy puddle.

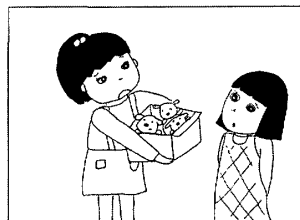


As he comes home covered with mud, his mother says, "How clean your clothes look!"

Persuasion



Her dog just having given birth to puppies, Akiko is at a loss as to what to do with them. Her parents will not simply abandon the puppies.



Akiko goes to Kaori's house with the puppies. When Kaori tells her that she doesn't want them, Akiko says: "If you don't take them, my parents will make me get rid of them."

Fig. 1-2. All tasks 2

who had indicated their understanding of the situations presented by correctly answering Q 1 and excluded subjects who did not answer Q 1 correctly. Answers were categorized by the KJ method<sup>7)</sup> to evaluate the reasoning exhibited in the answers and to project the probability of passing. The first-stage categorization was to determine whether the replies successfully surmised "mental states," comprised of the thoughts and emotions of the characters in the vignettes, or were affected by "physical states," comprised of physical appearances and other non-mental factors. Replies satisfying the intentions of the questions were categorized into "A Group," while the other replies were designated the "Non-A Group." The rate of "A Group" among the total subject population is occupationally defined as the passing rate. These rates were calculated for the respective grades and sexes. The passing rate curve was subjected to regression analysis, and grade and sex differences were analyzed by a chi-square test. The level of significance was set at less than 5%. Microsoft Excel (version 2002) was used to categorize replies. The SPSS 11.0 J program for Windows 98 was used for statistical processing. In response categorization, double checks were conducted by two evaluators, including the lead author, on all collected replies. If multiple answers were written for a single task, analysis was conducted on the best response. That is, if a subject's answer included both physical and mental states, the justification would be scored as mental states. Similarly, if a subject gave both A Group and Non-A Group answers.

## Results

### 1. Passing rate by age

#### 1.1. Primary and junior-high school students

Lie: 1,177 subjects providing the correct answer to Q 1 were analyzed. There were 1,126 subjects in "A Group" (95.7%) (Table 2), among whom only 7 subjects (0.6%) responded, "He told a lie," about 89.0% of whom cited "He would be scolded," or "He does not want to be scolded" as reasons. The "Non-A Group" included replies indicating facts, such as "Goro broke it" (0.9%). The passing rates by age indicated a significant improvement up to the third grade. More than 80% of first graders succeeded in the task (Fig. 2-A).

White lies: Analyses were conducted on 1159 subjects, among whom 781 (67.4%) were categorized into the "A Group" (Table 2). Among them, more than half—56.0%—replied surmising the feelings of the elder brother who took consideration not to hurt the grandfather's feelings, such as "Making the grandfather feel sad," etc., followed by "Hard to say his brother went out" (6.5%), "Trying to protect the younger brother" (4.7%), and two girls replying "Considering the grandfather's feelings and trying to protect the younger brother" (0.2%). "Group A" was thus divided into these four sub-groups. "Non-A Group" included replies such as "Because the younger brother went out" (9.1%). The passing rates by age indicated a significant increase between the first and the second grades, exceeding 80% among sixth graders (Fig. 2-B).

Simile: 1153 subjects were analyzed,

**Table 2.** Passing rates and sex differences

| Primary and junior high school students |                   |     |       |         |     |        |                 |      |                |                   | Young adults |        |         |    |                |                 |      |    |      |    |      |         |
|-----------------------------------------|-------------------|-----|-------|---------|-----|--------|-----------------|------|----------------|-------------------|--------------|--------|---------|----|----------------|-----------------|------|----|------|----|------|---------|
| Tasks                                   | Subjects analyzed |     |       | A Group |     |        | Sex differences |      |                | Subjects analyzed |              |        | A Group |    |                | Sex differences |      |    |      |    |      |         |
|                                         | Male              |     | Total | Male    |     | Female | Total           |      | (Female> Male) | Male              |              | Female | Total   |    | (Female> Male) |                 |      |    |      |    |      |         |
|                                         | n                 | %   | n     | %       | n   | %      | n               | %    | n              | %                 | n            | %      | n       | %  | n              | %               |      |    |      |    |      |         |
| Lie                                     | 580               | 597 | 1177  | 97.8    | 552 | 95.2   | 574             | 96.1 | 1126           | 95.7              | ns           | 25     | 29      | 54 | 98.2           | 23              | 92   | 29 | 100  | 52 | 96.3 | ns      |
|                                         | 573               | 586 | 1159  | 96.3    | 359 | 62.7   | 422             | 72   | 781            | 67.4              | p=0.001      | 21     | 27      | 48 | 87.3           | 18              | 85.7 | 26 | 96.3 | 44 | 91.7 | ns      |
|                                         | 571               | 582 | 1153  | 95.8    | 506 | 88.6   | 538             | 92.4 | 1044           | 90.5              | p=0.034      | 24     | 30      | 54 | 98.2           | 21              | 87.5 | 29 | 96.7 | 50 | 92.6 | ns      |
| Metaphor                                | 524               | 528 | 1072  | 89      | 368 | 70.2   | 407             | 74.3 | 775            | 72.3              | ns           | 25     | 29      | 54 | 98.2           | 24              | 96   | 29 | 100  | 53 | 98.1 | ns      |
| Pretending                              | 581               | 596 | 1177  | 97.8    | 497 | 85.5   | 535             | 89.8 | 1032           | 87.7              | p=0.034      | 25     | 30      | 55 | 100            | 24              | 96   | 28 | 93.3 | 52 | 94.5 | ns      |
| Appearance/<br>reality                  | 460               | 532 | 992   | 82.4    | 348 | 75.7   | 426             | 80.1 | 774            | 78                | ns           | 23     | 30      | 53 | 96.4           | 21              | 91.3 | 27 | 90   | 48 | 90.6 | ns      |
| Contrary emo-<br>tion                   | 547               | 577 | 1124  | 93.4    | 473 | 86.5   | 524             | 90.8 | 997            | 88.7              | p=0.027      | 22     | 25      | 47 | 85.5           | 22              | 100  | 25 | 100  | 47 | 100  | ns      |
| Joke                                    | 579               | 587 | 1166  | 96.8    | 318 | 54.9   | 363             | 61.8 | 681            | 58.4              | p=0.019      | 25     | 30      | 55 | 100            | 23              | 92   | 30 | 100  | 53 | 96.4 | ns      |
| Sarcasm                                 | 562               | 597 | 1159  | 96.3    | 232 | 41.3   | 303             | 50.8 | 535            | 46.2              | p=0.002      | 24     | 30      | 54 | 98.2           | 20              | 83.3 | 28 | 93.3 | 48 | 88.9 | ns      |
| Persuasion                              | 544               | 577 | 1121  | 93.1    | 286 | 52.6   | 381             | 66   | 667            | 59.5              | p=6.0 e-06*  | 25     | 30      | 55 | 100            | 19              | 76   | 30 | 100  | 49 | 89.1 | P=0.016 |

\*: floating point expression

among whom 1044 (90.5%) were categorized into "A Group" (Table 2), which can be subdivided into those who indicated understanding of the intended similes, such as "cluttered like after a storm," etc. (89.9%) and those who surmised the mental state of the mother, as expressed by "Appalled" (0.6%). "Non-A Group" included replies such as "The mother did not know that brothers were playing" (1.7%). The passing rate by age indicated a significant increase between the first grade and the second grade, and went over 80% among second graders (Fig. 2-C).

**Metaphor:** Analyses were conducted on 1072 subjects, among whom 775 (72.3%) were categorized into "A Group" (Table 2), which can be subdivided into those who indicated understanding on the intended metaphoric expressions, such as "proverbs" and "bad manners," etc. (37.8%) and those who replied, "She wanted to say that Asami may get fat" (34.5%). The "A Group" was categorized into these two subgroups. "Non-A Group" included replies such as "Joke" (3.9%) and "Not fun if fallen into sleep" (1.2%), etc. The passing rate by age indicated a rapid increase up to the third grade and exceeded 80% among the second graders (Fig. 2-D).

**Pretending:** 1177 subjects were analyzed, among whom 1032 (87.7%) were categorized into "A Group" (Table 2), which may be further categorized into two subgroups: those replying "Trying to avoid others from finding out that she has eaten it, pretending ignorance" (38.3%) and those anticipating the future, as in "Sachiko would be scolded (if her sister finds out)," (49.4%). "Non-A Group" included replies such as "Sachiko

wanted to eat it" (4.1%), etc. The passing rate by age indicated a significant increase between the first grade and the second grade, as well as between the third grade and the fourth grade. The passing rate exceeded 80% among the second graders (Fig. 2-E).

**Appearance/reality:** 992 subjects were analyzed, among whom 774 (78.0%) were categorized into "A Group" (Table 2), which can be further categorized into two subgroups: those replying "Because the store clerk wanted to sell the candies by telling the girl there were many in the novelty bottle" and "Business" (73.4%), and those surmising the mental state of the woman intending to communicate with children, as in "Joke" (4.6%). "Non-A Group" included replies such as "It looked as if there were (actually) many in it" (2.6%), etc. The passing rate by age exceeded 80% among fifth graders (Fig. 3-A).

**Contrary emotion:** 1124 subjects were analyzed, among whom 997 (88.7%) were categorized into "A Group" (Table 2), which can be further categorized into three subgroups: those surmising Taro's kind consideration toward the friend, as in "Taro does not want to make Jiro carry the bag, as Jiro has a stomach-ache," etc. (74.6%); "(Taro's) bold front" (10.6%); and "friendship" (3.5%). "Non-A Group" included replies such as "Lie" (1.7%), etc. The passing rate by age indicated a significant increase between the first and second grades, as well as between the fourth and fifth grades. The passing rate exceeded 80% among second graders (Fig. 3-B).

**Joke:** 1166 subjects were analyzed, among whom 681 (58.4%) were catego-

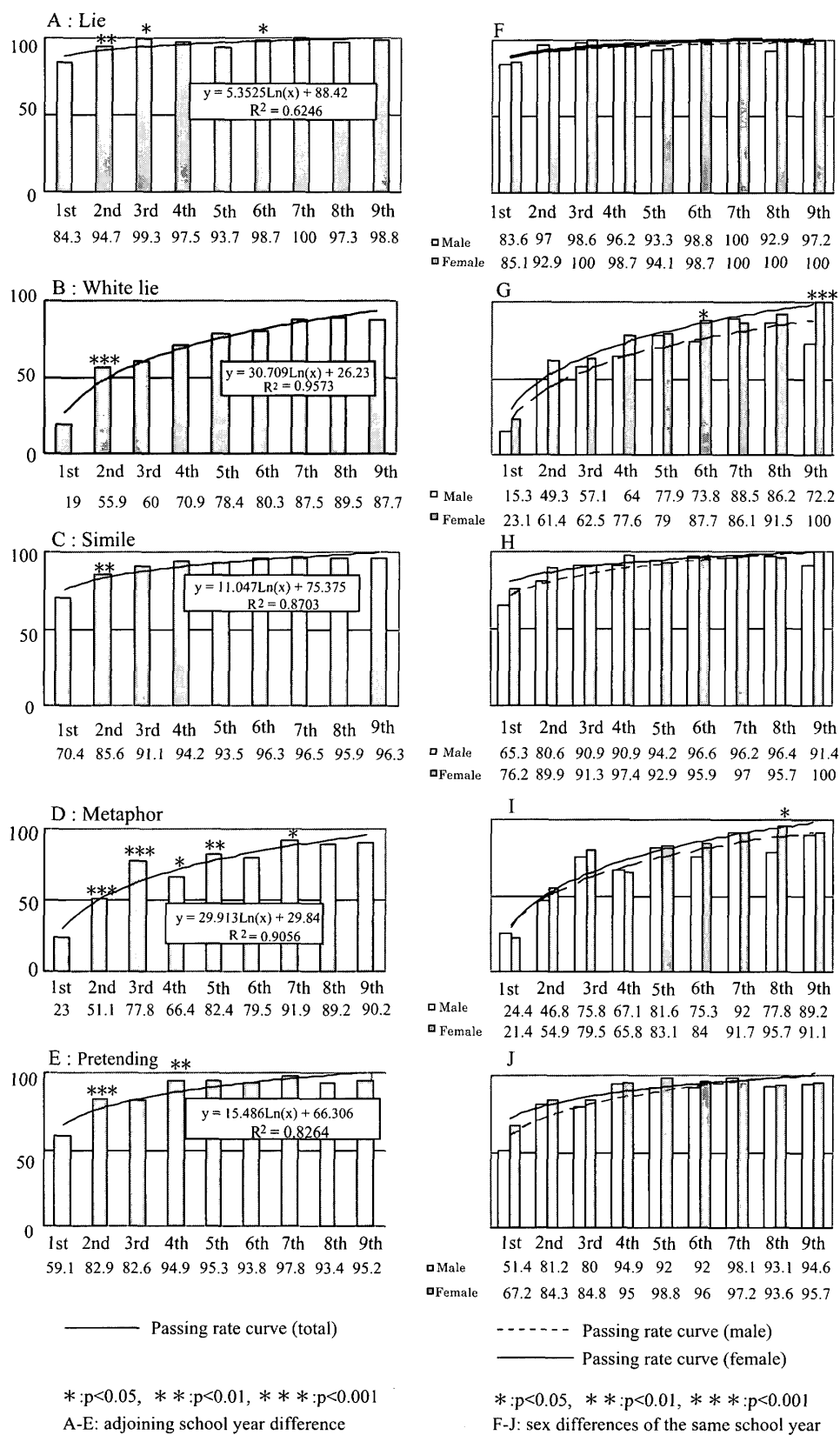


Fig. 2. Passing rate by age (A-E)• Passing rate by gender (F-J) 1

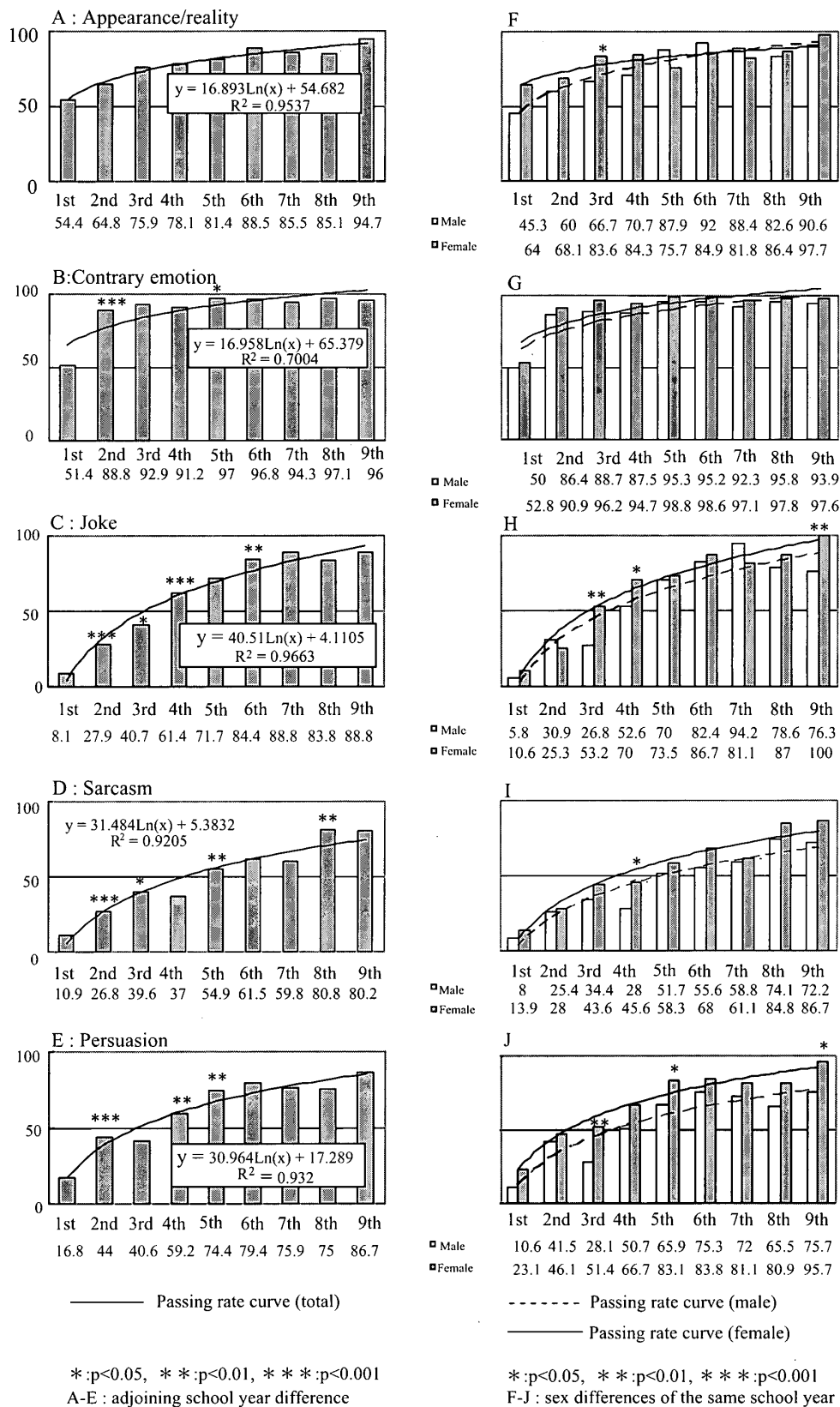


Fig. 3. Passing rate by age (A-E)• Passing rate by gender (F-J) 2

**Table 3.** Ages at which 50% and 80% passing rates are achieved

| Tasks                  | 50%   |      |        |      |       |      | 80%   |      |        |      |       |      |
|------------------------|-------|------|--------|------|-------|------|-------|------|--------|------|-------|------|
|                        | Male  |      | Female |      | Total |      | Male  |      | Female |      | Total |      |
|                        | Grade | %    | Grade  | %    | Grade | %    | Grade | %    | Grade  | %    | Grade | %    |
| Lie                    | <1 st | 83.6 | <1 st  | 85.1 | <1 st | 84.3 | <1 st | 83.6 | <1 st  | 85.1 | <1 st | 84.3 |
| White lie              | 3 rd  | 57.1 | 2 nd   | 61.4 | 2 nd  | 55.9 | 7 th  | 88.5 | 6 th   | 87.7 | 6 th  | 80.3 |
| Simile                 | <1 st | 65.3 | <1 st  | 76.2 | <1 st | 70.4 | 2 nd  | 80.6 | 2 nd   | 89.9 | 2 nd  | 85.6 |
| Metaphor               | 3 rd  | 75.8 | 2 nd   | 54.9 | 2 nd  | 51.1 | 5 th  | 81.6 | 5 th   | 83.1 | 5 th  | 82.4 |
| Pretending             | <1 st | 51.4 | <1 st  | 67.2 | <1 st | 59.1 | 2 nd  | 81.2 | 2 nd   | 84.3 | 2 nd  | 82.9 |
| Appearance/<br>reality | 2 nd  | 60   | <1 st  | 64   | <1 st | 54.4 | 5 th  | 87.9 | 4 th   | 84.3 | 5 th  | 81.4 |
| Contrary emo-<br>tion  | <1 st | 50   | <1 st  | 52.8 | <1 st | 51.4 | 2 nd  | 86.4 | 2 nd   | 90.9 | 2 nd  | 88.8 |
| Joke                   | 4 th  | 52.6 | 3 rd   | 53.2 | 4 th  | 61.4 | 6 th  | 82.4 | 6 th   | 86.7 | 6 th  | 84.4 |
| Sarcasm                | 5 th  | 51.7 | 5 th   | 58.3 | 5 th  | 54.9 | >9 th |      | 8 th   | 84.8 | 8 th  | 80.8 |
| Persuasion             | 4 th  | 50.7 | 3 rd   | 51.4 | 4 th  | 59.2 | >9 th |      | 5 th   | 83.1 | 9 th  | 86.7 |

\*First columns indicate ages at which subjects first achieved 50% or 80% rates; second columns indicate specific passing rates.

rized into “A Group” (Table 2), which included those surmising the intent of the store clerk to be friendly with the girl, as in “Joke” (25.3%), “To surprise” (16.6%), and “To amuse the girl” (6.1%). “Non-A Group” included replies such as “The store clerk wanted to make more money” (8.7%) and “Mistake” (15.9%), etc. The passing rate by age indicated a significant increase between the first and fourth grades, as well as between the fifth and sixth grades. The passing rate exceeded 80% among sixth graders (Fig. 3-C).

Sarcasm: 1159 subjects were analyzed, among whom 535 (46.2%) were categorized into “A Group” (Table 2), which included those replying “Sarcastic” (13.2%), “Flabbergasted” (7.9%), and “Too dirty” (16.0%), etc. “Non-A

Group” included replies such as “Mud looked like a designed pattern” (11.0%) and “Pitiful” (6.2%), etc. The passing rate by age indicated significant increases between the first and third grades, between the fourth and fifth grades, and between the seventh and eighth grades. The passing rate exceeded 80% among eighth graders (Fig. 3-D).

Persuasion: 1121 subjects were analyzed, among whom 667 (59.5%) were categorized into “A Group” (Table 2), which was further categorized into the five following subgroups: More than half replied, “She wanted the friend to have the puppy no matter what, persuasion” (52.8%), “Pitiful puppies” (5.7%), “She wanted to give the puppies away, as the parents were perplexed” (0.4%), “She doesn’t know what to do and

pushed them off" (0.5%); and one girl commenting "The parents were perplexed and did not want to abandon the puppies, so she wanted the friend to keep the puppies" (0.1%). The "Non-A Group" included replies such as "She doesn't like dogs" (9.8%), etc. The passing rate by age indicated significant improvements between the first and second grades, as well as between the third and fifth grades. The passing rate exceeded 80% among ninth graders (Fig. 3-E).

### 1.2. Young adult

With respect to passing rates for young adults, the highest rate was achieved for "contrary emotion" (100%), while the lowest was achieved for "sarcasm" (88.9%), indicating a 90–100% consistency with expected task results (Table 2).

## 2. Task-specific age levels capable of understanding and pertinent for screening

Table 3 indicates ages at which 50% and 80% probabilities of passing were achieved. By designating the 50% threshold of passing tasks as the age levels of understanding, first graders were determined to be capable of understanding lies, similes, pretending, appearances/realities, and contrary emotions; second graders capable of understanding white lies and metaphors; fourth graders capable of understanding jokes and persuasions; and fifth graders capable of understanding sarcasm.

Designating the 80% threshold for passing tasks as the age level for screening defines lies to be for first graders and older; similes, pretences, and contrary emotions may be for second grad-

ers and older; metaphors and appearances/realities may be for fifth graders and older; white lies and jokes may be for sixth graders and older; sarcasm may be for eighth graders and older; and persuasion maybe for ninth graders and older.

## 3. Sex differences

In the passing rates for primary and junior high school students combined, female students exhibited significantly higher passing rates than male students in seven (white lie, simile, pretending, contrary emotion, joke, sarcasm, and persuasion) of the ten tasks. In the other three tasks (lie, metaphor, appearance/reality), while male passing rates were lower than those of females, the differences were insignificant (Table 2).

With respect to sex differences in passing rates by age, the rates for lies increase with age similarly for both sexes. No sex difference was observed there (Fig. 2-F). An appreciation for white lies rapidly improved among female subjects between the third and fourth grades, an increase delayed by about one year for male subjects. Significant differences were observed in the passing rates of male and female subjects among sixth and ninth graders (Fig. 2-G). The rates for simile were lower among male subjects in the first and second grades, but these rates eventually equaled that of female subjects in the third grade, resulting in no difference attributable to gender (Fig. 2-H). For metaphor, a significant sex difference can be observed in male and female passing rates among eighth graders (with females showing a higher success rate) (Fig. 2-I). For pretending, male subjects exhibited a lower passing

rate than females in the first grade, but equaled that of females in the second grade, resulting in no significant sex differences (Fig. 2-J). For appearance/reality, male students exhibited a lower passing rate than females in the first to fourth grades, but equaled that of females in the fifth grade, making up the significant sex difference seen in the third grade (Fig. 3-F). For contrary emotion, the passing rates for both male and female-subjects increased almost similarly (Fig. 3-G). For joke, while the passing rates of females jumped from the third to fourth grades, the increases in rates of males lagged by one year, resulting in significant sex differences in the third, fourth, and ninth grades (Fig. 3-H). For sarcasm, while the rates of females jumped from the second to third grade, the increases among males were delayed by one to two years. A significant sex difference was observed in passing rates among fourth graders (Fig. 3-I). For persuasion, while the passing rate of females rapidly jumped from the third to fifth grades, the increases among males were delayed by more than a year, and significant sex differences were observed in the passing rates among third, fifth, and ninth graders (Fig. 3-J).

Judging from age levels exhibiting 50% and 80% passing rates (Table 3), the tasks that proved to be understood by males and females almost equally were lie, simile, pretending, contrary emotion (first grade), and sarcasm (fifth grade). On the other hand, tasks in which sex differences can be observed in the age of understanding proved to include appearance/reality (males: second, females: first), white lie, and metaphor (males: third, females: second), and joke and persuasion (males: fourth, females:

third). In each case, female subjects demonstrated an understanding almost one year earlier than their male counterparts.

The tasks for which the ages at which 80% of male and female subjects passed were nearly equal proved to be lies (first grade), similes, pretending, and contrary emotions (second grade), metaphor (fifth grade), and joke (sixth grade). On the other hand, tasks that showed sex differences in ages concerning the 80% passing rate proved to be white lies (males: seventh, female: sixth), appearance/reality (males: fifth, females: fourth), sarcasm (males: ninth grade and older, females: eighth), and persuasion (males: ninth and older, females: fifth). For these four tasks, while the ages of the 80% passing rate for white lies and appearance/reality came earlier among females than males by about one year, the passing rate among male subjects for sarcasm and persuasion failed to exceed 80%, even among ninth graders (sarcasm: 72.2%, persuasion: 75.7%). In addition, the passing rates for these two tasks for male young adults were 83.3% for sarcasm and 76.0% for persuasion (Table 2).

Concerning the passing rates among young adults, 100% understanding was attained by both male and female for contrary emotion. Females attained a 100% passing rate for five tasks (lie, metaphor, contrary emotion, joke, and persuasion), while males attained a 100% passing rate only for "contrary emotion." A significant sex difference (with females showing a higher success rate) was revealed only in "persuasion," but males exhibited lower passing rates in six tasks (lie, white lie, simile, metaphor, joke,

and sarcasm) by 4.0–10.6%.

## Discussion

### 1. Validity of compiled tasks

As the passing rates among young adults exhibited 90–100% correspondence with the levels anticipated by the authors for all tasks, the validity of the use of the compiled tasks in testing has been confirmed.

### 2. Background of compiling tasks

In accordance with Astington<sup>8)</sup>, a case in which “something said is untrue, and the speaker knows it is untrue, but intends to make others believe it is true” can be defined as a lie, while cases in which the speaker does “not intend to make others believe it is true” can be called jokes, sarcasms, or metaphors, etc. Children grow to be capable of understanding the nature of deception, to tell lies intentionally, or to try to fool others by the age of four or five years<sup>9)</sup>. It is only after entering school that they can make sarcastic remarks to tease others, tell white lies to avoid hurting others’ feelings, or use metaphors to create poetic images<sup>10)</sup>. Furthermore, Winner et al.<sup>11)</sup> contend that between metaphor and sarcasm, the latter is more difficult to understand, due to the levels of difference fundamentally required to understand the state of mind of others. In Japan, Koyasu et al.<sup>12)</sup> reports on additional differentiation tasks concerning lies and sarcastic remarks<sup>13)</sup> involving 890 primary school students in Kyoto, concluding that 50% of sixth graders can provide correct reasons for sarcastic remarks.

Our study indicates that lies, similes,

pretending, appearances/realities and contrary emotion can be understood by first graders; white lies and metaphors can be understood by second graders; joke-sand persuasions can be understood by fourth graders; and sarcasm can be understood by fifth graders. From these results, the following seven points have been confirmed:

- 1) Passing rates increase with age for all tasks.
- 2) The age of understanding may differ due to the purpose of the stories.
- 3) Lies may be understood in early childhood, as pointed out by Leekam<sup>9)</sup>.
- 4) In a comparison of similes and metaphors, the latter is understood later than the former—only after the first grade.
- 5) In particular, understanding sarcasm develops at a later time.
- 6) As hypothesized by Winner, et al.<sup>11)</sup>, an understanding of sarcasm arrives later than that of metaphor.
- 7) As pointed out by Koyasu, et al.<sup>12)</sup>, the passing rate for providing reasoning to sarcasm exceeds 50% only in the fourth to sixth grades.

### 3. Relationship between manifestation of disorders and development of social communication

Happé<sup>14)</sup> studied relationships between developments in the theory of mind and verbal development. She determines that a 50% probability of passing tasks exhibited by 3-to-4 year-olds normally developed children can be attained at the verbal mental ages of 9–10 in the case of autistic subjects by examining the passing ages in first-order tasks for 70 autistic subjects. In other words, children with HFA/AS in the fourth to sixth grade-shave grown to acquire the theory of mind and are capable of reading others’

mental states to some extent. But while normally developed children can read other minds intuitively, HFA/AS children appear to read them with different strategies by using different portions of the brain<sup>15)</sup>. Sugiyama<sup>16, 17)</sup> infers that this growth process may result in many erroneous readings, which may explain the increasing number of problems first encountered due to their fears of being harmed, although incidents of breaking rules at group settings dramatically decrease with an understanding of the theory of mind. He also points out that small groups of children with HFA/AS may show increased behavioral problems in around the fourth to sixth grades, becoming the targets of severe bullying.

Our study indicates that normal children can understand joke, persuasion, and sarcasm by the fourth and fifth grades. At that age, the interpersonal relations of subjects with HFA/AS generally tend to be troubled and faced to difficulty<sup>2, 16, 17)</sup>. This difficulty is presumed to be related to a problem affecting the development of social communication skills.”

#### 4. Effects of sex differences

Judging from the ages at which the 50% passing rate can be attained, it has been determined that of all ten tasks, female subjects understand the five tasks of appearance/reality, white lies, metaphor, joke, and persuasion about one year before their male counterparts. For the two tasks of sarcasm and persuasion, male students are unable to achieve an 80% passing rate even in the ninth grade. In the case of young adults, the passing rate for the persuasion task is significantly higher among females than males. Judging from these results, further study

of the understanding of sarcasm and persuasion may be justified, broadening the subject group to those older than young adults.

Among young adults, the passing rates for male subjects were slightly lower than for female students not only in the task of persuasion, but in the other six tasks. Since the number of young adult subjects was limited in our study, sex differences may have been detected in certain cases had we increased the number of subjects.

With respect to factors in which sex differences can be detected, the following observations have been made from the perspectives of 1) verbal development, 2) E-S Theory, and 3) social brain.

##### 4.1. Perspective of verbal development

It has been reported that the development in theory of mind involves the development of verbal ability<sup>14)</sup>. It has been verified that females, in general, have better language abilities than males<sup>18)</sup>. It is a generally accepted theory in brain physiology that the brain is functionally asymmetrical, and that male brains are highly lateralized, while female brains are highly bilateralized. This difference is theorized to be derived from the different commissural systems connecting right and left hemispheres<sup>19, 20)</sup>. Specifically, one theory contends that the female splenium in the corpus callosum is more bulbous and larger than the male counterpart<sup>21)</sup>. Another states that the cross-section of the female anterior commissure is larger than the male counterpart<sup>22)</sup>. Yet another hypothesis states that an embryonal androgen delays the development of the cerebral cortex of the left hemisphere and accelerates the development of the

right cerebral cortex<sup>23)</sup>. Thus, in our study, sex differences in commissural systems and the embryonal hormone environment may account for the sex differences observed.

#### 4.2. Perspective of E-S theory

Baron-Cohen<sup>24, 25)</sup> reviewed the historical development of studies on sex differences and mentioned the key features of verbal and spatial abilities before, but pointed out the importance of “empathizing” and “systemizing” in presenting the E-S hypothesis. The theory contends that in the male brain, systemizing is significantly better developed than empathy, while the female brain is defined as having the opposite cognitive profile, exhibiting superior empathizing than systemizing capacities. All individuals are located somewhere along the continuum from the female brain to the male brain. Autism may be considered an extreme instance of the typical male profile. “Empathizing” includes the recognition of other mental states, and is required for the development of social communication. The E-S theory may explain the sex differences confirmed in our study.

#### 4.3. Perspective of social brain

Theory of mind implies capabilities associated with social intelligence, independent of general intelligence, to read the mental states of others and to respond to the behavior of other individuals<sup>26)</sup>. Brothers<sup>27)</sup> proposed a hypothesis under which social intelligence is linked to a network involving the frontal lobe, temporal lobe, and amygdala; that is, a social brain. Baron-Cohen, et al.<sup>26)</sup> confirmed the social brain hypothesis by using functional magnetic resonance imaging on normal subjects and patients with HFA/AS. Normal subjects exhibited in-

creased activation of superior temporal gyrus and amygdala related to tasks involving social intelligence. Some areas of the prefrontal cortex also showed activation in relation to such tasks. In contrast, patients with HFA/AS activated the frontal-temporal lobe regions but not the amygdala when working on such tasks. These results support both the social brain theory of normal function and the amygdala theory of autism. The amygdala is reported to be related to judgments of the feelings of others<sup>28)</sup>. Arai<sup>20)</sup> also reports sex differences in the physical aspects of the amygdala. Sex differences in the amygdala may function as a contributing factor in the sex differences observed in our study.

The results of our study indicate that in handling problems in interpersonal relations, we must recognize developmental differences in social communication with respect to age and sex before attempting interventions.

### Acknowledgements

The authors wish to express their sincere appreciation to Dr. Chisato Kawasaki (Sasebo City Children's Development Center) who reviewed the manuscript; Ms. Setsuko Orii (Osaka College of Rehabilitation) who rendered kind assistance in organizing materials; and Ms. Mariko Baba (Kansai Seishonen Sanatorium, OTR), who helped create the illustrations used in this study.

Parts of this study have been reported on four previous meetings<sup>29-32)</sup>.

## References

1. Happé FG. An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *J Autism Dev Disord* 24 : 129–154, 1994.
2. Itoh M, Yamada T, Yagi Y, et al. A life story of how a schoolchild with Asperger's disorder overcome bullying (in Japanese). *Sagyoryoho (Suppl) (Tokyo)* 20 : 191, 2001.
3. Itoh M, Takahara A, Tsuchida R, et al. An attempt to compose an advanced test of theory of mind in picture story formats—Response characteristics in normal school children (in Japanese). *Shoni No Seishin To Shinkei (Suppl) (Tokyo)* 40 : 53–54, 2000.
4. Itoh M, Takahara A, Tsuchida R, et al. A pilot study Japanese version of the strange stories test — advanced test of theory of mind: Using picture-stories to evaluate communication abilities of people with high functioning autistic disorder and Asperger's disorder (in Japanese). *Nagasaki Daigaku Iryo Gijutsu Tanki Daigakubu Kiyo (Nagasaki)* 14 : 69–76, 2001.
5. Itoh M, Kawasaki C, Tsukazaki A, et al. A study on childhood understanding of jokes and sarcasm (in Japanese). *Shoni No Seishin To Shinkei (Suppl) (Tokyo)* 41 : 393–394, 2001.
6. Premack D, Woodruff G. Does chimpanzee have a theory of mind? *Behav Brain Sci* 1 : 515–526, 1978.
7. Kawakita J. How to come up with ideas. 64th ed (in Japanese). Tokyo, Chuokoron-sha, 1991.
8. Astington JW. The child's discovery of the mind. Cambridge, Harvard University Press, 1993. How does the child discover the mind? Tokyo, Shinyosha, pp.169–185, 1997. translation by Matsumura N.
9. Leekam SR. "Believing and deceiving: Steps to becoming a good liar," (In) Cognitive and social factors in early deception, Ceci SJ, Leichtman MD, and Putnick ME (Ed.) Hillsdale, Erlbaum, pp.47–62, 1992.
10. Winner E. The point of words. Cambridge, Harvard University Press, 1988.
11. Winner E, Gardner H. Metaphor and irony: Two levels of understanding. (In) Metaphor and thought. 2nd ed. Ortony A (Ed.) Cambridge University Press, pp.425–443, 1993.
12. Koyasu M, Nishigaki J, Hattori K. A survey of children's understanding of mind by picture book form (in Japanese). *Kyoto Daigaku Kyoiku Gakubu Kiyo (Kyoto)* 44 : 1–23, 1998.
13. Winner E, Leekam S. Distinguishing irony from deception: Understanding the speaker's second order intention. *Br J Dev Psychol* 9 : 257–270, 1991.
14. Happé FG. The role of age and verbal ability in the theory of mind task performance of subjects with autism. *Child Dev* 66 : 843–855, 1995.
15. Happé F, Ehlers S, Fletcher P, et al. 'Theory of mind' in the brain. Evidence from a PET scan study of Asperger syndrome. *Neuroreport* 8 : 197–201, 1996.
16. Sugiyama T. The experience of autism: A review of clinical studies of high-functioning PDD (in Japanese) *Shoni No Seishin To Shinkei (Tokyo)* 40 : 88–100, 2000.
17. Tsujii M, Sugiyama T. "Theory of mind" and maladjusted behavior in high functioning pervasive developmental disorders (in Japanese). *The 37th Nihon Jido Seinen Seishin Igakkai Sokai Syorokushu (Kyoto)* 56, 1996.
18. Maccoby EE. The development of sex differences. Stanford, Stanford University Press, 1966. (Sex differences – Their origins and roles. 1st ed. Tokyo, Kaseishuppan-sha, pp.52–56, 1979. translation by Aoki Y, Ikegami C, Kawano K, et al.)
19. Kimura D. Sex and cognition. Cambridge, Massachusetts institute of technology, 1999. (Female ability, male ability. Shinyo-sha, Tokyo, pp.165–176, 2001. translation by Nojima H, Miyake M, Suzuki M.)
20. Arai Y. Sex Difference of brain (in Japanese) Tokyo, Kyoritsu Shuppan, 1999.
21. deLacoste-Utamsing MC, Holloway RL. Sexual dimorphism in the human corpus callosum. *Science* 216 : 1431–1432, 1982.

22. Allen LS, Gorski RA. Sexual dimorphism of the anterior commissure and massa intermedia of the human brain. *J Comp Neurol* 312 : 97–104, 1991.
23. Geschwind N, Galaburda AM. Cerebral lateralization. Biological mechanisms, associations, and pathology : I. A hypothesis and a program for research. *Arch Neurol* 42 : 428–459, 1985.
24. Baron–Cohen S. The extreme male brain theory of autism. *Trends Cogn Sci* 6 : 248–254, 2002.
25. Baron–Cohen S, Richler J, Bisarya D, et al. The systemizing quotient : an investigation of adults with Asperger syndrome or high–functioning autism, and normal sex differences. *Philos Trans R Soc Lond B Biol Sci* 358 : 361–374, 2003.
26. Baron–Cohen S, Ring HA, Wheelwright S, et al. Social intelligence in the normal and autistic brain : an fMRI study. *Eur J Neurosci* 11 : 1891–1898, 1999.
27. Brothers L. Social brain. *Concepts in neuroscience* 1 : 27–51, 1990.
28. Shaw P, Lawrence E, Baron–Cohen S, et al. Role of the amygdala in social sensitivity. *Ann N Y Acad Sci* 985 : 508–510, 2003.
29. Itoh M, Takada S, Kaneko T. Development and sex differences in understanding lies and sarcasm (in Japanese). *Nihon Shonika Gakkai Zasshi (Suppl) (Tokyo)* 107 : 227, 2003.
30. Itoh M, Takada S, Kaneko T. Development and sex differences in understanding pretence, jokes, and persuasion (in Japanese). *No To Hattatsu (Suppl) (Tokyo)* 35 : S 128, 2003.
31. Itoh M, Kaneko T, Takada S, et al. Development and sex differences in understanding white lies and persuasion (in Japanese). *Sagyoryoho (Suppl) (Tokyo)* 22 : 346, 2003.
32. Itoh M, Takada S, Kaneko T. Development and sex differences in understanding simile, sarcasm, and persuasion : Formulation of an advanced test of theory of mind, Japanese version. *16 th Asian Conference on Mental Retardation Proceedings* 344–352, 2003.