Correlations between the Broad Autism Phenotype and Social Cognition among Mothers of Children with Autism Spectrum Disorder

（ 自閉症スペクトラム児をもつ母親の自閉症広域表現型と社会的認知との関連 ）

大阪大学大学院
大阪大学・金沢大学・浜松医科大学
連合小児発達学研究科
小児発達学専攻

長 谷 川　恭　子

２０１４年6月　博士学位論文

Correlations between the Broad Autism Phenotype and Social Cognition among Mothers of Children with Autism Spectrum Disorder

Background

Autism Spectrum Disorder (ASD) is characterized by impairments in three domains: social interaction, communication, and imagination (Wing & Gould, 1979). Families with children who have ASD often face difficulties in child-rearing due to challenges in establishing loving relationships and dealing with problems caused by the child (Kusunoki, 2009). Nishimura & Inumaki (2010) reported that the inability of a child with ASD to appropriately express his/her own intentions plays a role in ineffective parent-child communication. On the other hand, there are studies that also report that deficiencies exist on the part of the parent when interacting with a child with ASD (Takei, Terasaki & Noyori, 2010). A parent may have problems with appropriately understanding the intentions of others. Recently, a study using family data identified a single autistic proband, which suggested that many parents of children with ASD exhibit autism-like characteristics known as the Broad Autism Phenotype (BAP) (Piven, Palmer, Jacobi, Childress, & Arndt, 1997). Characteristics of BAP include having an aloof personality style, a rigid personality style, and impaired pragmatic language, which is milder but qualitatively similar to the defining features of autism (Piven et al., 1997). Neuropsychology research has used the Social Cognition Task to measure cognitive characteristics of ASD and BAP. Compared to a control group

with no family history of autism or developmental delays, ASD and BAP individuals had greater difficulty identifying others' emotions from their expressions and movements (Losh, Adolphs, Couture, Penn, Baranek, & Piven, 2009). During situations of communication between children with ASD and their parents, the parent must possess the social-cognitive ability to accurately interpret intentions, understand motivations from small responses, gestures, or behaviors, and take appropriate action (Tsuji & Takayama, 2006). When parents have specific deficits in these social-cognitive abilities, BAP tendencies may be present, which increase the level of difficulty in effective communication between the parent and their child with ASD. Thus, the focus of the present study was to investigate the social cognition necessary to read psychological states, such as emotions and intentions, from expressions and movements.

The tools used to measure social cognition in this study can be broadly grouped into two tasks: "reading emotions" and "assessing the trustworthiness" of others' expressions and movements (Losh et al., 2009). The "reading emotions task" can be further divided into the categories of "expression" and "movement". Children with ASD have specific deficits in the "reading emotions from expressions task" (Harms, Martin, & Wallace, 2010; Klin, Sparrow, Bildt, Cicchetti, Cohen, & Volkmar, 1999). Similar deficits have been found in the parents of children with ASD. For example, during tests that measure interpersonal communication abilities, parents of children with ASD have difficulty reading emotions from images that presented only a person's eyes and surrounding area of the face (Losh & Piven, 2007). In addition, it has been reported that parents of children

with ASD rely more on the mouth than the eyes for the assessment of emotions (Adolphs, Spezio, Parlier, & Piven, 2008). A recent study also reported that on tasks assessing the reading of emotions from facial expressions and gestures, parents of children with ASD who displayed BAP disregarded facial expressions and read basic emotions using only gestures (Losh et al., 2009). On the “reading emotions from movement task,” children, adolescents, and adults with ASD had difficulty with emotionally processing movements, even though they were able to perceive those movements (Blake, Turner, Smoski, Pozdol, & Stone, 2003; Hubert, Wicker, Moore, Monfardini, Duverger, Fonseca, & Deruelle, 2007; Losh et al., 2009; Saygin, Cook, & Blakemore, 2010; Rutherford, & Troje, 2012). For the “assessing the trustworthiness task,” parents who displayed BAP and had children with ASD tended to rate positive faces as “less trustworthy” (Losh et al., 2009). We predicted that parents of children with ASD who displayed tendencies associated with BAP would have greater difficulty during interpersonal communication, which will be correlated to specific deficits in social cognition.

Thus, it is important to understand the correlations between BAP tendencies and social cognition in response to emotional stimuli such as expressions and gestures in the parents of children with ASD. However, in Japan, no study to date has focused on the parents of children with ASD, investigating BAP tendencies in parents or associations with social cognition. Therefore, the present study aims to clarify the characteristics of Japanese mothers with BAP, and compare them with the characteristics of mothers with BAP in the United States.

Previous studies that investigated BAP tendencies and social cognition often used a single social cognition task (Adolphs et al., 2008; Blake et al., 2003; Hubert et al., 2007; Losh et al., 2007; Rutherford et al., 2012; Saygin et al., 2010). Although Losh et al. (2009) used multiple social cognition tasks, no results of detailed analysis for all of the emotions were presented. Therefore, multiple social cognition tasks were performed in this study and differences in the reading of emotions with or without facial information were investigated for each emotion.

Since the study by Losh et al. (2009) did not specify which BAP characteristics were related to social cognition, and some researchers have reported that clarification of this issue is needed (Wilson, Freeman, Brock, Burton, & Palemo, 2010), it is necessary to understand the characteristics of the BAP subscales. Thus, to better understand BAP tendencies and social cognition, it is necessary to comprehensively evaluate the relationships between the subscales of the BAP and multiple social cognition tasks. In order to provide appropriate assistance to the parents of children with ASD, it is important to understand the correlations between BAP tendencies and general social cognition. In turn, this may lead to better programs for fostering parent-child communication and offer guidance to care-providers who aid parents in raising their children with ASD.

The present study examined the parents of children with ASD in Japan, specifically the correlations between BAP tendencies and social cognition in mothers based on the cultural differences in BAP present between Japan and the United States.

Methods

Participants

Participants for the present study were 51 mothers who had a child with ASD between the ages of 3 and 12 and visited Osaka University Hospital Pediatrics Developmental Disorder Outpatient Department for a diagnosis. Researchers with no competing interests asked the mothers to participate in the study at the outpatient clinic. The survey was distributed to only those who provided consent. The ASD diagnosis was conducted using the Text Revision of the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV-TR: American Psychiatric Association, 2000). In this study, “mother-child relationship” refers only to the biological relation (biological mother with her biological child). The survey period was from July to October 2012. This study was approved by Osaka University Hospital Ethics Committee.

Procedure

Mothers completed a questionnaire and a social cognition task. The questionnaire was the Japanese version (BAPQ-J) (Sakai, 2012; Sakai, Eto, Wada, Tatsumi, Yamamoto, Yoshizaki, & Mohri, 2012) of the Broad Autism Phenotype Questionnaire (BAPQ: Hurley, Losh, Parlier, Reznick, & Piven, 2007). For the social cognition task, four tasks were conducted using a computer’s built-in DVD playback. The presentation order of the four tasks were randomized and counterbalanced. Before each task, instructions were provided to the mothers and the task began only after confirming that the participant understood the instructions. It took mothers approximately 1 hour to complete the task.

Questionnaire survey

The BAPQ is used for characterizing BAP. The BAPQ is composed of 36 questions along with the following three subscales: aloof: “I like being around other people”; rigid: “I am comfortable with unexpected changes in plans”; and pragmatic language: “I find it hard to get my words out smoothly”. As BAPQ-J is the Japanese version of BAPQ, the number of the questions are the same as BAPQ and the same subscales were applied. The average total score and the score for each subscales are used to score BAP. Six answers are provided for each item, with choices range from “*Very rarely*” to “*Very often*.” A higher score indicates a greater tendency toward BAP. There are established cutoff scores (3.00 for total BAPQ; 3.00 for the aloof subscale; 2.90 for the rigid subscale; and 2.60 for pragmatic language) to determine the presence of BAP (Hurley et al., 2007). Its reliability and validity have been confirmed in both clinical and non-clinical samples (Ingersoll, Hopwood, Wainer, & Brent, 2011).

Social cognition tasks

The tasks were created and implemented by Losh et al. (2009), and were used after translating the original version into Japanese. The tasks originated in studies investigating lesions and functional magnetic resonance imaging. Losh et al. (2009) suggested that this social cognition task incorporates a BAP approach as well as more direct measures of neurocognitive functions, such as structural and functional imaging. The purpose of the social cognition task is to measure cognitive characteristics in the mothers.

The Reading the Mind in the Eyes Task (RE) (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). During this task, participants are shown slides of faces depicting only the eyes. Participants are given four choices for emotions [adjectives or phrases that represent emotions or states (e.g., jealous, panicked, arrogant, hateful)] and asked to identify the emotion displayed in the image. There are 37 slides, and the aim of the task is to identify the correct emotion.

The Movie Stills Task (MS) (Adolphs & Tranel, 2003). Participants are shown still movie scenes (16 photos) from a complex situation with and without "facial information" and are asked to predict the emotions of the characters. Sixteen still movie scenes depict six emotions (two scenes for happy, three each for afraid, surprised and angry, four for sad, and one for neutral), seven answer choices are provided describing the following emotions: happy, sad, afraid, surprised, angry, disgust and neutral. This task measures the level of dependence on facial information for the understanding and assessment of complex emotions.

The Point Light Basic Emotions Task (PL-B) (Heberlein, Adolphs, Tranel, & Damasio, 2004). This task utilizes point-light walkers to differentiate between types of movements and to predict emotions from biological motion stimuli. Participants were asked to identify the most appropriate emotion from movements of light-emitting diodes that track a person's movements (22 videos). Five answer choices were provided describing the following emotions: happy, sad, afraid, angry, and neutral. Participants are asked to select the answer that best fits the movements in the video. This task measures the ability to assess emotions from movements and gestures without using facial expressions.

The Point Light Trustworthiness Task (PL-T) (Heberlein et al., 2004). This task was conducted immediately after PL-B utilizing similar videos (26 videos) to rate the trustworthiness of the person in the video using a five-point rating scale (1: *very trustworthy* to 5: *very untrustworthy*). This task measures the ability to assess trustworthiness from movements and gestures without the use of facial expressions.

The Trustworthiness Task (TT) (Adolphs, Taniel, & Damasio, 1998; Adolphs, Sears, & Piven, 2001). This task utilizes pictures of men and women displaying different expressions and gaze directions. Participants are asked to rate the trustworthiness of the pictured person using a seven-point scale (-3: *not at all* trustworthy to 3: *very trustworthy*). There are 42 pictures of faces with either positive or negative valence. This task is used to measure the ability to assess trustworthiness.

Figure 1. Examples of social cognition tasks

Calculation Methods

For the social cognition task, the total score for correct responses in the task was calculated for the RE, while average scores were calculated for the PL-T and TT. For the MS and PL-B tasks, the scoring methods used in a previous study (Adolphs et al., 2003) were applied by converting performance into an accuracy score based on data from a normal subjects. For example, in a task completed by normal subjects, if 50% responded “surprised”, 40% responded “afraid”, and 10% responded “sad”, the accuracy scores of the study participants would be 1.0 for

surprised, 0.8 for afraid, and 0.2 for sad, according to the ratio (Adolphs et al., 2003). We used the performances obtained from a survey of 69 Japanese university students who did not have a diagnosis of ASD (Eto & Sakai, 2012) and the subject score was automatically calculated by a computer.

Analytic Methods

Accuracy on the MS was analyzed in a two-way analysis of variance [facial information (without faces, with faces) × emotion (happy, sad, afraid, surprised, angry, and neutral)] using the MS accuracy score as dependent variable. The total BAPQ-J score and the three subscale scores were analyzed using Pearson correlation coefficients with each of the social cognition task scores in the mothers. The analysis was conducted using the statistical analysis software SPSS (Statistical Package for the Social Science 20), and the significance value was set at $p < .05$.

Results

Demographics

Participants in this study included 51 mothers of children who had been diagnosed with ASD. Table 1 shows the demographic characteristics of the mothers. Of those, 21 mothers had more than one child, and none of them had a child diagnosed with ASD other than the one considered in this study. Furthermore, none of the mothers were aware of any relatives who were diagnosed with ASD, aside from their children.

Table 1. Characteristics of participants

BAP tendencies in mothers

We calculated the BAPQ-J scores and compared the present results to a previous study that used the BAPQ (Hurley et al., 2007). Table 2 displays the average score, standard deviation, BAPQ cutoff score, percentage of mothers with BAP in the present study, and percentage of mothers with BAP in Hurley et al.'s study. The percentage of BAP present among mothers in this study was compared with that among mothers in the previous study (Hurley et al., 2007) using chi-square tests. The results indicated that the percentage of BAP present for pragmatic language was significantly higher in this study than the score reported by Hurley et al. (2007) ($\chi^2 = 2.19$, $p < .05$).

Table 2. Participants' total BAPQ-J score and subscale scores

Measures of social cognition tasks scores in mothers

Table 3 shows the means, standard deviation, minimum and maximum values for mothers' social cognition task scores. To determine whether there were differences in the MS accuracy scores for facial information and emotions, a two-way analysis of variance [facial information (without faces, with faces) × emotion (happy, sad, afraid, surprised, angry, and neutral)] was conducted with accuracy scores as a dependent variable. The results indicated significant main effects for facial information (F (1,50) = 5.51, $p < .05$) and emotion (F (5,250) = 59.79, $p < .001$) , and a significant interaction (F (5,250) = 3.83, $p < .01$) between facial information and emotion. Since significant interaction was seen, analysis

of the simple main effects of facial information was conducted, and there were significant differences on happy (F (1,50) = 7.32, p < .01), sad (F (1,50) = 4.34, p < .05), afraid (F (1,50) = 4.40, p < .05), and neutral (F (1,50) = 6.06, p < .05) emotion. These results indicated that the accuracy scores were higher 'with faces' for the happy, afraid, and neutral emotions, and were higher 'without faces' for the sad emotion. For the simple main effects of emotion, there were significant differences on 'without faces' (F (5,46) = 33.69, p < .001) and 'with faces' (F (5,46) = 62.67, p < .001). Furthermore, Bonferroni *post-hoc* tests revealed that for emotions, the mean accuracy score for the surprised emotion was lower both with and without faces when compared to the other emotions (happy, sad, afraid and angry). When reading the surprised emotion in the MS, the percentage of choosing incorrect emotion answers differed between "with faces" and "without faces". On the MS "without faces", nearly half of the participants predicted the correct surprised emotion (43%) and a small range of other emotions (afraid16%, angry 13%, sad 12%, neutral 8%, happy 5%, and disgust 3%) followed. Whereas "with faces", though those who predicted the correct surprised answer was 41%, the percentage participants predicted as afraid was also high (27%) than other emotions (neutral 10%, angry 9%, disgust 5%, sad 7%, and happy 1%).

Table 3. Participants' social cognition tasks scores

Correlations between BAP tendencies and social cognition

The correlations between total BAPQ-J score and its subscales with each of the social cognition task scores were examined. Adjusted correlation coefficients and *P* values are presented in Table 4. For the “reading emotions from others’ expressions and movements task,” significant negative correlations with the rigid subscale score and MS without faces (happy) (r = -.294, p < .05) and MS with faces (surprised) (r = -.305, p < .05) were found. Ceiling effects were observed in the MS tasks without faces (happy, sad), MS with face (happy, afraid), and PLE (happy, sad, afraid, neutral). Spearman’s rank correlation analysis indicated that significant differences were the same level in tasks with ceiling effects. A high score on the rigid subscale was associated with greater difficulty in correctly reading emotions for scenes without happy facial information and for scenes with surprised facial information. For the “assessing the trustworthiness of others’ expressions and movements task,” significant negative correlations were observed between the following: the total BAPQ-J score and PL-T positive valence stimuli (r = -.321, p < .05), the rigid score and PL-T positive valence stimuli (r = -.298, p < .05), TT positive valence faces (r = -.315, p < .05), and TT negative valence faces (r = -.373, p < .01). In summary, mothers with a higher total BAPQ-J or rigid subscale score judged the PL-T positive valence stimuli and the TT positive and negative valence faces as less trustworthy.

Table 4. Correlation coefficients for scores in social cognition tasks

Discussion

The present study examined the relationship between BAP tendencies with social cognition among mothers of children with ASD.

BAP tendencies in mothers

In order to examine BAP tendencies in mothers in Japan, we compared our results to a study conducted by Hurley et al. (2007). The present study suggested a cultural difference in “pragmatic language.” Examples of the items on this scale are, “I find it hard to get my words out smoothly” and “I can tell when someone is not interested in what I am saying.” “Pragmatic language” measures deficits in the social aspects of language, resulting in difficulties with communicating effectively or difficulties in holding a fluid, reciprocal conversation (Hurley et al., 2007). However, considering the fact that a large percentage of mothers met the BAP criteria for “pragmatic language,” cultural differences may have accounted for this result. In a comparative study investigating communication patterns in the United States and Japan, differences were found in communication ability and awareness of communication patterns beginning in adolescence (Nagao, 1996). Nagao (1996) suggested that in the United States, self-assertion is recognized as a part of communication ability, while in Japan, it is suggested that, although people may say that self-assertion is a positive attribute, it is actually frowned upon. In the present study, these cultural differences likely affected the disparity in the BAP scores for “pragmatic language” for questions that involved communication ability and awareness of communication patterns. In the future, it will be necessary to consider cultural differences when extrapolating the results

from the BAPQ-J and understanding the BAP propensities of mothers of children with ASD.

Measures of social cognition tasks scores in mothers

Task scores were higher in the MS “with faces” for the happy, afraid, and neutral emotions, whereas participants scored higher “without faces” for the sad emotion. Kobayashi and Naemura (2005) reported that people pay attention to the head and face when reading the happy and afraid emotions. Since facial information was included in the task stimulus “with faces”, this result assumed that facial information in particular was one of the important clues when reading emotion among the multiple stimuli. In previous studies, the neutral emotion was considered to be a neutral stimulus for facial expression, and there are few studies that have examined how the neutral emotion itself is perceived (Seki & Ayabe, 2013). While the extent to which neutral emotion can be considered an emotional category is limited, our study suggested that when reading neutral emotion, facial information itself may also be an important clue. In contrast, the sad emotion was suggested to be more easily read in tasks “without faces” than “with faces”. For the sad emotion, it has been found that people tend to pay more attention to the hands and upper body than to the head and face, and that they read emotions from body movements that represent “covering motions” and “hiding motions” (Kobayashi et al,, 2005). The results of the present study also suggested that emotions were more likely to be read correctly in tasks “without faces”, indicating that reading the sad emotion relies on gestures. In sum, these findings suggest that in the MS, the differences in scores depended on whether

facial information was present or not for several emotions. In conclusion, when reading the characters' emotions contextually from the situations, the information people relied on, such as the facial information, gestures and situation, varied depending on the type of emotion. The surprised emotion would be discussed in the next section.

Correlations between BAP tendencies and social cognition

First, on the MS task, our results demonstrated that mothers with higher BAPQ-J scores for the "rigid" subscale tended to have greater difficulty in reading the emotions of characters, especially in scenes without happy facial information or in scenes with surprised facial information. Previous studies have reported that when reading happy expressions, children with ASD may depend only on the mouth (Baron-Cohen, Spitz, & Cross, 1993), and children and adults with ASD tended to rely more on their attention towards limited stimuli, such as the mouth (Sonoyama & Kobayashi, 1989; Adolphs et al., 2008). Thus, it is suggested that children and adults with ASD rely on the mouth when assessing happy expressions. The results of this study are thought to be due to the rigid characteristics of BAP, such as strictness, inflexibility, and stereotyped behaviors (Piven et al., 1997). In situations in which information about the mouth, essentially the most important clue, is not available, mothers with higher BAPQ-J scores for the "rigid" subscale seem to be unable to integrate and flexibly assess other pieces of information, which in turn makes it difficult for them to read emotions. People who have rigid characteristics tend to have difficulty adjusting

to change and it can be assumed that this tendency affects their judgments of happy expressions without faces.

Before discussing the negative correlation between BAPQ-J subscale score for the “rigid” and surprised emotion with face, the difficultly of reading surprised in general needs to be pointed out. All participants in the present study showed difficulties in reading the surprised emotion compared to other emotions, regardless of whether or not a face was presented, and in with faces, tended to confuse with afraid. When reading surprised or afraid emotions from facial expressions, the initial decision is based on the shared facial parts such as “eyebrows raised”, “eyes widened”, and “mouth opened” between these two emotions (Watanabe, Suzuki, Yoshida, Tsuzuki, Bamba, Chandrasiri, Tokita, Wada, Morishima & Yamada, 2007). However, Watanabe et al. (2007) also pointed out that there are differences in the expression of the “inner brow raised” and “pulling lip corner”. These slight differences may make it difficult to distinguish between these two emotions. Our study also indicated this confusion of reading emotions that all participants’ tendency in with faces surprised scene, afraid was the next chosen emotion. Narrowing our focus to BAPQ-J subscale score, the present study indicated that BAP rigid tendency had significant negative correlation with surprised expression when facial information was added. It has been suggested that when reading surprised expressions, children with ASD (Baron-Cohen et al., 1993) and adults with ASD (Wakamatsu, 2003) have difficulty integrating different areas of the face to judge a surprised emotion. BAP is a milder but qualitatively similar characteristic to the defining features of ASD,

and our study suggested that within BAP characteristics, “rigid” may play an important role in the deficit of reading surprised facial expression.

Second, on the PL-T and TT tasks, our results demonstrated that mothers with higher on the total BAPQ-J scores and on the “rigid” subscale tended not to trust movements or various informational cues, such as facial stimuli, the gender of the person, expressions around the mouth, gaze direction, hairstyle, or the use of glasses during information processing. Losh et al. (2009) found that on the PL-T task, parents who displayed BAP were more likely than those without BAP tendencies to rate the person in the video as less trustworthy. Furthermore, on the TT task, parents of children with ASD who displayed BAP were more likely to rate the person in the picture as less trustworthy, compared to those without BAP or those who did not have children with ASD. The present results were congruent with previous findings (Losh et al., 2009). Losh et al. (2009) suggested that the reason parents of children with ASD who displayed BAP were less trustworthy of facial stimuli on the TT was that they rated these faces as “somewhat threatening.” In addition, for the PL task in the present study, no difficulties were found in reading emotions from movements, but difficulties were observed on the more complex decision-making tasks (Adolphs et al., 2001), such as judging trustworthiness. On the TT, it has been suggested that adults with ASD have difficulty in the process of first perceiving the face and then assessing the trustworthiness of the perceived target (Adolphs et al., 2001). In particular, mothers with higher BAPQ-J scores for the “rigid” subscale seem to find it difficult to flexibly integrate presented stimuli to make a judgment, similar to people with

BAP rigid tendencies. In other words, it is considered that the BAP rigid characteristics described above can cause dysfunction in these processes and affect people's trust in others. Tasks that required mothers to judge complex emotions, such as trustworthiness, are thought to tap into amygdala functions, but the complex processing of emotion recognition is not yet clearly understood. We expect that advances in lesion and imaging studies will allow us to further examine this point in future studies. No previous studies have shown what kind of cognition people with rigid characteristics have, or how rigid characteristics affect social cognition. Therefore, this study investigated the point to which rigid characteristics affect social cognition.

Conclusion

The results of the present study can be summarized as follows: First, in terms of mothers' BAP characteristics, mothers in Japan tended to score higher than those in the United States in the "pragmatic language" subscale of the BAPQ-J. Second, the present study indicated that in the MS tasks, differences in scores were observed depending on the presence or absence of facial information for each emotion. Third, mothers with higher scores on the "rigid" subscale tended to show specific social cognition. The rigid characteristics of BAP include strictness, inflexibility and stereotyped behavior (Piven et al., 1997). On the MS task, it was demonstrated that mothers with higher BAPQ-J scores for the "rigid" subscale tended to rely on limited stimuli that were easy to read, and they had trouble reading emotions by integrating multiple stimuli. Moreover, since they have

difficulty flexibly judging what they perceive, it was found to be difficult for them to make complex judgments, such as judging trustworthiness.

Finally, it can be assumed that difficulties in reading emotions from various informational cues and judging complex emotions will likely arise during day-to-day parent-child communication for parents of children with ASD who displayed BAP tendencies. In these cases, care providers should understand the characteristic style of each parent who has a child with ASD, and concrete strategies necessary for a positive parent-child relationship must be communicated to the parent.

The limitations and future directions for the present study can be summarized in the following four points. First, the mothers of this study did not have additional children or family members with ASD. This information could allow for a better comparison with results from previous studies (Losh et al., 2009). In future studies, genetic determinants of ASD should be considered and analysis should focus on individuals with more than one child or relative with ASD. Second, BAP tendencies were measured in subjects using the BAPQ-J, but it may be possible that some mothers could have been diagnosed with ASD. Thus, stricter measures can ensure that subjects do not have ASD, but only BAP tendencies. Third, the tasks used in this study contained photos of Western people, possibly making it difficult for Japanese mothers to read emotions and intentions if they were not accustomed to interacting with Westerners. Future studies should use photos of people from the same racial and cultural background when conducting tasks assessing how others read emotions. Lastly, the results of the correlation

analysis revealed a relationship between BAP tendencies and social cognition. Future research should include comparisons with control groups with no family history of autism or developmental delays.

Acknowledgments

We used translated versions of Dr. Ralph Adolphs's social cognition tasks and would like to express our gratitude to Dr. Adolphs for allowing us to use the tasks. We would also like to thank the many mothers who participated in this study. This work was supported by MEXT Grant-in-Aid for Young Scientists (B) 22730543(principal investigator Saeko Sakai).

References

Adolphs, R., Taniel, D., & Damasio, A. (1998). The human amygdala in social judgment. *Nature,* 393, 470-474.

Adolphs, R., Sears, L., & Piven, J. (2001). Abnormal processing of social information from faces in autism. *Journal of Cognitive Neuroscience,* 13, 232-340.

Adolphs, R., & Tranel, D. (2003). Amygdala damage impairs emotion recognition from scenes only when they contain facial expressions. *Neuropsychologia,* 41, 1281-1289.

Adolphs, R., Spezio, M. L., Parlier, M., & Piven, J. (2008). Distinct face-processing strategies in parents of autistic children. *Current Biology,* 18, 1090-1093.

American Psychiatric Association. (2000). *The diagnostic and statistical manual of mental disorders* (4th ed. TR). Washington DC: Author.

Baron-Cohen. S., Spitz, A., & Cross, P. (1993). Do children with autism recognize surprise? *Cognition and Emotion*, 7, 507-516.

Baron-Cohen. S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The Reading the Mind in the Eyes Test Revised Version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal Child Psychological Psychiatry,* 42, 241-251.

Blake, R., Turner, L. M., Smoski, M. J., Pozdol, S. L., & Stone, W. L. (2003). Visual recognition of biological motion is impaired in children with autism. *American Psychological Society,* 14, 151-157.

Eto, M., & Sakai, S. (2012). Correlation between social awareness and autism-like characteristics in adults. *The 23rd Annual Meeting for the Japan Society of Developmental Psychology*, 688. (In Japanese.)

Harms, M. B., Martin. A., & Wallace. G. L. (2010). Facial emotion recognition in autism spectrum disorder: a review of behavioral and neuroimaging studies. *Neuropsychology Review*, 20, 290-322.

Herberlein, A. S., Adolphs, R., Tranel, D., & Damasio, H. (2004). Cortical regions for judgments of emotions and personality traits from point-light Walkers. *Journal of Cognitive Neuroscience,* 16, 1143-1158.

Hubert, B., Wicker, B., Moore, D. G., Monfardini, E., Duverger, H., Fonseca, D. D., & Deruelle, C. (2007). Recognition of emotional and non-emotional

biological motion in individuals with autistic spectrum disorders. *Journal of Autism and Developmental Disorders*, 37, 1386-1392.

Hurley, R. S. E., Losh, M., Parlier, M., Reznick, J. S., & Piven, J. (2007). The broad autism phenotype questionnaire. *Journal of Autism and Developmental Disorders*, 37, 1679-1690.

Ingersoll, B., Hopwood, C. J., Wainer, A., & Brent, D. M. (2011). A comparison of three self-report measures of the broader autism phenotype in a non-clinical sample. *Journal of Autism and Developmental Disorders,* 41, 1646-1657.

Klin, A., Sparrow, S. S., Bildt, A., Cicchetti, D. V., Cohen, D. J., & Volkmar, F. R. (1999). A normed study of face recognition in autism and related disorders. *Journal of Autism and Developmental Disorders,* 29, 499-508.

Kobayashi, Y., & Naemura, M. (2005). The Study of Emotion Extraction Method from Human Motion Expression : for Interaction with yourself. *Institute of Electronics Information and Communication Engineers technical research report. MVE*, 104, 41-46. (In Japanese with English abstract.)

Kusunoki, H. (2009). Special needs and family support for children with developmental disorders. *Japanese Journal of Studies on Disability and Difficulty*, 37, 12-20. (In Japanese with English abstract.)

Losh, M., & Piven, J. (2007). Social-cognition and the broad autism phenotype: identifying genetically meaningful phenotypes. *Journal of Child Psychology Psychiatry,* 48, 105-112.

Losh, M., Adolphs, R., Poe, M. D., Couture, S., Penn, D., Baranek, G. T., & Piven, J. (2009). Neuropsychological profile of Autism and the Broad Autism Phenotype. *Archives of General Psychiatry,* 66, 518-526.

Nagao, M. (1996). Self-assertion attitudes and recognition as communication abilities of Americans: comparison of communication patterns in Japan and America. *Doshisha American Studies*, 32, 81-89. (In Japanese.)

Nishimura, S., & Inumaki, S. (2010). Tendencies of interaction in play between an infant with autistic disorder and his mother; using picture book, puzzle piece, and soap bubble. *Shiraume Gakuen University Junior College Proceedings*, 46, 1-14. (In Japanese.)

Piven, J., Palmer, P., Jacobi, D., Childress, D., & Arndt, S. (1997). Broader autism phenotype: evidence from a family history study of multiple-incidence autism families. *American Journal of Psychiatry,* 154, 185-190.

Rutherford, M. D., & Troje, N. F. (2012). IQ predicts biological motion perception in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 42, 557-565.

Sakai, S. (2012). Development of Japanese version of questionnaire regarding social and communication traits (first report). *The 23rd Annual Meeting for the Japan Society of Developmental Psychology*, 617. (In Japanese.)

Sakai, S., Eto, M., Wada, N., Tatsumi A., Yamamoto, T., Yoshizaki, A., & Mohri, I. (2012). Development of Japanese version of Broad Autism Phenotype

Questionnaire. *The 53rd Annual Meeting for the Japanese Society for Child and Adolescent Psychiatry,* 372. (In Japanese.)

Saygin, A. P., Cook, J., & Blakemore, S. J. (2010). Unaffected perceptual thresholds for biological and non-biological form-from-motion perception in autism spectrum conditions. *PLoS ONE*, 5, 10, 1-7.

Seki, N & Ayab, S. (2013). Perception of emotions within neutral facial expressions. *Tsukuba Psychological Research.* 46, 1-8. (In Japanese with English abstract.)

Sonoyama, S., & Kobayashi, S. (1989). Purpose of excessive selectivity of stimuli in autism disorder research. *The Japanese Journal of Special Education*, *27*, 61-70. (In Japanese.)

Tsuji, A., & Takayama, Y. (2006). An investigation of changes in the sequence of actions of an autistic boy interacting with his mother. *The Japanese Journal of Developmental Psychology*, 17, 159-170. (In Japanese with English abstract.)

Takei, Y., Terasaki, M., & Noyori, N. (2010). Screening tools for assessing the social development of toddlers with pervasive developmental disorders —Differences in assessment criteria and approach between parents and professionals—. *Kawasaki Medical Welfare Journal*, 20, 179-187. (In Japanese with English abstract.)

Wakamatsu, A. (2003). Recognition of the facial expressions of surprise from moving displays by people with autistic disorder. *School for Educational Studies*, *9*, 89-96. (In Japanese with English abstract.)

Watanabe, N., Suzuki, R., Yoshida, H., Tsuzuki, D., Bamba, A., Chandrasiri, N., Tokita, G., Wada, M., Morishima, S & Yamada, H. (2007). Facial Information Norm Database (FIND): Constructing a database of Japanese facial images. *The Japanese Journal of Research on Emotions,* 14, 1, 39-53. (In Japanese with English abstract.)

Wilson, C. E., Freeman, P., Brock, J., Burton, A. M., & Palermo, R. (2010). Facial Identity Recognition in the Broader Autism Phenotype. *PLoS ONE*, 5, 9 , 1-7.

Wing, L., & Gould, J. (1979). Severe impairments of social interaction and associated abnormalities in children: epidemiology and classification. *Journal of Autism and Developmental Disorders, 9*, 11-29.

Abstract

The present study examined the relation between Broad Autism Phenotype (BAP) tendencies and social cognition in mothers who had a child with Autism Spectrum Disorder (ASD) in Japan. The participants of this study were 51 mothers who had a child with ASD. The survey consisted of a questionnaire (BAPQ-J) and four social cognition tasks. The results indicated a cultural difference in “pragmatic language”. Next, those who scored higher on the total BAPQ-J or on the “rigid” subscale had greater difficulty in reading emotions in situations without happy facial cues or surprised facial cues. Additionally, these individuals had greater difficulty with complex judgments, such as judging trustworthiness, from movements and multiple facial stimuli. In summary, BAP and social cognition have some correlation in mothers who have children with ASD.

Table 1

Characteristics of participants (N = 51)

Characteristic	M (SD)	n (%)
Mother		
Age	39 (5.7)	
Education		
High school graduate		9 (17.6)
Junior college graduate [a)]		21 (41.2)
College graduate		13 (25.5)
Not reported		8 (15.7)
Child		
Age	5.9 (2.9)	
Gender		
Male		44 (86.3)
Female		7 (13.7)
Diagnosis		
Autism		37 (72.5)
Autism Spectrum Disorder		14 (27.5)
Developmental Quotient [b)]	71.9 (22)	
Number of Siblings		
None		30 (59)
More than one[c)]		21 (41)

[a)] Including trade school.

[b)] The Kyoto Scale of Psychological Development.

[c)] None were diagnosed with ASD.

Table 2

Participants' total BAPQ-J and subscale scores (N = 51)

BAPQ-J	*M (SD)*	BAPQ cutoff	BAP present (%)	
			Present study	Hurley et al.'s study[a)]
Total BAPQ-J	2.55 (.45)	3.00	13	23
BAPQ-J subscales				
Aloof	2.63 (.62)	3.00	24	29
Rigid	2.50 (.53)	2.90	29	22
Pragmatic language	2.52 (.54)	2.60	41	23

[a)]Hurley et al., (2007).

Table 3

Participants' social cognition tasks scores (N = 51)

Measure	*Mean*	*SD*	Range	
			Min	Max
Total Correct Scores in the Reading the Mind in the Eyes Task [a)]	22.67	2.98	16.00	28.00
Average Accuracy Scores in the Movie Stills Task [b)]				
Without faces	.73	.09	.51	.91
Happy	.89	.17	.35	1.00
Sad	.87	.17	.28	1.00
Afraid	.80	.19	.45	1.00
Surprise	.54	.19	.12	1.00
Angry	.69	.21	.12	1.00
Neutral	.47	.30	.00	1.00
With faces	.75	.08	.59	.92
Happy	.94	.10	.56	1.00
Sad	.81	.18	.12	1.00
Afraid	.88	.17	.23	1.00
Surprise	.53	.19	.18	1.00
Angry	.71	.20	.10	1.00
Neutral	.63	.30	.00	1.00
Average Accuracy Scores in the Point Light Basic Emotions Task [b)]	.86	.09	.58	.97
Happy	.86	.16	.22	1.00
Sad	.90	.14	.44	1.00
Afraid	.81	.20	.20	1.00
Angry	.81	.18	.33	1.00
Neutral	.89	.12	.53	1.00
Average Scores in the Point Light Trustworthiness Task [c)]				
Positive stimuli	2.98	.53	1.39	4.15
Negative stimuli	2.92	.75	1.54	4.23
Average Scores in the Trustworthiness Task [d)]				
Positive faces	-.24	.90	-2.76	1.43
Negative faces	-.85	.81	-2.86	.90

[a)]Total correct scores on 37 tasks

[b)]Standared for accuracy was calculated based on a normal reference group.

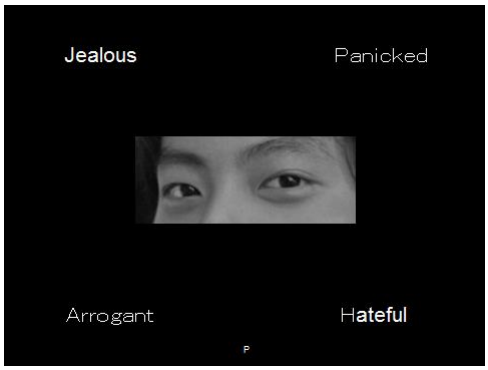
[c)]Five-point scale (1 to 5)

[d)]Seven-point scale (-3 to 3)

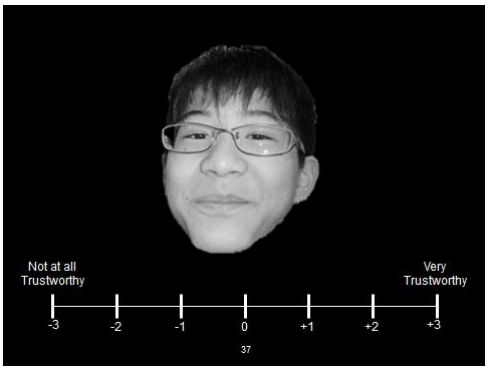
Table 4
Correlation coefficients for scores in social cognition tasks

Measure	Total BAPQ-J	BAPQ-J subscales		
		Aloof	Rigid	Pragmatic
Reading the Mind in the Eyes Task	.015	-.070	.150	-.026
Movie Stills Task				
Without faces	-.137	-.202	-.130	.019
Happy	-.256	-.240	-.294 *	-.071
Sad	-.051	-.062	-.066	.009
Afraid	.053	-.101	.036	.212
Surprise	.095	-.010	.201	.047
Angry	-.084	-.007	-.170	-.035
Neutral	-.272	-.275	-.213	-.151
With faces	.000	.040	-.120	.073
Happy	-.120	-.114	-.220	.052
Sad	.081	.071	.114	.002
Afraid	.045	.110	.071	-.089
Surprise	-.137	-.074	-.305 *	.051
Angry	.014	-.046	-.077	.165
Neutral	.084	.185	.044	-.050
Point Light Basic Emotions Task	-.027	-.007	-.030	-.090
Happy	-.044	-.053	-.012	-.036
Sad	-.106	-.119	.061	-.192
Afraid	.082	.161	-.009	.031
Angry	.032	-.013	.146	-.054
Neutral	-.068	-.022	-.141	-.006
Point Light Trustworthiness Task				
Positive stimuli	-.321 *	-.273	-.298 *	-.191
Negative stimuli	-.155	-.149	-.255	.042
Trustworthiness Task				
Positive faces	-.167	-.057	-.315 *	-.034
Negative faces	-.194	-.043	-.373 **	-.057

** $p < .01$, * $p < .05$.

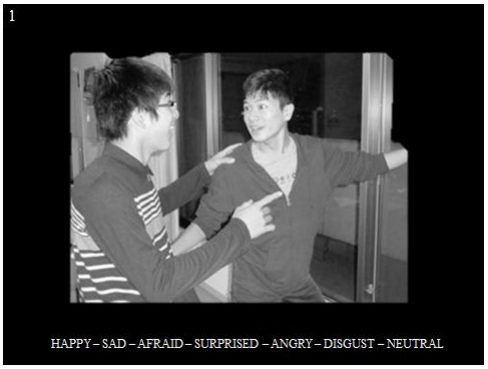


Reading the Mind in the Eyes Task



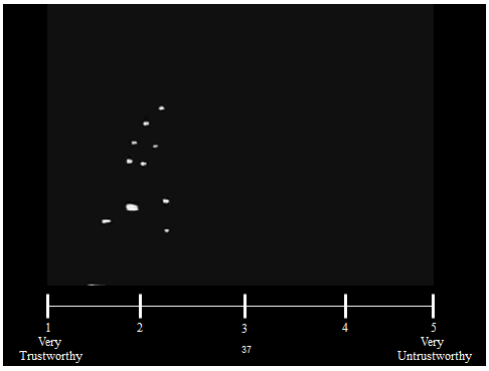
Trustworthiness Task

Movie Stills Task (without faces)



Movie Stills Task (with faces)

Point Light Basic Emotions Task



Point Light Trustworthiness Task

Figure 1. Examples of social cognition tasks. (Due to copyright restrictions, the example stimuli presented in this figure are similar to those used in the experiment. The actual tasks were performed by actors who were not Japanese.)