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Sensory modality and body-location imagery among persons with somatosensory amplification

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The purpose of this study was to assess whether somatosensory amplification influenced the relationship between basic emotions and sensory modality and body image by the modality differential (MD) method and the body-image location (BIL) scale. Approximately 130 undergraduate students were administered the Japanese Version of the Somatosensory Amplification Scale (SSAS) and were asked to rate the relevance of 10 sensory modalities (warm, cold, olfactory, gustatory, tactile, pain, equilibrium, kinesthetic, visual, and auditory) and 7 body parts (forehead, throat, chest, stomach, lower abdomen, internal organs, and whole body) to 6 basic emotions (happiness, sadness, fear, anger, surprise, and disgust). Participants also completed the Japanese version of the 20-item Toronto Alexithymia Scale. Each emotion was compared between the two groups (high and low SSAS) using the MD method and BIL scale. The high SSAS's relevance of sadness, fear, anger, and surprise to the proximal sensory image was stronger than that of the low SSAS. Moreover, the high SSAS's relevance of happiness, fear, anger, surprise, and disgust to body location image was stronger than that of the low SSAS. These results suggest that somatosensory amplification strongly influenced the combination of sensory modality and body image with emotion.

Key words: body image, sensory modality, basic emotions, somatosensory amplification

Introduction

When we want to express exact differences in our experiences of emotion, we often use a modifier related to sensory modalities and body images. For example, when we feel very sad, we express this as “crying our hearts or eyes out.” These expressions demonstrate exact differences in the qualities related to sadness. Expressions identified with fear include mention of the heart being in the mouth or feeling a lump in the throat. There are many such expressions that show connections between emotions and body imagery. In addition, happiness connects easily with warm sensory modality, while sadness connects with that which is cold. These are examples of emotional expression related to sensory modality.

Kusumi and Yoneda (2007) reported in a qualitative study that the expressions of emotion were a metonymy about the connections between the emotions and body, and they analyzed this using a cognitive-linguistics approach. They concluded that emotional expression is constructed by image schemas (Gibbs, 2006; Lakoff, 1987), which are structured based on combining a physiological experience (e.g., blood pressure, heart rate) with cultural universality.

Meanwhile, Okada and Gyoba (2017a, 2017d) suggested that there is a unique relationship

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between basic emotions (happiness, sadness, fear, anger, surprise, and disgust) and sensory modality and body image (sensory/body image) according to a specific rating method. Using the modality differential (MD) method (Suzuki, Gyoba, Kawabata, Yamaguchi, & Komatu, 2006), they concluded that emotional specificity exists. In other words, for each emotion there is a proximal (near) sensory modality (warm, cold, olfactory, gustatory, tactile, pain) to match. In addition, using the newly devised body-image location (BIL) scale, they measured the relevance of body image to basic emotions. All emotions had a strong association with the body, especially the chest.

Kusumi and Yoneda (2007) used a qualitative approach, while Okada and Gyoba (2017a, 2017d) used a quantitative approach, to examine the relationship between emotion and sensory/body image. In addition, there are clinical studies concerning this issue (psychosomatics; e.g., alexithymia; Sifneos, 1973) and irritable bowel syndrome: IBS (Fukudo et al., 2009), as well as neuroimaging studies (Moriguchi & Komaki, 2013).

Because the experience of emotion is subjective, individual, composite, and complex, we hypothesized that personal traits that cause psychosomatic responses influence the relationship between emotion and sensory/body image. Okada and Gyoba (2017b, 2017c) focused on this hypothesis. Sifneos (1973) defined alexithymia as a personality trait of being unable to describe or differentiate one's emotions. The researcher used alexithymia traits measured by the 20-item Toronto Alexithymia Scale (TAS-20; Bagby, Parker, & Taylor, 1994a; Bagby, Taylor, & Parker, 1994b). Using the Japanese version of the TAS-20 (Komaki & Maeda, 2015), Okada and Gyoba (2017c) compared the high alexithymia group with the low group. Moreover, using the MD method and the BIL scale, the relationship between emotion and sensory/body image was examined. There was a tendency for the high alexithymia group's senses to be stronger compared to the low alexithymia group according to the MD method and BIL scale.

The TAS-20 is structured on a three-factor model comprising 1) difficulty identifying feelings (DIF), 2) difficulty describing feelings (DDF), and 3) externally oriented thinking (EOT). In contrast with the DIF of alexithymia, Okada and Gyoba (2017c) found that the high alexithymia group rated stronger relationships between emotion and sensory/body image than did the low alexithymia group.

Based on these findings, we further focused on somatosensory amplification, which is strongly correlated with alexithymia traits in the present study. somatosensory amplification refers to the tendency to experience somatic sensations as intense and disturbing (Barsky, Goodson, Lane, & Cleary, 1988). It includes an individual's disposition to focus on unpleasant sensations and to consider them pathological, rather than normal (Nakao, Kumano, Kuboki, & Barsky, 2001). The Somatosensory Amplification Scale (SSAS) was designed and validated to measure this phenomenon (Barsky, Wyshak, & Klerman, 1990). Nakao, Barsky, Kumano, and Kuboki (2002) used the SSAS to show that somatosensory amplification appeared to be associated with DIF and DDF in Japanese psychosomatic patients.

The purpose of this study was to examine whether somatosensory amplification influenced

the relationship between basic emotions and sensory modality and body image using the MD method and the BIL scale, and to examine how persons with somatosensory amplification traits form characteristic combinations related to those relationships.

Method

Measures

Relevance of sensory and body image to basic emotions. We used the MD method (Okada & Gyoba, 2017a, 2017d). The MD method uses a 7-point Likert-type scale for relevance of sensory modality (warm, cold, olfactory, gustatory, tactile, pain, equilibrium, kinesthetic, visual, and auditory) from 0 (irrelevant) to 6 (highly relevant) to each basic emotion (happiness, sadness, fear, anger, surprise, and disgust). This was termed the MD data.

Simultaneously, we used the BIL scale (Okada & Gyoba, 2017a, 2017d), which uses a 7-point Likert-type scale to assess the relevance of body parts (forehead, throat, chest, stomach, lower abdomen, internal organs, and whole body) from 0 (irrelevant) to 6 (highly relevant) to each basic emotion (happiness, sadness, fear, anger, surprise, and disgust). This was termed the BIL data.

To make it is easier to rate the scales intuitively on the survey forms, we added a right triangle indicating the level of relevance to both scales. A total of twelve types of survey forms, which varied in terms of the presentation order of the six emotions (6) by presentation order of the sensory modalities and body parts (2), were randomly distributed to the participants.

Somatosensory amplification and alexithymia traits. The Japanese version of the Somatosensory Amplification Scale (SSAS) (Nakao, et al., 2001) was used in order to confirm the influence of individual traits. Because individual traits (e.g., alexithymia) enhance the relevance of sensory and body imagery to basic emotions. The participants were asked to complete the SSAS, which was developed to assess somatoform disorders and hypochondriasis (Barsky, et al., 1990). The Japanese version of the SSAS asked participants to rate the degree of what they were experiencing on an ordinal scale from 1 to 5 on 10 statements: “When someone else coughs, it makes me cough too.”; “I can’t stand smoke, smog, or pollutants in the air.”; “I am often aware of various things happening within my body.”; “When I bruise myself, it stays noticeable for a long time.”; “Sudden loud noises really bother me.”; “I can sometimes hear my pulse or my heartbeat throbbing in my ear.”; “I hate to be too hot or too cold.”; “I am quick to sense the hunger contractions in my stomach.”; “Even something minor, like an insect bite or a splinter, really bothers me”; and “I have a low tolerance for pain.” The validity and reliability of the Japanese version of the SSAS were verified by Nakao, et al. (2001). The responses for the 10 items were summed. The maximum score was 50 points, and the minimum was 10 points. The higher score indicates stronger somatosensory amplification. The SSAS is a clinically useful tool to evaluate Japanese psychosomatic patients (Nakao, et al., 2001).

At the same time, the participants were asked to complete the Japanese version of the

TAS-20 (Komaki & Maeda, 2015). The TAS-20 has 20 questions rated on a 5-point scale, whereby 1 is “strongly disagree” and 5 is “strongly agree.”

Participants

A total of 130 undergraduate students (27 men and 101 women, 2 unidentified: mean age=18.8, SD=.98) at Aomori University of Health and Welfare participated in this experiment. The questionnaire took approximately 15 minutes to complete.

All procedures were approved by the ethics committee of Aomori University of Health and Welfare.

Results

Analysis of the SSAS Scores

Each participant’s SSAS score was summed. The highest score was 47 points, the lowest score was 19 points, and the mean (SD) was 35.2 (5.6). The Cronbach’s alpha of the SSAS was .671. This Cronbach’s alpha was not sufficient, but it could still be said that the scale was valid, given the comparison with the clinical result of Nakao et al. (2001) of .79. Therefore, the SSAS score in this study showed adequate internal consistency.

Grouping by somatosensory amplification traits using the SSAS was performed by arranging the total scores in ascending order, then assigning the 23 participants scoring in the top 20 points of the scale (including the participants with the same rank) to the high SSAS group and the 21 participants scoring in the bottom 20 points of the scale (including the participants with the same rank) to the low SSAS group. Table 1 shows both group means and standard deviations. An independent sample t-test revealed that the high-SSAS group’s mean score was significantly higher than the low-SSAS group’s mean score, $t(42) = 23.2$ $p = 0.000$.

Table 1 *Means and Standard Deviations of SSAS and TAS-20 Scores for Both the Low and High SSAS Groups*

	SSAS score <i>M(SD)</i>	TAS-20score <i>M(SD)</i>
Low SSAS(N=21)	26.3(2.8)	49.8(11.3)
High SSAS(N=23)	43(1.9)	59(7.7)

Relationship between the SSAS and the TAS-20

The TAS-20 score was summed using the DIF, DDF, and EOT total scores, according to Komaki & Maeda (2015). The highest score was 81 points, and the lowest score was 28 points, while the mean (SD) was 55.2 (9.9). The SSAS and TAS-20 scores were significantly correlated ($r(130) = .345$, $p < .001$). Table 2 shows each correlation coefficient between the SSAS and the TAS-20 (subscales DIF, DDF, and EOT). In addition, the TAS-20 mean scores in the SSAS-high and low groups are shown in Table 1. The SSAS-high group’s TAS-20 score (59) was significantly higher than that of the SSAS-low group (49.8), $t(42) = 3.2$ $p = .003$.

Table 2 Correlations among SSAS and TAS-20 Scores (Total-score, DIF, DDF, EOT)

	TAS-20 score	DIF	DDF	EOT
SSAS score	.343***	.422**	.233**	-0.005
			*** $p < .001$	** $p < .005$

Relationship between the SSAS and the MD Data

To examine whether somatosensory amplification traits relate to the strength of sensory modality images, MD data were analyzed. Okada and Gyoba (2017c) found that the MD profiles of high-alexithymia traits showed distinctive patterns in proximal (near) sense (warm, cold, olfactory, gustatory, tactile, and pain). Therefore, the present study used MD profiles (putting the proximal senses on the horizontal axis, and as the degree of relevance we arranged the average score of each subject on the vertical axis). The MD profiles shown in Figure 1 a (sadness), b (fear), c (anger), and d (surprise) made it possible to compare the two groups for each of the emotions.

Each of the emotions was compared between the two groups (high SSAS and low SSAS) across 6 proximal senses. We examined the statistical differences by conducting a two-way

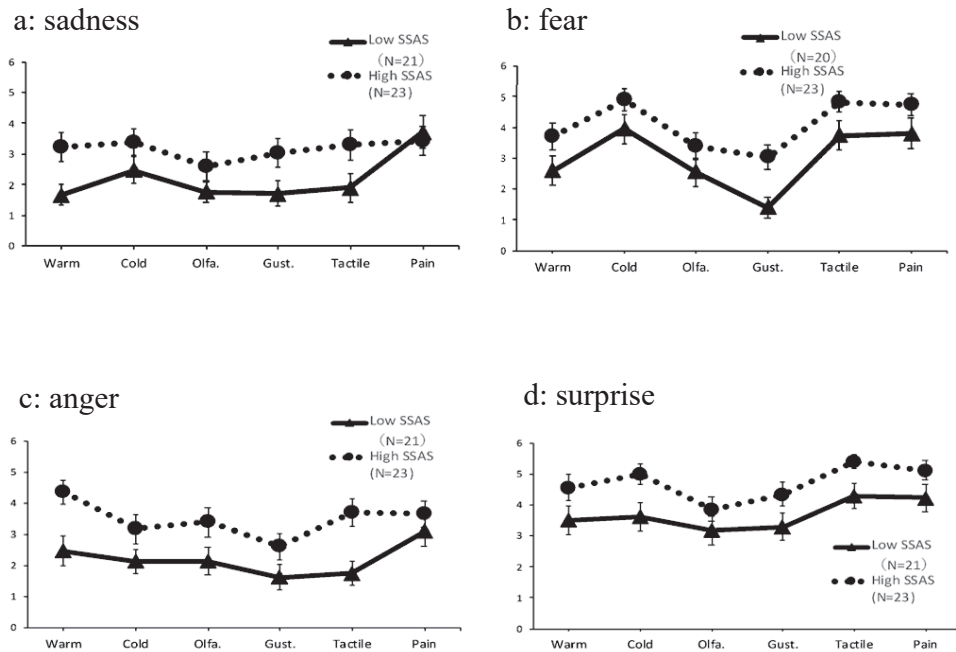


Figure 1. a: MD profile of sadness for the high and low SSAS groups. b: MD profile of fear for the high and low SSAS groups. c: MD profile of anger for the high and low SSAS groups. d: MD profile of surprise for the high and low SSAS groups. The error bars represent standard errors. Note. The symbols “Olf.” and “Gust.” signify olfactory and gustatory, respectively.

ANOVA with SSAS (high and low groups) \times 6 proximal senses.

For sadness, an ANOVA with the factor of SSAS and sensory modality revealed main effects for SSAS ($F(1,42)=4.1$, $p=.049$ $\eta_p^2=.089$), but there was no interaction of SSAS and sensory modality, ($F(5,210)=2.1$, $p=.069$ $\eta_p^2=.047$). For fear, an ANOVA with the factor of SSAS and sensory modality revealed main effects for SSAS ($F(1,41)=6.1$, $p=.018$ $\eta_p^2=.129$), but there was no interaction of SSAS and sensory modality, ($F(3.8,157)=.43$, $p=.78$ $\eta_p^2=.01$). For anger, an ANOVA with the factor of SSAS and sensory modality revealed main effects for SSAS ($F(1,42)=6.7$, $p=.013$ $\eta_p^2=.138$), but there was no interaction of SSAS and sensory modality, ($F(5,210)=1.79$, $p=.12$ $\eta_p^2=.04$). For surprise, an ANOVA with the factor of SSAS and sensory modality revealed main effects for SSAS ($F(1,42)=4.9$, $p=.032$ $\eta_p^2=.105$), but there was no interaction of SSAS and sensory modality, ($F(4.2,175.7)=.47$, $p=.77$ $\eta_p^2=.01$).

To summarize, the high SSAS group's relevance of proximal sensory image was stronger than that of the low SSAS group in terms of sadness, fear, anger, and surprise.

Relationship between the SSAS and the BIL Data

In the same way, to examine whether somatosensory amplification traits related to strength of body-location images, BIL data were analyzed. We drew the BIL profiles putting the seven body parts (forehead, throat, chest, stomach, lower abdomen, internal organs, and whole body) on the horizontal axis. As the degree of relevance, we arranged the average score of each of the subjects on the vertical axis. BIL profiles shown in Figure 2 a (happiness), b (fear), c (anger), d (surprise), and e (disgust) made it possible to compare the two groups for each of the emotions.

Each emotion was compared between the two groups (high and low SSAS) across seven body parts. We examined the statistical differences by conducting a two-way ANOVA with SSAS (high and low groups) \times 7 body parts. For happiness, the ANOVA with the factor of SSAS and body parts revealed main effects for SSAS ($F(1,40)=4.4$, $p=.042$ $\eta_p^2=.1$), but there was no interaction of SSAS and body parts, ($F(4.6,185.9)=.98$, $p=.43$ $\eta_p^2=.024$). For fear, the ANOVA with the factor of SSAS and body parts revealed main effects for SSAS ($F(1,42)=10.1$, $p=.0003$ $\eta_p^2=.194$), but there was no interaction of SSAS and body parts, ($F(3.9,162.8)=1.19$, $p=.32$ $\eta_p^2=.028$). For anger, the ANOVA with the factor of SSAS and body parts revealed main effects for SSAS ($F(1,42)=7.8$, $p=.008$ $\eta_p^2=.156$), but there was no interaction of SSAS and body parts, ($F(4.3,179.8)=1.37$, $p=.24$ $\eta_p^2=.032$). For surprise, the ANOVA with the factor of SSAS and body parts revealed main effects for SSAS ($F(1,42)=4.2$, $p=.048$ $\eta_p^2=.09$), but there was no interaction of SSAS and body parts, ($F(4.6,194.7)=.96$, $p=.44$ $\eta_p^2=.022$). For disgust, the ANOVA with the factor of SSAS and body parts revealed main effects for SSAS ($F(1,42)=4.8$, $p=.034$ $\eta_p^2=.102$), but there was no interaction of SSAS and body parts, ($F(4.3,178.6)=1.94$, $p=.10$ $\eta_p^2=.044$). For sadness, there was no significant difference between the high and low groups in terms of the ANOVA results of the MD data.

To summarize, the high SSAS group's body-location image relevance was stronger than that of the low SSAS regarding happiness, fear, anger, surprise, and disgust. Sadness was the only emotion not found to be influenced by SSAS.

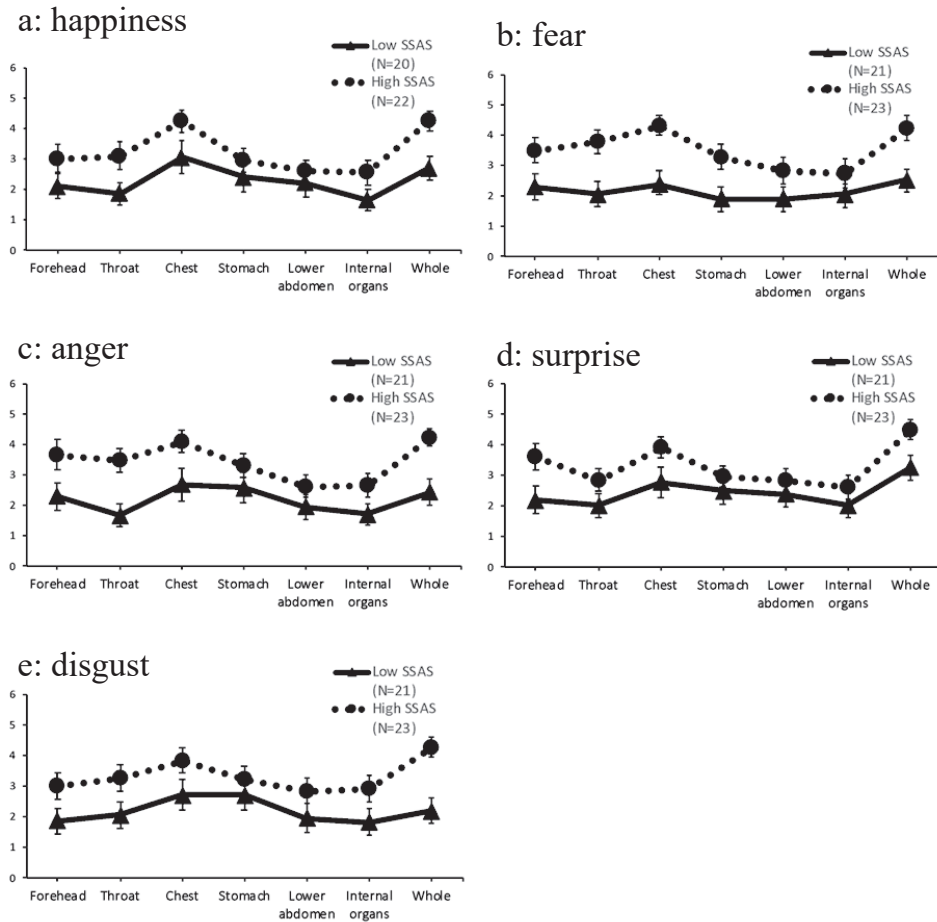


Figure 2. a: BIL profile of happiness for the high and low SSAS groups. b: BIL profile of fear for the high and low SSAS groups. c: BIL profile of anger for the high and low SSAS groups. d: BIL profile of surprise for the high and low SSAS groups. e: BIL profile of disgust for the high and low SSAS groups. Error bars represent standard errors.

Cluster Analysis of Basic Emotions by SSAS Group (High or Low)

To examine the similarity of six basic emotions by each SSAS-group (high or low), we conducted cluster analysis using Ward's method, based on MD and BIL data.

The results of MD data by low SSAS, shown in Figure 3a, indicated that there were two types of emotions that resulted in sadness, anger and fear, surprise, disgust, and happiness. In contrast, the results of MD data by high SSAS, shown in Figure 3b, indicated that there were two types of emotions that resulted in sadness, anger and happiness, surprise, disgust, and fear.

The results of BIL data by low SSAS, shown in Figure 4a, indicated that there were two types of emotions that resulted in happiness, anger, disgust fear and surprise, and sadness. The

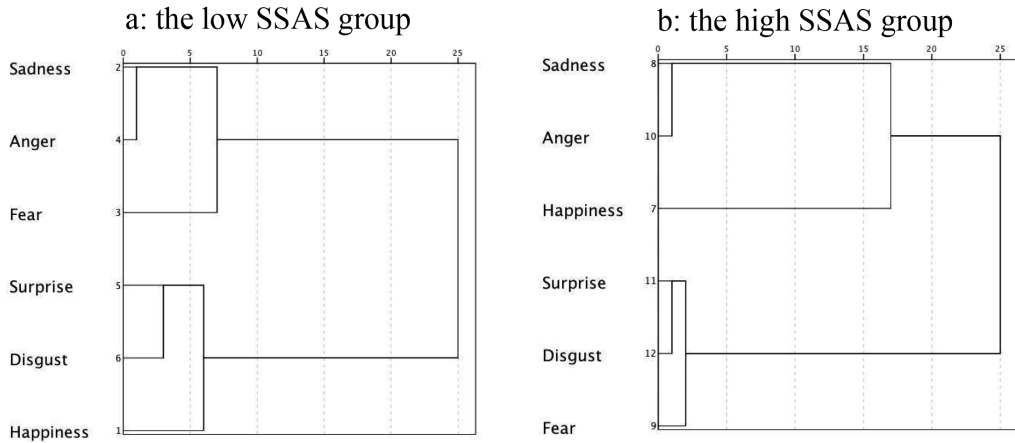


Figure 3. The results of cluster analysis (Ward's method). a: MD data in the low SSAS group. b: MD data in the high SSAS group.

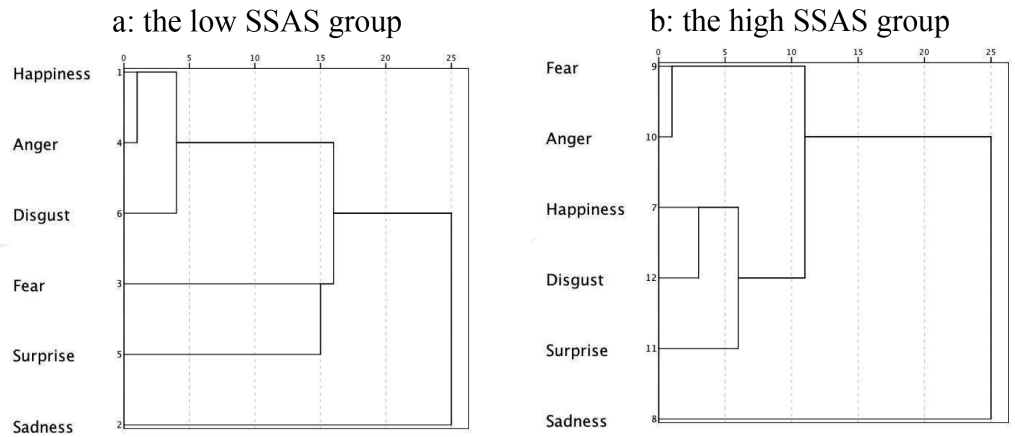


Figure 4. The results of cluster analysis (Ward's method). a: BIL data in the low SSAS group. b: BIL data in the high SSAS group.

results of BIL-data by high SSAS, shown in Figure 4b, indicated that there were two types of emotions that resulted in fear, anger, happiness, disgust, surprise, and sadness. Comparing Figure 3a with Figure 3b, demonstrates there were properties that were different between sadness and fear. In contrast, comparing Figure 4a with Figure 4b demonstrates two types of emotions, sadness and the grouping of five emotions, were the same.

Discussion

The Relationship between Alexithymia and Somatosensory Amplification

Nakao, et al. (2002) found that somatosensory amplification by using SSAS was

significantly associated with the two TAS-20 factors of DIF and DDF in the Japanese psychosomatic patients. In addition, Nakao and Takeuchi (2018) reported that the SSAS score was explained by the TAS-20 score using a model of somatic manifestation of psychosomatic illness based on the results of the structural equation model.

The present study shows that TAS-20 and SSAS scores were also significantly correlated. Further, the SSAS score of the high alexithymia group was significantly higher than that of the low group. Therefore, the results support that persons with strong alexithymia have strong somatosensory amplification traits.

The Influence of Somatosensory Amplification in the Relationship Between Emotions and Sensory/Body Image

The main purpose of this study was to examine the relationship between basic emotions and sensory/body image in persons with somatosensory amplification, using the MD method and the BIL scale.

As noted in the introduction to this article, Okada and Gyoba (2017c) showed that the alexithymia trait influenced the relationship between limited emotions and sensory modality image. However, the present study using MD data shows that the somatosensory amplification trait strongly influenced the relevance of sadness, fear, anger, and surprise to proximal sense (warm, cold, olfactory, gustatory, tactile, and pain), because the MD data of the high SSAS group was higher than that of the low group. Somatosensory amplification refers to the tendency to experience somatic sensations as intense and disturbing. Sadness, fear, and anger are usually classified as negative feelings, and surprise has bivalence. The MD data suggest that these negative and bivalence emotions in high somatosensory amplification individuals are strongly related to proximal sensory modality images. On the other hand, happiness and disgust are not influenced by somatosensory amplification. This result shows that positive emotions like happiness are not related to proximal modality images. Disgust is usually a negative emotion, but it cannot be determined why the difference of disgust was not demonstrated here.

The BIL data show that the somatosensory amplification trait strongly influences the relevance of happiness, fear, anger, surprise, and disgust with body-location images (forehead, throat, chest, stomach, lower abdomen, internal organs, and the whole body), because the BIL data of the high SSAS group was higher than that of the low group. Individuals who have the somatosensory amplification trait strongly experience emotions in relation to the body-location image; therefore, they experience somatic sensations as intense and disturbing. Accordingly, we speculate that persons with somatosensory amplification easily combine their emotional ups and downs in daily life with body-location image, which increases their somatic symptoms. Only sadness demonstrates no differences between the high and low SSAS groups. Okada and Gyoba (2017c, 2017d) pointed out that sadness was specific, since sadness was related most strongly to the chest and the throat, while sadness had the weakest relevance to the other body-locations. The present result suggests sadness also has specific characteristics to

body-location images.

In the MD data, the result of the cluster analysis for basic emotions for the SSAS group (high or low) shows that the obtained dendrograms are different in the two groups, especially sadness and happiness have opposite positions (Figures 3a and b). In the low SSAS group, it seems naturally that the distance between sadness and happiness is long. However, in the high SSAS group, the positions of sadness and happiness are close, and they are in the same cluster. These data suggest that persons with somatosensory amplification combined the opposite emotions (sadness and happiness). This is a very interesting result, since the person without somatosensory amplification can differentiate the opposite emotions (sadness and happiness) clearly and naturally, while the person with somatosensory amplification may confuse the opposite emotions when they depends on sensory modality imagery. In other words, people with somatosensory amplification may not be able to separate sadness and happiness using their sensory modality images.

In contrast, for the BIL data, the results of the cluster analysis for basic emotions according to SSAS group (high or low) show the similar tendency. Both the dendrograms according to the BIL data (Figures 4a and b) show that one cluster was only sadness, and another cluster contained the five emotions group. Therefore, somatosensory amplification does not influence the similarity of basic emotions in the context of body-location imagery.

To summarize, this study has demonstrated the relevance of sensory modality and body image to emotions in persons with somatosensory amplification using the MD method and the BIL scale. The results of the analyses illustrate that somatosensory amplification strongly influenced the combination of sensory modality and body image with emotion. Moreover, especially concerning the sensory modality image, persons with somatosensory amplification share particular similarities in relation to emotions.

One limitation of this study was its reliance on normal young participants' data. The original SSAS was standardized with psychosomatic patients. Thus, it is important to examine the relationship between emotion and sensory/body image among the psychosomatic patient group. Another question worthy of future research is how individuals focus on somatosensory aspects with regard to positive emotions. The individuals in the current study focused on their somatosensory aspects with regard to negative emotions. Therefore, it is necessary to examine the relationship between positive emotions and sensory modality and body images, using the MD method and BIL scale, more precisely.

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