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DEVELOPMENTAL PSYCHOLOGY | RESEARCH ARTICLE

The traits of autism spectrum disorder in the general population influence humor appreciation: Using the autism-spectrum quotient and HSPS-J19

Kai Nagase*

Abstract: Previous studies show differences in humor appreciation between individuals with autism spectrum disorder and typically developing individuals; however, the relationship between humor appreciation and ASD traits has not been fully examined. This study tried to clarify the effect of ASD traits on humor appreciation. One hundred and two typically developing undergraduates were asked to answer 24 items measuring humor appreciation in response to joke stimuli and to complete the Japanese version of the Autism-Spectrum Quotient (AQ-J), which measures the ASD traits of social communication, attention, and imagination, and the Japanese version of the 19-item Highly Sensitive Person Scale (HSPS-J19), which measures the trait of sensory sensitivity. Stepwise multiple linear regression analysis revealed that social skills (AQ-J) and ease of excitation (a subscale of the HSPS-J19) were unique predictors of humor appreciation, with a significant coefficient of determination. These findings suggest that poor social skills and ease of excitation influence the cognitive processes underlying humor appreciation. Ease of excitation was found to be specifically associated with recognizing incongruity, whereas social skills were



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PUBLIC INTEREST STATEMENT

Humor is defined as an emotion of mirth that is elicited by cognitive incongruity and known for its function of improving social communication. For this function of humor, it is considered that humor appreciation might influence deficits in social communication, which is a major trait of autism spectrum disorder (ASD). ASD is a neurodevelopmental disorder characterized by deficits in social communication along with the presence of restricted and repetitive behavioral patterns. The purpose of this study was to reveal the relationships between humor appreciation and ASD traits in the general population. The results demonstrate that poor social skills and ease of excitation in ASD traits influence humor appreciation. In particular, individuals with poor social skills have difficulties with humor appreciation, and individuals with ease of excitation can appreciate humor easily. The findings are considered to provide the guidance in the assessment of deficits in social communication of individuals with ASD.

found to be associated with the elaboration of the stimulus. This study contributes to our understanding of the relationship between sensory sensitivity and social communication in individuals with ASD.

Subjects: General Psychology; Cognitive Psychology; Developmental Psychology

Keywords: humor appreciation; autism spectrum disorder; social skills; ease of excitation; developmental psychology

1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication along with the presence of restricted and repetitive behavioral patterns (American Psychiatric Association, 2013). Interestingly, some of the characteristics of individuals with ASD are seen to a lesser extent in the general population (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Wakabayashi, Tojo, Baron-Cohen, & Wheelwright, 2004), which suggests a cognitive, emotional, and behavioral continuity between ASD and typical development. Based on this premise, many studies have explored the relationships between ASD traits and peculiarity of emotion or emotional problems. “Peculiarity of emotion” in ASD means that there are differences between individuals with ASD and typically developing individuals in the elicitation and recognition of emotions and emotional regulation (Kuusikko et al., 2009; Samson, Hardan, Podell, Phillips, & Gross, 2015). In this regard, many research studies pointed out that individuals with ASD have difficulties in emotional recognition (Kuusikko et al., 2009) and emotional dysregulation (Samson et al., 2015) in relation to typically developing individuals, and there are few studies that explored the relationships between ASD traits and the elicitation and recognition of emotions and emotional regulation in general populations.

Previous studies have found a distinctive relationship between ASD traits and humor appreciation, which is one example of such emotion elicitation (Lyons & Fitzgerald, 2004; Samson, 2013). Humor is an emotion of mirth that is elicited by cognitive incongruity (Nomura & Maruno, 2011). Many believe that humor has the function of improving social communication (Davis & Farina, 1970). For instance, Fraley and Aron (2004) showed that appreciating humor and sharing humor with others assist in the development of intimate relationships, which forms the basis of social support. Therefore, specificity of humor appreciation in individuals with ASD might influence deficits in social communication, which is a major ASD trait (Silva, Da Fonseca, Esteves, & Deruelle, 2017).

Some previous studies on the relationship between ASD traits and humor appreciation revealed that individuals with ASD had more difficulty in humor appreciation than did typically developing individuals. Samson, Huber, and Ruch (2013) examined the characteristics of humor appreciation among 40 individuals with ASD and 113 typically developing individuals. They found that the typically developing individuals had significantly higher scores on the 3 Witz-Dimension (3WD) Humor Test, which assesses the subjective funniness of jokes and cartoons (Ruch, 1992), than did individuals with ASD. Higher scores on the 3WD Humor Test indicated that participants appreciated jokes and humorous cartoons. Therefore, this result suggested that typically developing individuals are more appreciative of humor than individuals with ASD. Accordingly, stronger ASD traits might be linked to less humor appreciation.

On the other hand, other previous studies have found that individuals with ASD have no difficulty in humor appreciation (Silva et al., 2017; Weiss et al., 2013). Weiss et al. (2013) examined the characteristics of humor appreciation among children with ASD in comparison to typically developing children using animations. Participants watched some video animations that included incongruity (which tends to elicit humor and laughter) and some that did not include incongruity; then, participants rated how funny they found the animations. The results indicated that the children with ASD appreciated humor as much as typically developing children did. Similar results

were obtained by Silva et al. (2017), who used humorous pictures to explore differences in humor appreciation between individuals with ASD and typically developing individuals. They found that individuals with ASD were able to enjoy and understand the humorous pictures as much as typically developing individuals were. Taken together, the literature has not reached a definitive conclusion on the relationship between humor appreciation and ASD traits.

One potential reason for the inconsistencies in past findings is that only some ASD traits are related to humor appreciation. The specific traits of ASD are subject to individual differences in individuals with ASD (Cholemkery, Medda, Lempp, & Freitag, 2016; Klopper, Testa, Pantelis, & Skafidas, 2017). Cholemkery et al. (2016) identified clinically meaningful ASD subgroups and suggested that the severity of symptoms varies widely among people with ASD. Klopper et al. (2017) found that individuals with ASD form two subgroups in terms of their ASD trait profile and suggested that some individuals have different characteristics despite having the same diagnosis of ASD. In addition, the specific traits of ASD are also subject to individual differences in the general population (Kitazoe, Fujita, Izumoto, Terada, & Hatakenaka, 2017; Palmer, Paton, Enticott, & Hohwy, 2015); for example, Palmer et al. (2015), who recruited a large general population sample, found that people in general formed two distinct subgroups for ASD trait profiles. Accordingly, further research on the relationship between humor appreciation and ASD should focus on specific ASD traits.

The Autism-Spectrum Quotient (AQ) is a self-report questionnaire that measures levels of autistic traits in the general population and has good test-retest reliability and validity (Ruzich et al., 2015). Baron-Cohen et al. (2001) designed the AQ as a screening or research tool for adult community samples. It consists of 50 items describing various situations and is organized into five subscales: social skills, local details, attention switching, communication, and imagination. Several studies have used the AQ in studying the relationship between humor appreciation and various ASD traits (Rawlings, 2008, 2013). Rawlings (2008) examined the relationship between responses to joke stimuli and total AQ score among 479 typically developing individuals. Joke stimuli were initially obtained from a range of sources or were constructed by Rawlings (2008). The results of this study showed positive correlations between unpleasant responses to joke stimuli and total AQ scores. However, a relationship between responses to joke stimuli and five of the AQ subscales emerged in this study. Based on the results of this study, Rawlings (2013) also examined the relationship between humor appreciation and various ASD traits (as measured by the AQ) in 126 typically developing individuals. Humor appreciation was measured with the Humor Appreciation Measure (HAM), which covers both hypothetical real-life situations and jokes. The results indicated a negative correlation between the social skills subscale of the AQ and humor appreciation for hypothetical humorous real-life situations, indicating that difficulties in applying social skills are associated with poorer humor appreciation. In addition, the results also indicated a positive correlation between the attention switching and communication subscales of the AQ and unpleasant responses to humorous hypothetical real-life situations. These results are important in that they suggest that specific traits of ASD are associated with humor appreciation in individuals without ASD.

However, these past studies had several limitations, one of which is that the AQ can only capture a few ASD traits. It cannot, for instance, capture sensory sensitivity, which is considered a key trait of ASD. Sensory sensitivity refers to hyper- or hypo-reactivity to sensory input or unusual interests in the sensory aspects of the environment and has been included as a diagnostic criterion for ASD in the DSM-5 (American Psychiatric Association, 2013). Additionally, unusual sensory sensitivity among individuals with ASD has been reported in numerous studies (e.g. Chouman, 2014; Minshew & Hobson, 2008; Talay-Ongan & Wood, 2010). For instance, Crane, Goddard, and Pring's questionnaire-based study (2009) found that sensory abnormalities were prevalent among adults and adolescents with ASD and suggested that individuals with ASD may experience very different, yet similarly severe, sensory processing abnormalities. Additionally, Hilton, Graver, and La Vesser (2007) showed that individuals with ASD and severe sensory sensitivity had higher levels of autistic

traits than did those with ASD and mild to moderate sensory sensitivity. Thus, sensory sensitivity is considered one of the most important traits for individuals with ASD.

Furthermore, sensory sensitivity has been associated with ASD traits in the general population (Liss, Mailloux, & Erchull, 2008; Robertson & Simmons, 2013). Liss et al. (2008) examined the relationship between sensory sensitivity, as measured by the Highly Sensitive Person Scale (HSPS), and ASD traits (measured via the AQ) in 201 individuals of the general population, specifically undergraduates. The HSPS contains three factors (Liss et al., 2008): ease of excitation (EOE), which evaluates feelings of becoming overwhelmed by external and internal demands; low sensory threshold (LST), which assesses unpleasant sensory arousal; and aesthetic sensitivity (AES), which assesses aesthetic awareness. Liss et al. (2008) found that both the EOE and LST scores were significantly related to poorer social skills, greater attention to details, and poorer communication, while AES scores were significantly related to greater attention to details and poorer communication. These results suggested that sensory sensitivity is also an ASD trait that is prevalent in the general population.

According to the findings of these studies, it might be necessary to examine the relationship between humor appreciation and sensory sensitivity as an ASD trait in the general population, given that sensory sensitivity is one of the traits of ASD. In addition, sensory sensitivity is considered to be closely related to humor appreciation. As mentioned above, humor is an emotion elicited by cognitive incongruity (Nomura & Maruno, 2011; Wyer & Collins, 1992). Cognitive incongruity is defined as deviations from what we anticipate (Nomura & Maruno, 2011). These deviations are closely related to changes in individuals' experiences of the surrounding environment. Normally, we live according to our ability to predict what will happen in the future and to the results, based largely on attention paid to our surrounding environment (Ito, 2009). Moreover, we experience humor when some aspect of our surrounding environment changes in a way that contradicts our expectations (Ito, 2009). Sensory sensitivity is associated with a greater awareness of such changes as well as greater emotional responsiveness to such changes (Liss et al., 2008). Accordingly, there might be a relationship between humor appreciation and sensory sensitivity. Particularly, humor appreciation might be influenced by the ease of awareness of environmental changes, as represented by LST scores on the HSPS, and emotional responses to environmental changes, as represented by EOE scores on the HSPS. Due to this possibility, it is necessary to be aware of the changes in the external environment as stimuli and to generate an emotional response to those changes when humor is elicited (Ito, 2009). Therefore, humor is likely influenced by the LST, which consists of many items representing the awareness of environmental changes, and the EOE, which consists of many items representing the ease of an emotional response to environmental changes. In other words, it is considered that individuals high in LST and EOE appreciate humor more easily. However, previous studies have not examined these relationships. Therefore, the aim of this study was to reveal the relationships between humor appreciation and ASD traits. This study focused on social skills, local details, attention switching, communication and imagination (captured by the AQ) and EOE, LST, and AES (captured by the HSPS) as traits of ASD. Based on the findings of previous studies and the points mentioned above, the hypothesis of this study was that social skills under the AQ and LST and EOE under the HSPS would influence humor appreciation. In other words, it was predicted that high scores in social skills under the AQ would negatively influence humor appreciation, and high scores in LST and EOE would positively influence humor appreciation. On the other hand, it has also been argued that local details, attention switching, communication, and imagination, as captured by the AQ, do not influence humor appreciation, since Rawlings (2013) did not show any correlation between these subscales of the AQ and appreciation for hypothetical, humorous real-life situations. Also, the relationships between each subscale in AQ-J and HSPS-J19 were examined in this study, in order to confirm that there would be different characteristics compared to previous studies using AQ-J and HSPS-J19. The nature of the similarities and differences in these relationships here compared to previous studies are unclear, since they have not been examined in detail in Japan. Therefore, it is necessary to do so. In addition, this hypothesis was examined in typically developing individuals. As mentioned above, it is known that some of the characteristics of individuals with ASD

are seen to a lesser extent in the general population. However, only few studies have examined the relationship between ASD traits and humor appreciation in typical development. Therefore, the purpose of this study was to reveal the relationships between humor appreciation and ASD traits in the general population.

2. Method

2.1. Participants

One hundred and two undergraduates without ASD were recruited to participate in this study (34 males and 68 females). Their mean age was 19.97 years ($SD = 1.16$; range 18–22 years). All the participants were Japanese. The questionnaire was completed during the last 25 minutes of class.

2.2. Humor materials

Joke stimuli were used in this study as humorous materials. These joke stimuli were created by Ito (2010) to measure humor appreciation and comprise 12 daily life episodes selected from a reader's post column in a fashion magazine for adolescents. Participants' humor appreciation is often captured using daily life episodes as stimuli in Japanese humor research (Ito, 2007, 2010; Nomura & Maruno, 2011). Ito (2010) used these stimuli to explore the cognitive processes underlying humor appreciation in typically developing individuals. In this study, participants were instructed to imagine the situation of these episodes and answer on a 6-point scale to what degree they felt "funny" feelings. Ito (2010) showed that the average score of humor appreciation for these joke stimuli exceeds 3 points, and these joke stimuli are valid for measuring the humor appreciation of the participants. Therefore, these joke stimuli have validity for measuring humor appreciation in this study. Two statements were used to measure humor appreciation for each of these 12 episodes: "I found the joke sentence funny" and "I was inclined to laugh or laughed" for each of the 12 episodes. Participants rated both statements on a 7-point scale ranging from 1 (*completely disagree*) to 7 (*completely agree*) (Nomura & Maruno, 2011). A humor appreciation score was derived through the following procedure. First, the total score of the two items ("I found the joke sentence funny" and "I was inclined to laugh or laughed") for each stimulus was calculated. Second, the overall humor appreciation score was calculated by summing the scores of the 12 stimuli. The total possible score ranged from 24 to 144. All joke stimuli are shown in Table 1.

2.3. Questionnaire

ASD traits were measured using the Japanese version of the AQ (AQ-J; Wakabayashi et al., 2004). The AQ-J contains 50 items, like the original, which participants rate on a 4-point scale (strongly agree, agree, disagree, and strongly disagree). The AQ-J consists of five subscales: social skills, local details, attention switching, communication, and imagination. For scoring purposes, answers of "agree" and "strongly agree" are combined, as are answers of "disagree" and "strongly disagree." Responses indicating the presence of ASD symptoms are scored 1 point; thus, the total score ranges from 0 to 50. The Japanese questionnaire appears generalizable, as Wakabayashi et al. (2004) found that comparisons of individuals with ASD and typically developing individuals were similar between the UK and Japan. An adequate level of reliability and validity of the AQ-J and its five subscales has been demonstrated (Wakabayashi et al., 2004). In this regard, Wakabayashi et al. (2004) showed that the scores of the AQ-J in individuals with ASD was significantly higher than those in typically developing individuals. This suggested that the AQ-J has clinical validity. Wakabayashi et al. (2004) also showed that Cronbach's alphas for the AQ-J were .81, .78, .57, .63, .64, .51 for total AQ-J, social skills, local details, attention switching, communication, and imagination, respectively. In the present study, Cronbach's alphas for the AQ-J were .77, .65, .64, .54, .62, .44. for total AQ-J, social skills, local details, attention switching, communication, and imagination, respectively. The reliability of the AQ-J shown in this study was very similar to that shown in Wakabayashi et al.'s study (2004).

To measure sensory responsibility, the Japanese version of the 19-item HSPS (HSPS-J19) was used. The HSPS-J19 was developed by Takahashi (2016), based on the original HSPS (Aron & Aron, 1997). The HSPS-J19 contains the same three-factor structure (Takahashi, 2016) as the original (i.e. EOE, LST, and AES). Participants answer each question on a scale ranging from 1 (*not at all*) to 7

Table 1. Examples of the episode in the joke stimulus

Episode 1

Since I have been dating my current boyfriend, who likes “someone who eats a lot,” I have gained 10 kg within 6 months.

Episode 2

One day, I hurriedly got ready and left the house, and it was only upon arriving at my workplace that I noticed I was wearing mismatched shoes.

Episode 3

While I was working an office job, one night, I felt too lazy to cook. So, I took some instant noodles, straight from the packet, and I munched on them, just like that.

Episode 4

I saw a Japanese tourist group in Australia, and they were all wearing hats with numbers, like “1,” “2,” and “3,” perhaps to keep track of the group members.

Episode 5

Ms. M, who lives in the same company-provided housing as I do, is an attractive woman with a thin figure. However, the other day, when the superintendent told her in a nasty manner, that she had not thrown away some large-sized trash (a sofa) in the right place, she apparently got annoyed and moved the sofa alone, by carrying it over her shoulder.

Episode 6

On Christmas Eve, we had not made dinner reservations, so the two of us—my boyfriend and I—had to dine at a gyoza chain restaurant on a holy night.

Episode 7

One morning, after waking up for work earlier than usual, I realized I was brushing my teeth with my hair brush.

Episode 8

When we first began dating, I went on a beach date with my boyfriend. However, the sea water kept washing my makeup off, leaving me exposed with my bare face.

Episode 9

I sent a message to a subordinate in my company, who I was slightly interested in, inviting him to a meal. However, when I happened to look at my message history, I realized that I had sent it to my superior, who has a very similar name.

Episode 10

Our company becomes the venue for a state exam, once every two months. Even though it's on my day off, I have to spend three hours commuting there. My job is to hand out plastic bags for people to put their shoes in.

Episode 11

At Christmas last year, when I saw I only had 50 yen in my wallet, I was forced to make do by eating Japanese pickled vegetables.

Episode 12

I am quite forgetful; I lost the handmade silver ring that my boyfriend gave me on my birthday, the day after I received it.

(*extremely*), and the total score (the sum of the item scores) ranges from 19 to 133. Takahashi (2016) demonstrated that the HSPS-J19 has good reliability and validity. Takahashi (2016) showed that there are significant correlations between the total scores of the HSPS-J19 and scores on various scales in measuring neurotic tendency. This suggested that the HSPS-J19 has construct validity. Takahashi (2016) also showed that Cronbach's alphas for the HSPS-J19 were .78, .78, .71, .57 for total HSPS-J19, EOE, LST, and AES, respectively. In the present study, Cronbach's alphas for the HSPS-J19 were .82, .70, .80, .57 for total HSPS-J19, EOE, LST, and AES, respectively.

2.4. Data analysis

All 102 participants completed the humor appreciation measure and the HSPS-J19. Pearson's correlations were then calculated between the humor appreciation score, the scores on the five

AQ-J subscales, and the scores on the three subscales of the HSPS-J19 in order to examine the relationships between ASD traits and humor appreciation. Second, a stepwise multiple linear regression analysis was performed containing the subscales of the AQ-J and HSPS-J19, which showed a significant correlation with the humor appreciation score as explanatory variables, and humor appreciation as the outcome variable in order to examine which ASD traits influence humor appreciation. In addition, Pearson's correlations were calculated between each subscale in AQ-J and each subscale in HSPS-J19 in order to confirm that different characteristics would appear compared to previous studies on AQ-J and HSPS-J19. SPSS Statistics 23.0 (IBM Corp., Armonk, NY) was used for all analyses.

2.5. Ethics statement

The study protocol was designed in accordance with the tenets of the Declaration of Helsinki (2000) and was reviewed and approved by the local ethics committee (Approval Number: 29-4). All participants were informed that their privacy and responses would be strictly protected. Furthermore, they were told that their participation or scores would not affect their academic evaluations. They were also informed that participation was not mandatory and that they could withdraw from the study at any time. Participants provided oral and written informed consent.

3. Results

3.1. Descriptive statistics and correlational analysis

Table 2 presents descriptive statistics for the Humor Appreciation measure, AQ-J, and HSPS-J19.

The Pearson's correlations between Humor Appreciation, the AQ-J subscales, and the HSPS-19 subscales are provided in Table 3. The social skills subscale of the AQ-J was significantly and negatively correlated with local details ($r = -.17, p < .05$) and positively correlated with attention switching ($r = .50, p < .01$), communication ($r = .54, p < .01$), and imagination ($r = .46, p < .01$). Attention switching was significantly and positively correlated with communication ($r = .50, p < .01$) and imagination ($r = .37, p < .01$), while communication scores were significantly and positively associated with imagination ($r = .48, p < .01$). As for the HSPS-J19, EOE had positive and significant correlations with LST ($r = .62, p < .01$) and AES ($r = .31, p < .01$). EOE scores were also significantly and positively correlated with four of the AQ-J subscales, including social skills ($r = .17, p < .05$), attention switching ($r = .51, p < .01$), communication ($r = .34, p < .01$), and imagination ($r = .19, p < .05$). Similarly, LST scores were significantly and positively correlated with social skills

Table 2. Descriptive Statistics in the Scores of Humor Appreciation, AQ-J, and HSPS-J19

	Mean score	SD	Min	Max
Humor Appreciation	92.01	29.22	24	144
AQ-J	18.98	6.61	5	41
social skills	3.40	2.30	0	9
local details	4.06	2.29	0	10
attention switching	5.19	2.05	0	9
communication	3.49	2.18	0	9
imagination	2.84	1.73	0	9
HSPS-J19	64.18	10.49	37	89
EOE	27.54	5.03	16	39
LST	22.58	5.65	8	34
AES	14.06	2.76	7	20

AQ-J = Japanese version of the Autism-Spectrum Quotient; HSPS-J19 = Japanese version of the 19-items Highly Sensitive Person Scale, EOE = ease of excitation, LST = low sensory threshold, AES = aesthetic sensitivity; SD = standard deviation, Min = minimum values, Max = maximum values $n = 102$.

Table 3. Correlations between the Score of Humor Appreciation, the Five Sub-Scale Scores of AQ-J, and Three Sub-Scale Scores of HSPS-J19									
Scale	1	2	3	4	5	6	7	8	9
1. Humor Appreciation	-	-.19*	.13	.00	.05	.02	.21*	.15*	.20*
2. social skills		-	-.17*	.50**	.54**	.46**	.17*	.29**	-.15
3. local details			-	-.13	.01	-.06	.07	.02	.26**
4. attention switching				-	.50**	.37**	.51**	.54**	.04
5. communication					-	.48**	.34**	.38**	.01
6. imagination						-	.19*	.32**	.04
7. EOE							-	.62**	.31**
8. LST								-	.05
9. AES									-

AQ-J = Japanese version of the Autism-Spectrum Quotient; HSPS-J19 = Japanese version of the 19-items Highly Sensitive Person Scale, EOE = ease of excitation, LST = low sensory threshold, n = 102
AES = aesthetic sensitivity
*: $p < .05$
**: $p < .01$

Table 4. Stepwise Multiple Regression Analysis: the Five Sub-Scale Scores of AQ-J, and Three Sub-Scale Scores of HSPS-J19 as Predictors of Humor Appreciation

	Humor Appreciation			
	β	t	p	VIF
Social skills	-.24	-2.35	.02*	1.03
EOE	.25	2.50	.01*	1.03
LST	.11	0.90	.37	1.72
AES	.11	1.03	.31	1.16

Humor Appreciation: $R^2 = .10$, $F(2, 99) = 5.39$, $p < .01$; β = standardized beta coefficients; VIF = variance inflation factor.
 *: $p < .05$

($r = .29$, $p < .01$), attention switching ($r = .54$, $p < .01$), communication ($r = .38$, $p < .01$), and imagination ($r = .32$, $p < .01$), while AES scores were positively and significantly associated with local details ($r = .26$, $p < .01$). Finally, humor appreciation was negatively associated with social skills ($r = -.19$, $p < .05$) but positively associated with EOE ($r = .21$, $p < .05$), LST ($r = .15$, $p < .05$), and AES ($r = .20$, $p < .05$).

3.2. Stepwise multiple linear regression analysis

Stepwise multiple linear regression analysis was performed using social skills, EOE, LST, and AES as explanatory variables to examine whether autistic traits predicted humor appreciation in typically developing participants. The variance inflation factors (VIFs) of the variables were examined to determine if multicollinearity was an issue. Table 4 shows the results of the regression analysis. The coefficient of determination of the model was significant ($R^2 = .10$, $F(2, 99) = 5.39$, $p < .01$). Both the EOE subscale of the HSPS-J19 ($\beta = .25$, $p < .05$) and the social skills subscale of the AQ-J ($\beta = -.24$, $p < .05$) were independent and significant predictors of humor appreciation. In addition, the VIFs of EOE and social skills were both 1.03, thus satisfying the criterion for absence of multicollinearity (less than 2.00).

4. Discussion

This study examined the relationship between humor appreciation and ASD traits in the general population. Before discussing the results concerning this relationship, the correlation between the AQ-J and HSPS-J19 will be discussed with reference to previous studies. The study results showed that the Pearson's correlations that emerged between the five subscale scores of the AQ-J were significant and positive, except for the correlations between local details and attention switching, communication, and imagination. The correlations between local details and attention switching, communication, and imagination were not significant. Previous studies in Japan have not examined the correlations between the five subscale scores of the AQ-J. However, the study results were very similar to previous studies conducted in other countries. For example, Palmer et al. (2015), who also examined the correlations between the AQ subscales, similarly showed significant positive correlations between most AQ subscales, except for the correlation between local details and imagination. In addition, while the correlations between local details and attention switching ($r = -.09$) and communication ($r = -.09$) in Palmer et al.'s study (2015) were significant, they were weak. Thus, despite slight differences, the present study and Palmer et al. (2015) found similar correlations among the AQ subscales. Second, the three subscales of the HSPS-J19 were also significant and positively correlated, except the correlation between LST and AES. This result was very similar to that of Takahashi (2016), who also examined the correlations between the subscales of the HSPS-J19 and showed a significant correlation between EOE and LST. However, Takahashi (2016) showed that there was no significant correlation between EOE and AES. The discrepancy between the aforementioned result of this study and Takahashi's (2016) results may relate to the characteristics of AES. Takahashi (2016) pointed out that AES consisted of items that represent the positive aspects of highly sensitive individuals and were selected based on qualitative research results and desirability of questionnaires. Therefore, the correlation between AES and

other subscales of the HSPS has been found to vary from study to study (Booth, Standage, & Fox, 2015; Konrad & Herzberg, 2017). For example, Booth et al. (2015) also examined these correlations in the HSPS and found significant and positive correlations among all subscales. Thus, the correlation between AES and other subscales of the HSPS needs to be further studied. As mentioned above, the relationships between each subscale in AQ-J and in HSPS-J19 that were revealed in this study were generally similar to those revealed in previous studies, although there were differences in the details. These results support the generalizability of the relationship between ASD traits and humor appreciation described below.

Next, the Pearson's correlations between the AQ-J and HSPS-J19 subscales were significant and positive. In particular, EOE scores were positively associated with social skills, attention switching, communication, and imagination; LST was positively associated with social skills, attention switching, communication, and imagination; and AES was positively associated with local details. Thus, these two measures were clearly relevant to each other, despite the lack of relationship between some subscales. These results were congruent with those of previous studies (Liss et al., 2008). Liss et al. (2008) also examined the correlation between the AQ-J and the HSPS-J19 subscales and showed that: a) EOE scores were positively associated with poor social skills, attention to detail, and poor communication; b) LST scores were also positively associated with poor social skills, attention to detail, and poor communication; and c) AES scores were positively associated with attention to detail and negatively associated with poor communication. These findings suggest that sensory sensitivity, as measured by the HSPS-J19, is related to ASD traits. Therefore, it can be considered that EOE, LST, and AES under the HSPS-J19 capture some of the characteristics of individuals with ASD.

The relationship of interest—humor appreciation and sensory sensitivity—will be discussed in this section. Humor appreciation was negatively correlated with social skills but positively correlated with EOE, LST, and AES. The regression analysis further confirmed that social skills and EOE were unique predictors of humor appreciation. In particular, individuals with poor social skills had difficulties with humor appreciation, and individuals with ease of excitation could appreciate humor easily. Accordingly, several ASD traits—namely, poor social skills and sensory sensitivity (particularly EOE)—were associated with humor appreciation. This result supported the hypothesis set in this study. This result can be discussed in light of the process underlying humor appreciation elucidated in previous studies (Ito, 2010; Nomura & Maruno, 2011). Ito (2010) highlighted that it is essential for individuals to recognize the divergence between a stimulus situation and anticipation, general knowledge, and common sense (i.e. incongruity) when he/she appreciates humor. Furthermore, Nomura and Maruno (2011) revealed that the elaboration of a stimulus, (i.e. making inferences about the features of the stimulus situation) influences the extent of humor appreciation. Elaboration of a stimulus includes imagining happenings that occurred in the past or that will occur in the future, inferring the mental state of the person featured in the stimulus, and remembering past events that individuals (participants) actually experienced.

These aspects of cognitive processes involved in humor appreciation can be further related to the distinct ASD traits found in this study: that is, EOE might relate to the ability to recognize incongruity, and poor social skills might relate to the elaboration of a stimulus. EOE to stimuli refers to the feeling of being overwhelmed by both external and internal demands (Listou & Diseth, 2016; Smolewska, McCabe, & Woody, 2006). In addition, as mentioned above, the EOE refers to the ease of emotional responses to environmental changes; thus, individuals high in EOE are more likely to be emotionally responsive to environmental changes that are contrary to their expectations and common sense (i.e. cognitive incongruities). Therefore, individuals high in EOE appear to appreciate humor more easily, enabling them to respond to environmental changes easily. Previous studies have shown that EOE for various stimuli relates to negative emotions such as anxiety (Booth et al., 2015); however, they did not show that EOE relates to positive emotions.

Therefore, this study was significant in showing that EOE is related not only to negative emotions but also to the elicitation of positive emotions, specifically humor.

Also, social skills under the AQ-J include items about interest in others and inferences about others' mental state; social skills under the AQ-J were negatively associated with the "extra-version" domain scale of the NEO-PI-R (Wakabayashi, Baron-Cohen, & Wheelwright, 2006). This shows that poor social skills are associated with sparseness of interest in others, indicating that individuals with poor social skills do not generally make inferences about others' mental states or behavior. As mentioned above, elaboration of the humor stimulus, which is important for the appreciation of humor, includes inferring the mental state of the person featured in the stimulus. Accordingly, the extent of humor appreciation may be weaker in individuals with poor social skills, hindering them from being able to infer the mental state of the person featured in the stimulus. As mentioned above, Rawlings (2013) also showed that social skills under the AQ are negatively associated with humor appreciation. Thus, the present study's results confirm those of Rawlings (2013).

On the other hand, LST did not influence humor appreciation. This finding did not support the hypothesis set in this study. This result can be discussed in terms of the format of the joke stimuli. Participants appeared to readily pay attention to divergences of the joke stimuli between the stimulus situation and their expectations, so that these were presented in written format in this study. In other words, participants were able to pay sustained attention to joke stimuli since the stimuli remained present in front of them. LST reflects unpleasant sensory arousal to external stimuli (Lionetti et al., 2018) and individuals' awareness of environmental changes. Participants easily recognized these divergences regardless of LST level using the joke stimuli format. Accordingly, this feature (sustained presentation) of the joke stimuli might account for why LST did not affect humor appreciation in this study.

The results of this study, specifically the fact that EOE and poor social skills were associated with humor appreciation, can help explain humor appreciation in individuals with ASD. As mentioned earlier, some individuals high in ASD traits easily appreciate humor, while other individuals high in ASD traits have difficulty in appreciating humor, a fact that constituted the basis of the hypothesis of this study—that some ASD traits are related to humor appreciation. It is rational to argue, based on the results of this study, that it may be that individuals with ASD who appreciate humor easily are easily excited by various stimuli or environmental changes and have some social skills; by contrast, those who find it difficult to appreciate humor might be less excited by stimuli or environmental changes and have poor social skills. This study contributes to understanding the relationship between sensory sensitivity and social communication in individuals with ASD.

However, this study has several limitations. First, the participants were all typically developing individuals. Further studies should recruit individuals with ASD using the same scales and humor stimuli to confirm the relationships of EOE and social skills with humor appreciation. In doing so, the generality of the relationship between humor appreciation and ASD traits revealed in this study can be replicated and thus confirmed, and the characteristics of individuals with ASD can be captured in more detail. Second, the relationship between EOE and recognition of incongruity, and that between poor social skills and stimulus elaboration, were not examined in this study. Further studies should examine these relationships using a more experimental method. Examining these relationships will advance the understanding of the relationship between cognition and emotion in individuals with ASD, which has been attracting attention recently. Due to these limitations, the findings of this study lack generalizability to other populations and do not grasp the whole picture of the relationships between humor appreciation and ASD traits. Therefore, it is necessary for future research to resolve these limitations, as described above.

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