資　料

The effects of interoceptive and exteroceptive awareness on empathy in youth[1]

Tomoko KINOSHITA[2], Takahiro HISAZAKI

Abstract: This research explores the relationship between understanding the emotions of others and feeling one's own bodily states or interoceptive awareness. In Study 1, we developed the Japanese version of the Multi-dimensional Assessment of Interoceptive Awareness for Youth as a measure of interoceptive awareness in Japanese youth and administered it to 374 junior and 812 high school students, respectively. Factor analysis identified seven factors, namely, regulation of attention to bodily sensations, control through attention to bodily sensations, somatic awareness of emotions, trust in the self-body, control of attention to physical discomfort, awareness of physical sensations, and tolerance to physical discomfort, with only the seventh factor exhibiting a slightly lower reliability. In Study 2, we used the questionnaire method to examine the relationship of empathy to interoceptive and exteroceptive awareness among Japanese high school students. The questionnaire included the Multi-dimensional Empathy Scale, which consists of four subscales (i.e., empathic concern, cognitive empathy, fantasy, and personal distress), the Japanese version of the MAIA-Y, and the Adolescent/Adult Sensory Profile, which consists of four subscales (i.e., low registration, sensation seeking, sensory sensitivity, and sensation avoidance). Multiple regression analysis demonstrated that sensation seeking and the interaction between bodily awareness of emotions and control of attention to physical discomfort significantly predicted empathic concern. This result suggests that students who tend to be curious about the outside world and be bodily sensitive to emotions and discomfort were more likely to be empathically concerned for the distress of others.

Key words: interoceptive awareness, self-other differentiation, empathy, personal distress, adolescents

Introduction

Empathy is an emotional response to the emotional state of another person (Blair, 2005). In this regard, the response that one experiences in the same manner as and warm and other-oriented feelings about negative emotional experiences of others is called empathic concern (Tobari, 2003). Elucidating the developmental process and mechanism of empathic concern is important not only for parents but also for educators, because the Japanese children of today are expected to live with people from various backgrounds in an increasingly globalized and diverse society. Regarding the developmental process in Japanese samples, empathic concern declines in the second grade of junior high school (Oyama, 2018) and increases from high school to college only for male students (Tobari, 2003).

Alternatively, regarding the developmental mechanism, scholars have examined the biological and environmental factors that lead to individual differences in empathic concern. Examples of environmental factors are parental

1 This paper is a revised version of a master's thesis the first author submitted to the Graduate School of Humanities, Kyushu Lutheran College in 2021.

2 Kumamoto Prefectural Board of Education

warmth, sensitivity, and emotional socialization, which increase the capacity of children for empathy (Spinrad & Gal, 2018). For adolescents, however, the contribution of the quality of parent-child and peer relationships to empathy remains ambiguous due to the use of different indicators of quality of relationships and empathy (Boele et al., 2019). In recent years, scholars have discussed that the quality of attachment fostered with adults may contribute to the development of the capacity for empathy as a basis for or a moderator of the development of empathy, although various environmental and contextual factors operate from childhood to adolescence.

How then should individual differences in empathic concern be considered in terms of the mechanism that generates it? Yamamoto (2017) presented a combination model of empathy to demonstrate the evolution of empathy and various empathy-related phenomena. The model is composed of three organizing factors, namely, matching with others (experiencing emotions that match the emotions of another person), understanding others (understanding what another person is thinking or feeling), and prosociality (motivation to care for and help another person). Empathic concern, which refers to other-oriented feelings elicited by and congruent with the perceived negative emotional experiences of another person, include the three abovementioned factors. How does the ability to perceive the emotional states of another person and reference them to oneself contribute to the factors of empathic concern, especially matching with, and understanding another person? In detail, is referencing the emotional states of another person to oneself needed when experiencing emotions that match their emotions and understanding what they are thinking or feeling? In terms of the vicarious experience of the pain of another person, one theory proposed that vicarious pain involves a shared experience (e.g., Iacoboni, 2009; Singer et al., 2004), which is generated by activating neuronal areas that represent somatic pain in oneself. Another theory posited that vicarious pain is a reflective, cognitive experience that we cannot mimic or directly simulate (e.g., Hooker et al., 2008; Zaki, 2014), which suggests that the pain of others may not activate neuronal areas that represent somatic pain in perceivers. Krishnan et al. (2016) measured and analyzed neural activity in somatic and vicarious pain using functional magnetic resonance imaging (fMRI) and found that perceiving the pain of another person did not activate the same neural circuits induced when one experiences personal pain. Instead, the brain system involved in representing the mental state (mentalizing) of another person was found to be recruited to understand the pain. The lack of the same neural activation as the experience of pain of another person may be the reason why vicarious pain is substantially less painful than the pain of another person. These studies suggest that empathic concern requires mentalizing, which involves inferring, or imagining a state of mind on the basis of the actions and expressions of others. However, does it require any bodily sensation? Does inferring the mental and emotional states of others require interoceptive sense, which perceive the internal states of the body such as the heart, lungs, and gastrointestinal tract?

It is widely accepted that the brain refers to its internal states to understand the mental and emotional states of others and that the interoceptive sense plays a major role in experiencing emotions (Fukushima et al., 2011). Therefore, individuals with high levels of interoceptive awareness may be more aware of their own mental and emotional states, then use them as a frame of reference for understanding those of others.

Individuals with high levels of interoceptive awareness may be better able to understand the

underlying mechanism of the movements and activities and to accurately infer the intentions and beliefs of others as well as their feelings (Ondobaka et al., 2017). For example, when a person is walking quickly and shivering from cold, one may understand that they intend to go to a warmer place. One's prediction of one's interoceptive state that leads to a feeling of being cold plays a principal role in understanding this feeling when seeing another person shivers. It also induces one's inference about their desires and intentions of getting to a warmer place.

The integration of interoceptive and exteroceptive information forms coherent bodily self-awareness (Palmer & Tsakiris, 2018). A strong rubber hand illusion was induced in individuals with low compared with high levels of interoceptive accuracy, which suggests that those with high levels of interoceptive accuracy exhibit more coherent bodily self-awareness (Tsakiris et al, 2011). Understanding the mental and emotional states of others, which may never perfectly match one's states, requires the simultaneous yet distinct co-representation of the self and others. According to Palmer and Tsakiris (2018), self-awareness is derived from a sense of interaction with the environment from the first-person perspective, which is generated through interoceptive processing. This process appears to stabilize the model of the self, such that individuals can readily and clearly attribute mental and emotional states to the self or others. In predictive coding theory, representations of the self are generated by the integration of predictions about the bodily state and prediction errors as the resultant percept across interoceptive and exteroceptive modalities. When integrating precise interoceptive prediction errors into relatively less precise exteroceptive prediction errors, the interoceptive input dominates the resultant percept and generates the stability of the model of the self, which leads to the simultaneous yet distinct co-representation of the self and others. Therefore, high levels of interoceptive awareness can maintain a self-other distinction and lead to the understanding of the mental and emotional states of others, which are not perfectly congruent with one's own. However, individuals with low levels of interoceptive awareness are likely to integrate relatively less precise interoceptive prediction errors into precise exteroceptive prediction errors and readily update their model of their own mental and emotional states, such that they automatically match their mental and emotional states to those of another person.

In summary, the first hypothesis of this study is that individuals with high levels of interoceptive awareness or, specifically, with a certain degree of dominance of interoceptive over exteroceptive awareness are more likely to understand the mind and emotion of another person, which are distinct from their own (cognitive empathy). The reason is that they readily use their interoceptive experiences as a frame of reference, obtain a view of the backgrounds of others, and maintain a distinct co-representation of oneself and others to understand the mind and emotion of others accurately. The second hypothesis is that individuals with low levels of interoceptive awareness are more likely to be sensitive to exteroceptive information and mimic the mind and emotion (emotional empathy) of another person, because they do not seemingly clearly distinguish between themselves and others.

This research uses the questionnaire to examine the effect of interoceptive awareness on empathy. No scale in Japan exists for measuring interoceptive awareness among students during their early adolescence; thus, developing the Japanese version of such a scale is necessary. In this regard, this research will be conducted in two parts. In Study 1, we formulate the Japanese

version of the Multi-dimensional Assessment of Interoceptive Awareness for Youth (MAIA-Y; Jones et al., 2020). In Study 2, we conduct a questionnaire survey to examine the relationship between interoceptive and exteroceptive awareness or sensitivity and empathy among high school students.

Study 1

Jones et al. (2020) introduced the MAIA-Y as a measure of the interoceptive awareness of young people aged 7-17 years. The current study developed the Japanese version of the MAIA-Y and used factor analysis to examine whether the factor structure of the Japanese version is the same as the original version.

Methods

Participants. We recruited a total of 374 first-, second-, and third-year students attending junior high school (response rate = 92.1%, average age = 13.1 years), 103 first- and second-year students at High School A (response rate = 66.9%, average age = 15.8 years), and 709 first- and second-year students at High School B (response rate = 91.5%, average age = 16.0 years) for Study 1.

Questionnaire. The original version of the MAIA-Y was forward-translated into Japanese and back-translated by a translator familiar with English. The authors of the original version were asked about the differences between the original and back-translated items after which the necessary corrections were made. After two rounds of revision, the Japanese version, which was easy to understand and retained all nuances of the original version, was developed. Similarly to the original version, the participants rated each item in terms of the extent to which they agree that it applies to their lives using a six-point scale ranging from 0 = *never* to 5 = *always* (worded differently for certain items).

Procedures. We informed the classroom teachers and parents of the participants about the following: (a) the participation of the students in the survey would be voluntary, (b) no personal information would be collected, and (c) the data would not be used for any purpose apart from those of the study. They were also assured that the researchers would not conduct the survey in class with any student whose parents indicated refusal. No parents specifically indicated refusal.

The survey was conducted per classroom. The teachers distributed the questionnaire and informed the participants of the abovementioned conditions presented to the teachers and parents. Moreover, the teachers read the instructions of how to respond to the questionnaire. The survey was administered only to participants who expressed understanding of these conditions and instructions. After completion, the teacher collected the answered questtionares. The Research Ethics Review Committee of Kyushu Lutheran College approved the content of the questionnaire and the procedure of the survey.

Results and Discussion

Data with three or more consecutive missing values in a scale were excluded from analysis. We used the multiple imputation method to complement missing values, and conducted exploratory factor analysis (i.e., maximum likelihood method and Promax rotation) on the data set without missing values using statistics software R.4.2.1. We determined the number of factors at the point where the cumulative contribution rate exceeded 50%. For the Japanese version of the 32 items, this study identified seven factors. Items 4, 23, and 25 produced low factor loadings on any factor, and the commonality of each item is low; thus, they were omitted, and the same method of factor analysis was conducted again with the assumption of the seven factors. This study examined the internal consistency of the factors by calculating the α coefficient for each factor.

Table 1 Results of Factor Analysis of the MAIA-Y Japanese version

Original MAIA-Y (Jones et al., 2020)	Item No.	Japanese items	F Ⅰ	F Ⅱ	F Ⅲ	F Ⅳ	F Ⅴ	F Ⅵ	F Ⅶ
Noticing	1	心が落ちつかないときに、それが体のどこで生じているかがかわかる	0.04	-0.03	0.05	0.00	0.01	**0.68**	0.01
	2	体の中で心地よくない感じがあるのがわかる	-0.09	-0.07	0.03	-0.07	0.09	**0.80**	0.04
	3	体のどこが心地よいかがわかる	0.01	0.01	-0.07	0.23	-0.07	**0.69**	-0.02
	4	呼吸が速くなったり遅くなったりするような呼吸の変化がわかる							
Not-Distracting	5 *	体の調子の悪さは、とても強く感じるまで無視する	0.05	-0.01	0.02	-0.08	0.37	0.02	**0.48**
	6 *	心地よくない感じや痛みがあるときは気を紛らす	-0.02	-0.08	0.00	0.11	**0.82**	0.05	0.18
	7 *	心地よくない感じや痛みがあるときはそれを忘れようとする	0.00	0.05	-0.02	0.07	**0.78**	-0.03	0.12
Not-Worrying	8 *	体に痛みを感じると、ドギマギする	-0.01	0.15	0.09	-0.18	**0.49**	0.06	-0.31
	9 *	心地よくない感じや痛みを感じたら、心配する	0.13	0.01	0.03	0.00	0.30	0.05	**-0.58**
	10	自分の体の調子が悪いとわかっていても、心配しない	0.02	0.04	0.00	-0.13	0.15	0.03	**0.66**
Attention Regulation	11	他のことを何も考えずに、息のしかたに意識を向けることができる	**0.57**	-0.08	-0.03	0.07	0.03	0.06	0.03
	12	周りでいろいろと起こっていても、自分の体の感じに意識を向けることができる	**0.75**	0.00	-0.03	0.03	-0.05	0.05	-0.02
	13	誰かと話しているときに、私は自分の立ちかたや座りかたに意識を向けることができる	**0.73**	-0.05	-0.03	0.02	0.12	-0.11	-0.07
	14	気が散っていても、自分の体の感じかたに再び気づくことができる	**0.86**	-0.01	-0.08	0.02	0.04	-0.02	-0.04
	15	何かを考えていても、自分の体を感じることに意識を戻すことができる	**0.93**	0.01	-0.09	-0.06	0.00	-0.04	-0.03
	16	体の一部が痛いときでも、自分の体全体に目を向けることができる	**0.55**	0.09	0.14	-0.09	-0.14	0.00	0.10
	17	やろうと思えば、自分の体全体に意識を向けることができる	**0.43**	-0.06	0.28	0.08	-0.12	-0.01	0.07
Emotional Awareness	18	怒ると体の変化を感じることができる	0.04	0.08	**0.63**	-0.22	-0.10	0.11	0.02
	19	生活の中で何か問題があったときに、体でもそれを感じることができる	0.13	0.13	**0.54**	-0.19	-0.04	0.10	-0.05
	20	のんびりゆったり過ごした後、体が違う感じがわかる	0.04	-0.07	**0.63**	0.17	0.11	-0.09	0.00
	21	快適なとき、呼吸が自由で楽になるのを感じることができる	-0.11	-0.09	**0.70**	0.30	0.06	-0.04	0.01
	22	嬉しいとき、体の変化の仕方を感じることができる	-0.10	-0.04	**0.73**	0.23	0.03	-0.03	-0.01
Self-Regulation	23	いろいろと起こっていても落ち着いていられる							
	24	自分が体でどう感じているかに意識を向けると、落ちつく	0.12	**0.46**	-0.02	0.18	-0.05	0.05	0.16
	25	心を休めて落ち着くために、呼吸を用いる							
	26	考えすぎるときは、体や呼吸に集中すると心を落ち着かせることができる	0.05	**0.42**	0.04	0.23	0.02	-0.04	0.07
Body-Listening	27	自分の感情を理解するのに体から生じる手がかりを待つ	-0.09	**0.83**	-0.02	0.01	-0.01	-0.02	0.03
	28	ドギマギしているときは、時間をかけて体の感じかたを確かめる	-0.08	**0.95**	0.00	-0.08	0.04	-0.08	-0.04
	29	自分の体の声を聞いてどうしようかを決める	0.08	**0.52**	0.00	0.07	0.03	0.04	-0.08
Trusting	30	体の調子の良さを感じる	0.02	-0.02	0.08	**0.74**	0.03	-0.03	-0.08
	31	安心感を自分の体で感じる	-0.05	0.08	0.03	**0.80**	0.05	0.05	-0.10
	32	自分の体の感じかたを信じている	0.14	0.05	-0.01	**0.59**	0.01	0.07	-0.09
		α coefficient	0.86	0.81	0.81	0.84	0.73	0.76	0.53
		F Ⅰ		0.60	0.63	0.50	0.14	0.49	-0.04
		F Ⅱ			0.58	0.49	0.20	0.45	-0.11
		F Ⅲ				0.47	0.25	0.54	-0.19
		F Ⅳ					-0.07	0.26	0.00
		F Ⅴ						0.33	-0.12
		F Ⅵ							-0.23

interinter-factor correlation

Except for Factor VII, all factors exhibited large α values, which confirms internal consistency (Table 1).

The original version of the MAIA-Y has eight factors, namely, Noticing (captures the awareness of the participants about body sensation), Not-Distracting (measures the tendency to ignore bodily feelings of discomfort or pain), Not-Worrying (captures the ability of the participants to not become emotionally reactive to negative sensation), Attention Regulation (captures the capacity to regulate attention when multiple sensory stimuli compete), Emotional Awareness (explores the ability of the participants to be aware of the relationship between bodily and affective states), Self-Regulation (captures the ability of the participants to use attention to bodily states to regulate psychological distress), Body Listening (presents an index of the ability of the participants to attend to bodily sensations for psychological insight), and Trusting (measures the degree to which the participants experience their body as safe and trustworthy; Table 1). The factor structure of the Japanese version slightly differed from that of the original version, and a few items in the Japanese version were omitted from the factors or placed in other factors of the original version.

Each factor was interpreted and named with reference to the content of items with factor loadings of 0.40 or higher, which keeps the factor structure different from the original version (Table 1). Factor I in the Japanese version was the same as Attention Regulation in the original version and was renamed "regulation of attention to bodily sensations." Factor Ⅱ was composed of the three items of Body Listening and the two items of Self-Regulation in the original version and was named "control through attention to bodily sensations" after considering the two factors in an integrated manner. Factor Ⅲ was the same as Emotional Awareness in the original version and was renamed "somatic awareness of emotions." Factor Ⅳ was the same as Trusting in the original version and was renamed "trust in the self-body." Factor Ⅴ was composed of the two and one reversed items for Not-Distracting and Not-Worrying, respectively, in the original version, and was renamed "control of attention to physical discomfort" after considering the two factors. Factor Ⅵ included three items and excluded one item in Noticing in the original version and was renamed "awareness of physical sensations." Finally, Factor Ⅶ positively contributed to one reversed item of Not-Distracting and one item of Not-Worrying and negatively contributed to one reversed item of Not-Worrying in the original version. This factor was renamed "tolerance to physical discomfort" based on the totality of the three items.

Lastly, this study did not examine the construct, convergent, and discriminant validity of the Japanese version of the MAIA-Y.

Study 2

This study administered a questionnaire survey to Japanese high school students to examine the contribution of interoceptive and exteroceptive awareness to empathy among high school students. The questionnaire survey in Study 1 partially included the survey in this study.

Methods

Participants. Also participated in this study total of 812 high school students participated in Study 1 (response rate = 87.2%, average age = 16.0 years old).

Questionnaire. We used the Japanese version of the MAIA-Y as a scale for measuring interoceptive awareness, the Adolescent/Adult Sensory Profile (AASP, Hagiwara et al., 2015) as a scale for exploring exteroceptive awareness, and the Multi-dimensional Empathy Scale

(Tobari, 2003) for measuring empathy in high school students.

1. MAIA-Y Japanese version: This study used the data obtained from Study 1. The scores for each factor were estimated using regression methods based on the factor structure obtained from the results of the factor analysis in Study 1.

2. AASP: This is a self-rated questionnaire in the Japanese language (translated from the original AASP of Brown and Dunn (2002)) and is intended for individuals aged 11-82 years. It is designed to assess the characteristics of sensory processing, in which respondents indicate their typical responses to sensory stimuli using a five-point scale: 1 = *almost never*, 2 = *rarely*, 3 = *sometimes,* 4 = *often, and* 5 = *nearly always*. Based on the AASP responses, the quadrant scores for low registration, sensation seeking, sensory sensitivity, and sensation avoiding can be obtained to reveal the sensory processing patterns of the respondents. This questionnaire consisted of 15 items for each quadrant score (a total of 60 items). In the conceptual model of Dunn (1997), low registration corresponds to a neurological high threshold and passive response, and individuals with low registration tend not to respond or take longer to respond to stimuli of which others are aware. Sensation seeking corresponds to a neurological high-threshold and active response, and individuals with high levels of sensation seeking tend to create sensory stimuli or seek out environments that provide stimuli to meet their neurological threshold. Sensory sensitivity corresponds to a neurological low-threshold and passive response, and sensory-sensitive individuals tend to respond to stimuli readily due to their low neurological threshold. Sensation avoiding corresponds to a neurological low threshold and active response, and individuals with high levels of sensation avoiding tend to avoid sensory stimuli because they feel overwhelmed, or have trouble with sensory stimuli.

3. Multi-dimensional Empathy Scale (MES): This scale has four subscales, namely, empathic concern, personal distress, fantasy, and cognitive empathy. The scores for each subscale were averaged by summing related item scores and dividing by the number of items. Empathic concern refers to the feeling that one feels about the unfortunate emotional experiences of others in the same manner and expresses warm and other-oriented feelings in response to the situation of others. The fact that I feel in the same manner refers to emotional empathy, the fact that I respond to the situation of others refers to cognitive empathy from the perspective of others, and the fact that I have warm and other-oriented feelings seems to refer to prosociality. In other words, empathic concern represents a response pattern that combines emotional empathy, cognitive empathy, and prosociality according to the combination model of Yamamoto (2017). Alternatively, personal distress is a self-centered emotional response that is not directed toward others such as anxiety and distress toward the distress of others. It is based on emotional empathy in that it is a direct experience of the distress of others, but cognitive empathy, which perceives and recognizes distress from the perspective of others, and prosocial motivation, which intends to eliminate the distress of others, are not at work. In addition, fantasy pertains to empathizing with fictional others who appear in novels, movies, and so on. Fantasy seemingly involves an understanding of the situation of fictional others and identifying with the feelings of the others; thus, emotional and cognitive empathy are likely involved in fantasy. Finally, cognitive empathy denotes imagining the feelings and situations of others, which is the construct described in the model of Yamamoto (2017).

Procedures. The procedure is the same as that in Study 1. The Research Ethics Review

Table 2 The basic statistics for the MAIA-Y, AASP, and MES

	The MAIA-Y Japanese version							The AASP				The MES			
	regulation of attention to bodily sensations	control through attention to bodily sensations	somatic awareness of emotions	trust in the self-body	control of attention to physical discomfort	awareness of physical sensations	tolerance to physical discomfort	low registration	sensation seeking	sensory sensitivity	sensation avoiding	empathic concern	personal distress	fantasy	cognitive empathy
M	0.003	0.055	0.038	-0.065	0.192	0.056	-0.116	2.404	2.948	2.620	2.558	3.740	2.780	3.163	3.493
SD	0.931	0.893	0.898	0.888	0.823	0.855	0.832	0.543	0.541	0.559	0.579	0.459	0.745	1.003	0.766
Max	2.407	2.750	2.025	2.176	1.923	2.144	2.879	4.400	4.667	4.600	4.733	5.000	5.000	5.000	5.000
Min	-2.981	-2.453	-2.997	-3.184	-2.835	-2.345	-2.462	1.000	1.000	1.000	1.000	1.615	1.000	1.000	1.000

Committee of Kyushu Lutheran College approved the content of the abovementioned questionnaire and the procedure of the survey.

Results and Discussion

Table 2 presents the basic statistics for the MAIA-Y, AASP, and MES.

Correlations Between the Interoceptive and Exteroceptive Awareness Scale and the Empathy Scale. This study analyzed the correlation between the subscales of the MAIA-Y and AASP and the subscales of the MES to examine the relationship of each type of empathy to feeling one's body state and perceiving outside of the body (Table 3).

Focusing only on the relationships that displayed correlation coefficients with absolute values of 0.20 or higher, we found a significant positive correlation for empathic concern to control through attention to bodily sensations, somatic awareness of emotions, and control of attention to physical discomfort. This finding suggests that students who easily note and adjust their attention to bodily changes due to the generation of emotions and control them are more likely to exhibit empathic reactions from the perspectives of others and to be prosocial. However, personal distress was not correlated with any of the factors of the MAIA-Y by more than 0.20, which implied that interoceptive awareness has little to do with a self-centered emotional response to the distress of others. Fantasy and cognitive empathy were positively correlated with control of attention to physical discomfort and awareness of physical sensations. In addition, cognitive empathy was positively correlated with regulation of attention to bodily sensations, control through attention to bodily sensations, and somatic awareness of emotions. These results indicated that understanding the feelings of others, whether real or imaginary, may be related to interoceptive awareness, especially in easily identifying bodily sensations

Table 3 Correlations between the MES and the MAIA-Yand AASP

	low registration	sensation seeking	sensory sensitivity	sensation avoiding	regulation of attention to bodily sensations	control through attention to bodily sensations	somatic awareness of emotions	trust in the self-body	control of attention to physical discomfort	awareness of physical sensations	tolerance to physical discomfort
empathic concern	.076*	.206**	.082*	.019	.122 **	.203**	.218**	.154**	.249**	.192**	-.124**
personal distress	.280**	-.179**	.257**	.189**	-.177**	-.050	-.075*	-.192**	.174**	.033	-.077*
fantasy	.078*	.206**	.095*	.065+	.150**	.087*	.181**	.075*	.274**	.233**	-.166**
cognitive empathy	.000	.180**	.069+	.109**	.222**	.213**	.260**	.153**	.268**	.266**	-.121**

$+p<.1$, $*p<.05$, $**p<.01$

and adjusting one's attention to one's physical discomfort. Furthermore, cognitive empathy was also related to the factors of the MAIA-Y relevant to attention to and awareness of bodily sensations, which implied that sharpened attention to and awareness of one's bodily state is necessary for accurately understanding the feelings of others.

In terms of the relationship between empathy and exteroceptive awareness, empathic concern and fantasy were positively correlated with sensation seeking (cognitive empathy was also positively correlated, although at <0.20). This finding indicated that the tendency to seek specific external stimuli may be necessary in understanding the feelings of others. However, personal distress was positively correlated with low registration and sensory sensitivity, which differ in terms of neurological thresholds, although they are the same passive behavioral patterns. Sensitivity to certain external stimuli and insensitivity to other stimuli in the same environment may make people less attentive to others and their situation and more likely to engage in self-centered empathic responses.

Multiple Regression Analysis with Empathic Concern as the Dependent Variable. This study aimed to verify whether or not control through attention to bodily sensations, somatic awareness of emotions, and control of attention to physical discomfort, and sensation seeking, which were correlated with empathic concern, exert a predictive influence on empathic concern. Thus, this study constructed a first-order interaction model with these factors as the independent variables and conducted regression analysis using the forward-backward stepwise selection method. The reason for using the first-order interaction model is that the study assumed that the understanding of the mind and emotion of others, which differ from those of the self, is established when interoceptive awareness is relatively more sensitive than exteroceptive awareness (Palmer & Tsakiris, 2018). The current research believed that the interaction between interoceptive and exteroceptive awareness is particularly important for cognitive empathy. To be precise, the first-order interaction term between the MAIA-Y and AASP subscales was introduced into the regression model, because this research assumed that when a certain subscale score of the MAIA-Y is higher than a certain subscale score of the AASP, the subscale scores associated with cognitive empathy on the MES are higher, whereas the scale scores associated with emotional empathy on the MES are lower. Model selection was conducted using the Bayesian information criterion (BIC). Table 4 presents the selected models.

The coefficient of model determination (R^2 = 0.118) was significant ($F(4,698) = 23.248$, $p < .001$, $f^2 = 0.133$, $1 - \beta = 1.000$, adjusted $R^2 = 0.113$). Table 4 displays the partial regression

Table 4 Multiple regression models to explain empathic concern

	partial regression coefficient	standard error	t-value	p-value	β□
sensation seeking	.126	0.032	3.993	<.001	.148
somatic awareness of emotions	.063	0.020	3.194	.002	.123
control of attention to physical discomfort	.120	0.021	5.709	<.001	.216
somatic awareness of emotions × control of attention to physical discomfort	.055	0.017	3.203	.001	.089

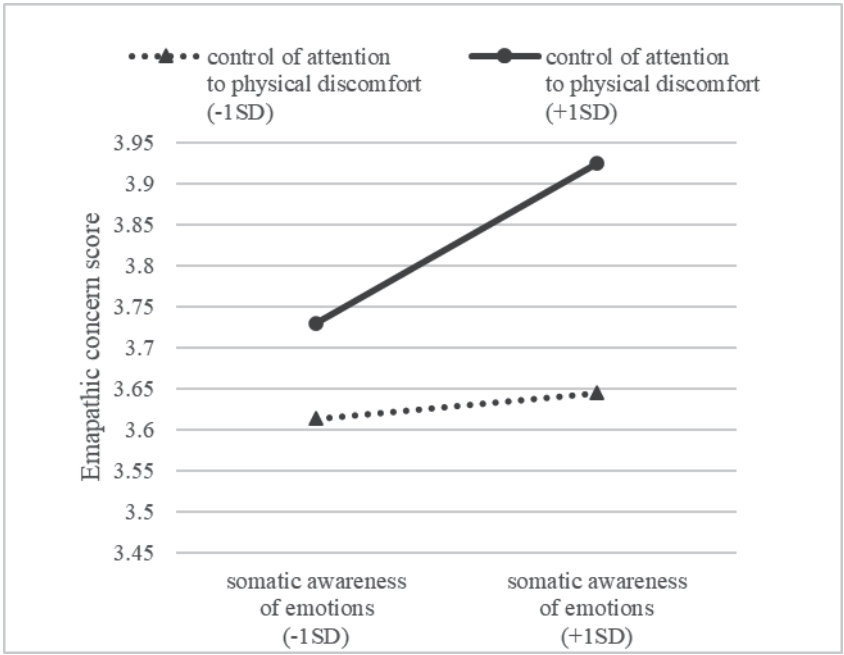

Figure 1 Simple slope analysis for the interaction effect of somatic awareness of emotions and control of attention to physical discomfort on empathic concern

coefficients of the independent variables in the selection model and the results of their tests. The interaction between somatic awareness of emotions and control of attention to physical discomfort was significant (b = 0.055, t(698) = 3.203, p = 0.001, β = 0.089). In simple slope analysis (Figure 1), the results of the significance test of the partial regression coefficients (α = 0.15; two-tailed test) demonstrated that the partial regression coefficient for control of attention to physical discomfort was significant at a high level (+1SD) of somatic awareness of emotions (b = 0.108, t(698) = 4.383, adjusted p = 0.000) but not at the low level (−1SD; b = 0.018, t(698) = 0.736, adjusted p = 0.462). Moreover, the estimate of empathic concern at a high level (+1SD) of control of attention to physical discomfort (3.925) was significantly larger than that at the low level (−1SD; 3.730). This study employed the method of Benjamini and Hochberg (1995) to adjust the p-values in the abovementioned and subsequent analyses. Alternatively, the partial regression coefficient of somatic awareness of emotions was significant

Table 5 Multiple regression models to explain personal distress

	partial regression coefficient	standard error	t-value	p-value	β□
low registration	.270	.061	4.440	<.001	.197
sensory sensitivity	.189	.059	3.207	.001	.142

at a low level (+1*SD*) of control of attention to physical discomfort (b = 0.071, t(698) = 2.969, adjusted p = 0.004). In addition, the estimate of empathic concern (3.730) at a high level (+1*SD*) of somatic awareness of emotions was significantly larger than that (3.613) at a low level (−1*SD*). In contrast, the partial regression coefficient for somatic awareness of emotions at a high level (+1*SD*) of control of attention to physical discomfort was significant (b = 0.17, t(698) = 6.016, adjusted p < .001). The estimate of empathic concern at a high level (+1*SD*) of somatic awareness of emotions (3.925) was significantly larger than that at a low level (−1*SD*; 3.645). The result of this interaction suggests that students who are more likely to physically feel discomfort or pain and to successfully defuse it are more likely to exhibit empathetic concern.

For the main effect, the partial regression coefficient for sensation seeking was significant (b = 0.126, t(698) = 3.993, p < 0.001, β = 0.148). This main effect suggests that students who are more inclined to search for stimuli for the stability of their selves tend to express more empathetic concern. For example, students who are more inclined to actively search for and pursue external stimuli are more likely to try to help another person to remove their emotional suffering from their perspective, while directly sharing their emotions.

Multiple Regression Analysis with Personal Distress as the Dependent Variable. We formulated the first-order interaction model with personal distress of the MES as the dependent variable and low registration and sensory sensitivity of the AASP (in the previous analysis, both variables exhibited a correlation) as the independent variables. Regression analysis was then conducted using the forward-backward stepwise selection method (BIC). The coefficient of model determination (R^2 = 0.092) was significant (F(2,700) = 35.309, p < .001, f^2 = 0.101, 1 − β = 1.000, adjusted R^2 = 0.089). Table 5 presents the partial regression coefficients of the independent variables of the selected models and the results of their tests. The study found no significant first-order interactions. For the main effect, each partial regression coefficient for low registration and sensory sensitivity was significant (low registration: b = 0.27, t(700) = 4.44, p < .001, β = 0.197; sensory sensitivity: b = 0.189, t(700) = 3.207, p = .001, β = 0.142). These main effects suggest that students who are more likely to miss and react slowly to external stimuli and more likely to express distraction and discomfort responses to external stimuli are more likely to react egocentrically to the emotional distress of others. Two exteroceptive sensory characteristics, which differ in terms of neurological thresholds, positively predicted personal distress.

Multiple Regression Analysis with Fantasy as the Dependent Variable. Regression analysis using the forward-backward stepwise selection method (BIC) was conducted on the first-order interaction model with fantasy of the MES as the dependent variable and sensation seeking of the AASP and control of attention to physical discomfort and awareness of physical sensations

Table 6 Multiple regression models to explain fantasy

	partial regression coefficient	standard error	t-value	p-value	β□
sensation seeking	.284	0.068	4.202	<.001	.153
control of attention to physical discomfort	.253	0.047	5.394	<.001	.208
awareness of bodily sensations	.143	0.046	3.119	.002	.217

Table 7 Multiple regression models to explain cognitive empathy

	partial regression coefficient	standard error	t-value	p-value	β□
regulation of attention to bodily sensations	.083	0.041	2.017	.044	.101
control through attention to bodily sensations	.019	0.042	0.459	.646	.022
somatic awareness of emotions	.125	0.046	2.712	.007	.146
control of attention to physical discomfort	.208	0.034	6.095	<.001	.224
regulation of attention to bodily sensations × somatic awareness of emotions	.062	0.023	2.687	.007	.067
control through attention to bodily sensations × control of attention to physical discomfort	.128	0.030	4.327	<.001	.123

(significant in the previous correlation analysis) as the independent variables. As a result, we selected the regression model in Table 6. The coefficient of model determination (R^2 = 0.117) was significant ($F(3,699) = 30.82$, $p < .001$, adjusted R^2 = 0.113). The study observed no significant first-order interactions. For the main effect, each partial regression coefficient for sensation seeking, control of attention to physical discomfort, and awareness of bodily sensations was significant (sensation seeking: $b = 0.284$, $t(699) = 4.202$, $p < .001$, $\beta = 0.153$; control of attention to physical comfort: $b = 0.253$, $t(699) = 5.394$, $p < .001$, $\beta = 0.208$; awareness of bodily sensations: $b = 0.143$, $t(699) = 3.119$, $p = .001$, $\beta = 0.122$). The main effect of sensation seeking suggests that students who tend to look for environments to constantly obtain or create stimuli are more likely to directly experience the minds and emotions of others and worry about them as if they were their own. The main effects of control of attention to physical discomfort and awareness of bodily sensations suggest that students who tend to feel discomfort or pain and to control their attention to it were more likely to transfer the minds and emotions of others and to worry about them as if they were their own. In other words, students who are able to pay and control their attention to their physical discomfort may be more likely to replace the physical discomfort of others onto their own bodies and to vicariously experience feelings of discomfort.

Multiple Regression Analysis with Cognitive Empathy as the Dependent Variable. We conducted regression analysis using the forward-backward stepwise selection method (BIC) on a first-order interaction model with cognitive empathy of the MES as the dependent variable and regulation of attention to bodily sensations, control through attention to bodily sensations, somatic awareness of emotions, control of attention to physical discomfort, and awareness of physical sensations (significant correlation in

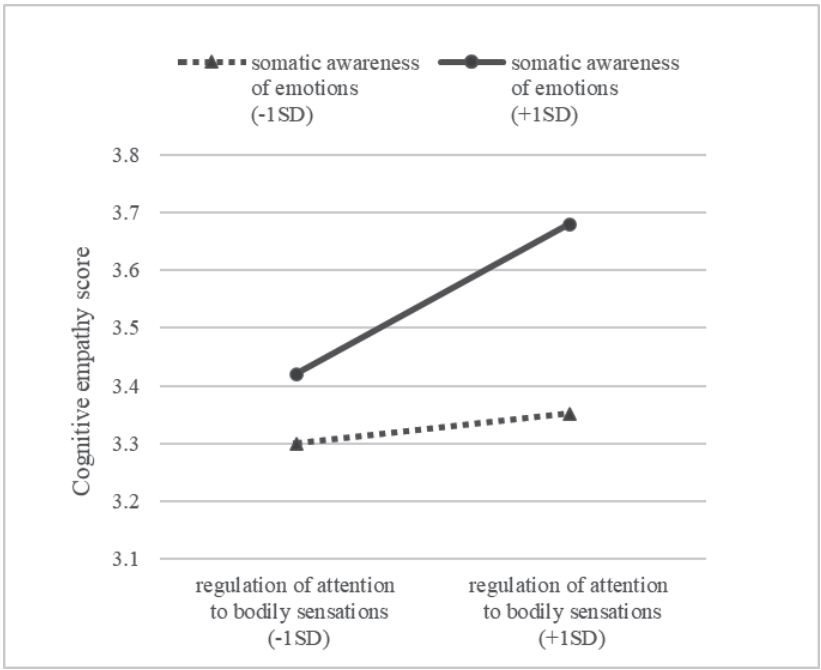

Figure 2 Simple slope analysis for the interaction effect of regulation of attention to bodily sensations and somatic awareness of emotions on cognitive empathy

the previous correlation analysis) as the independent variables. The regression model in Table 7 was selected. The coefficient of model determination (R^2 = 0.154) was significant ($F(6,696)$ = 21.084, p < .001, adjusted R^2 = 0.147). For the first-order interaction, the interaction between regulation of attention to bodily sensations and somatic awareness of emotions was significant (b = 0.062, $t(696)$ = 2.687, p = 0.007, β = 0.067). In the simple slope analysis (Figure 2), the results of the significance test of the partial regression coefficient (α = 0.15; two-tailed test) indicated that the partial regression coefficient for somatic awareness of emotions was significant at a high level (+1*SD*) but not at a low level (−1*SD*) of regulation of attention to physical sensations (high: b = 0.139, $t(696)$ = 2.923, adjusted p = 0.007; low: b = 0.028, $t(696)$ = 0.621, adjusted p = 0.534). Moreover, the estimate of cognitive empathy at a high level (+1*SD*) of somatic awareness of emotions (3.68) was significantly larger than that at a low level (−1*SD*; 3.42). Furthermore, the partial regression coefficient of regulation of attention to bodily sensations was significant at a high (+1*SD*) but not at a low (−1*SD*) level of somatic awareness of emotions (high: b = 0.182, $t(696)$ = 3.404, adjusted p = 0.002; low: b = 0.067, $t(696)$ = 1.407, adjusted p = 0.213). The estimate of cognitive empathy at the high level (+1*SD*) of regulation of attention to bodily sensations (3.68) was significantly larger than that at the low level (−1*SD*; 3.35). These interaction effects suggest that students who can regulate their attention to bodily sensations appropriately and perceive their emotions physically are likely to feel the bodies and situations of others which are different from those of their selves; thus, they may be able to imagine the feelings of others more easily.

In addition, the interaction effect of control through attention to bodily sensations and control of attention to physical discomfort was significant (b = 0.128, $t(696)$ = 4.327, p < .001, β

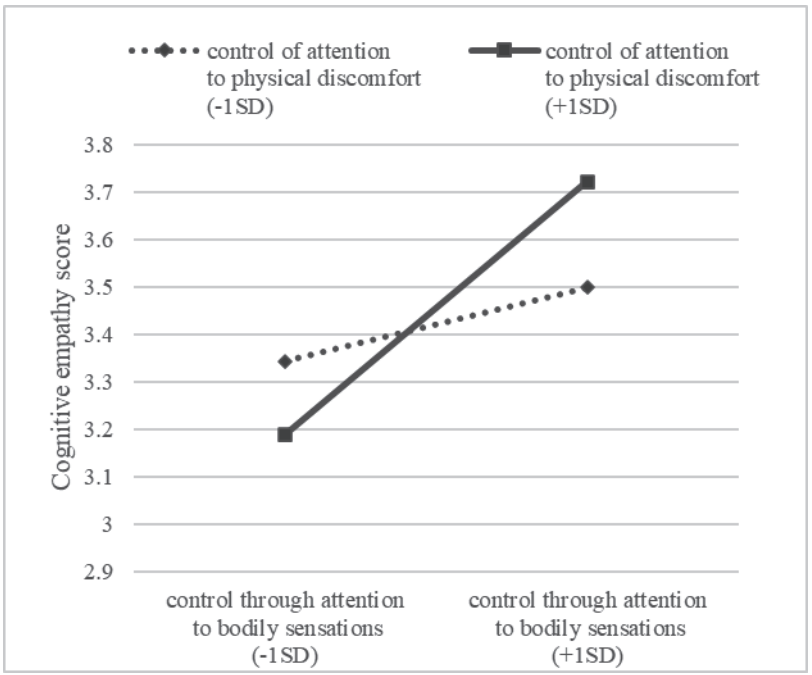

Figure 3 Simple slope analysis for the interaction effect of regulation of attention to bodily sensations and somatic awareness of emotions on cognitive empathy

= 0.123). The results of the simple slope analysis (Figure 3) indicated that the partial regression coefficient for control of attention to physical discomfort was significant at the low level (−1*SD*) of control through attention to physical sensations (b = −0.086, t(696) = 1.735, adjusted p = 0.083). Moreover, the estimate of cognitive empathy at the high level (+1*SD*) of control of attention to physical discomfort (3.19) was significantly smaller than that at the low level (−1*SD*; 3.34). The partial regression coefficient of control of attention to physical discomfort was significant at the high level (+1*SD*) of control through attention to physical sensations (b = 0.125, t(696) = 2.640, adjusted p = 0.017), and the estimate of cognitive empathy at the high level (+1*SD*) of control of attention to physical discomfort (3.72) was larger than that at the low level (−1*SD*; 3.50). The partial regression coefficient of control through attention to physical sensations was significant (b = 0.094, t(696) = 2.236, adjusted p = 0.034) at the low level (−1*SD*) of control of attention to physical discomfort. The estimate of cognitive empathy at the high level (+1*SD*) of control through attention to physical sensations (3.50) was significantly larger than that at the low level (−1*SD*; 3.34). Alternatively, the partial regression coefficient of control through attention to physical sensations was also significant at the high level (+1*SD*) of control of attention to physical discomfort (b = 0.323, t(696) = 7.273, adjusted p < .001), and the estimate of cognitive empathy at the high level (+1*SD*) of control through attention to physical sensations was significantly larger than that at the low level (−1*SD*; 3.19). These interaction results imply that students who are skilled in both aspects of self-control through attention to bodily sensations and control of attention to physical discomfort may be more likely to imagine the feelings of others by replacing the conditions and environments of others with their own.

Integrative Argument

Multiple regression analyses revealed that students with high levels of propensity for sensation seeking in exteroceptive awareness and high levels of propensity for somatic awareness of emotions and control of attention to physical discomfort in interoceptive awareness displayed high levels of propensity for empathic concern. Although we observed no interaction between interoceptive and exteroceptive awareness, incorporating external information seemingly could lead to a detailed understanding of the situation of others. In addition, we found the significant interaction between somatic awareness of emotions and control of attention to physical discomfort, suggesting that the physical perception of one's emotions and moderately adjust one's physical discomfort may lead to the establishment of a stable self-model and may form a representation of others that differs from that of the self, which makes it easier to attribute to others the minds and emotions perceived and felt from others. Hence, students who actively explore external information and are aware of and perceive their emotions and regulate their discomfort at the physical level may be more likely to objectively understand the distressing feelings and situations of others and experience the same feelings by proxy and may exhibit high levels of propensity for empathic concern.

For personal distress, we found that students who were insensitive and slow to respond to external stimuli or who were sensitive to changes in the external environment and prone to be uncomfortable when such changes became excessive were more likely to exhibit self-centered personal distress in response to the distressing situations of others. The MAIA-Y subscale, which measures the sensitivity of interoceptive awareness, exerted no effect on personal distress; thus, interoceptive awareness may be unrelated to personal distress. The hypothesis of this research is that people with poor sensitivity of interoceptive awareness tend to be unable to form stable self-models, are undifferentiated between the self and others, and are easily influenced by external stimuli and the distressing emotions of others. However, the present results did not support this hypothesis, because interoceptive awareness did not negatively contribute to personal distress. Conversely, exteroceptive awareness contributed to personal distress; moreover, insensitivity and sensitivity independently and positively contributed to personal distress, although both were equally passive in their reactivity. Thus, the need emerged to examine and elucidate the implication of the simultaneous effect of exteroceptive insensitivity and sensitivity on personal distress in the future.

The results of the regression analysis on fantasy demonstrated that students with high levels of propensity for sensation seeking in exteroceptive awareness and with a tendency for control of attention to physical discomfort or awareness of physical sensations in interoceptive awareness exhibit high levels of fantasy tendencies. Thus, understanding and sharing the feelings of others through language and images involve the active exploration of external stimuli, which may lead to a detailed understanding of verbal and visual information about the feelings and situations of others. In addition, the ability to pay attention to one's physical discomfort or to be aware of one's bodily sensations may form a stable self-model and enable one to share the feelings of others while understanding others who are different from oneself.

Regarding cognitive empathy, we found a significant interaction between regulation of attention to bodily sensations and somatic awareness of emotions, which suggests that students who can regulate their attention to bodily sensations appropriately and perceive emotions physically are more likely to

understand emotions from the perspective of others. In addition, we found a significant interaction between control through attention to bodily sensations and control of attention to physical discomfort, which implies that students who are more likely to pay attention to physical sensations in regulating their feelings and to consciously control physical discomfort are more likely to understand their feelings from the perspective of others. These abilities to perceive and regulate one's emotions and conditions on the basis of interoceptive awareness may lead to the formation of a stable self-model and the ability to imagine minds and emotions from the perspective of others while detaching from the self.

However, several issues need to be addressed in the future. First, the study did not examine the construct validity of the MAIA-Y. In the development of the MAIA (Mehling et al., 2012), the authors used various scales required to answer the following questions to test the convergent and discriminant validity of the scale: (a) Do any of the subscales measure the aspects of body awareness and mindful attention?; (b) Do any of the subscales relate to anxiety or distress in response to bodily symptoms or pain?; (c) Are any of the subscales negatively correlated with dissociation from the body and bodily sensations?; and (d) Do any of the subscales relate to the ability to regulate emotions appropriately? The convergent and discriminant validity of the Japanese version of the MAIA-Y should be verified.

Second, this research lacked a substantiation of the hypothesis. The results of Study 2 suggest that individuals with high levels of interoceptive awareness are more likely to understand the minds and emotions of another person, which are distinct from their own ones (cognitive empathy). We can obtain clues that enable us to understand the details of the feelings of others due to interoceptive awareness and use interoceptive senses associated with one's feelings as a framework for inferring the feelings of others. However, the results don't suggest that the dominance of interoceptive over exteroceptive awareness contributes to cognitive empathy, that is, it stabilizes the self-model and enables a clear distinction between the self and others and to attribute to others the feelings perceived and felt from others.

Finally, the results partially supported the hypotheses regarding the relationship of interoceptive and exteroceptive awareness to empathy. We hypothesized that empathy, especially understanding the pain feelings of others on the basis of discriminating between the self and others (cognitive empathy), requires a certain level of dominance of interoceptive over exteroceptive awareness, which generates a clear self-representation and definite self-other differentiation. However, the methodology used in this study was inappropriate for testing these hypotheses. The present research used a questionnaire that measures the trait of interoceptive awareness, but the trait questionnaire could only infer a causal relationship between two factors (e.g., a person with high levels of tendency toward A also has a high tendency toward B) on the basis of individual differences in traits. Thus, it was impossible for this research to elucidate the mechanism of how the state of interoceptive awareness leads to cognitive empathy. In the future, new paradigms and tasks are required to clarify the function of certain states of interoceptive awareness in the brief interval between seeing or hearing about the suffering of others and reacting on the basis of cognitive empathy or empathic concern. Regarding the heart, one of the organs related to interoceptive sense, which presents stimuli at a specific timing of the cardiac cycle, influences autonomic contexts with which they are perceived and recognized. For example, baroreceptor responses

due to stimuli presented in systole, instead of the diastole of the heart, lead to stronger processing of fearful expressions (Garfinkel et al., 2014) and stronger racial stereotypic responses (Azevedo et al., 2017). Using these methods, it may be possible to elucidate the effect of the interoceptive state or awareness (including those from the gastrointestinal and respiratory systems as well as the cardiac system) and exteroceptive state or awareness on processing related to self- and other-understanding and responses with cognitive empathy or empathic concern. Substantial evidence using paradigms and tasks that manipulate the interoceptive state will provide more detailed relationships among the interoceptive sense, self-representation, and the process of empathy.

Conflict of Interest

The authors declare there are no conflicts of interest associated with this manuscript.

Acknowledgements

We thank Mr. Alexander Jones of Middlesex University, UK, for permission to use the original MAIA-Y and for advice during back-translation of the scale in this research. We also thank the teachers of junior high schools and high schools for checking our questionnaires in advance and for their advice on survey methods.

Reference

Apps, M. A. J. & Tsakiris, M. (2014). The free-energy self: A predictive coding account of self-recognition. *Neuroscience and Biobehavioral Reviews, 41*, 85-97. https://doi.org/10.1016/j.neubiorev.2013.01.029

Azevedo, R. T., Garfinkel, S. N., Critchley, H. D., & Tsakiris, M. (2017). Cardiac afferent activity modulates the expression of racial stereotypes. *Nature Communications, 8*, 13854. https://doi.org/10.1038/ncomms13854

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society Series B*, *57*(1), 289-300.

Blair, R. J. (2005). Responding to the emotions of others: Dissociating forms of empathy through the study of typical and psychiatric populations. *Consciousness and Cognition*, *14*(4), 698-718. https://doi.org/10.1016/j.concog.2005.06.004

Boele, S., Van der Graaff, J., de Wied, M., Van der Valk, I. E., Crocetti, E., & Branje, S. (2019). Linking parent-child and peer relationship quality to empathy in adolescence: A multilevel meta-analysis. *Journal of Youth and Adolescence*, *48*(6), 1033-1055. https://doi.org/10.1007/s10964-019-00993-5

Brown, C., & Dunn, W. (2002). *Adolescent/adult sensory profile*. San Antonio, TX: Psychological Corporation.

Fukushima, H., Terasawa, Y., & Umeda, S. (2011). Association between interoception and empathy: Evidence from heartbeat-evoked brain potential. *International Journal of Psychophysiology*, *79*(2), 259-265. https://doi.org/10.1016/j.ijpsycho.2010.10.015

Garfinkel, S. N., Minati, L., Gray, M. A., Seth, A. K., Dolan, R. J., & Critchley, H. D. (2014). Fear from the heart: Sensitivity to fear stimuli depends on individual heartbeats. *The Journal of Neuroscience, 34*(19), 6573-6582. https://doi.org/10.1523/jneurosci.3507-13.2014.

Hagiwara, T., Iwanaga, R., Ito, H., & Tani, I. (2015). *AASP adolescent/adult sensory profile user manual*. Nihon Bunka Kagakusha. (In Japanese, translated by the author of this article.)

Hooker, C. I., Verosky, S. C., Germine, L. T., Knight, R. T., & D'Esposito, M. (2008). Mentalizing about emotion and its relationship to empathy. *Social Cognitive and Affective Neuroscience, 3*(3), 204-217. https://doi.org/10.1093/scan/nsn019

Iacoboni, M. (2009). Imitation, empathy, and mirror neurons. *Annual Review of Psychology 60*, 653-670. https://doi.org/10.1146/annurev.psych.60.110707.163604 1146/annurev.psych.60.110707.163604

Krishnan, A., Woo, C. W., Chang, L. J., Ruzic, L.,

Gu, X., López-Solà, M., Jackson, P. L., Pujol, J., Fan, J., Wager, T. D. (2016). Somatic and vicarious pain are represented by dissociable multivariate brain patterns. *eLife, 5*, e15166. https://doi.org/10.7554/eLife.15166

Jones, A., Silas, J., Todd, J., Stewart, A., Acree, M., Coulson, M., Mehling, W. E. (2021). Exploring the multidimensional assessment of interoceptive awareness in youth aged 7-17 years. *Journal of Clinical Psychology,* 77(3), 661-682. https://doi.org/10.1002/jclp.23067

Krishnan, A., Woo, C. W., Chang, L. J., Ruzic, L., Gu, X., López-Solà,, M., Jackson, P. L., Pujol, J., Fan, J., & Wager, T. D. (2016). Somatic and vicarious pain are represented by dissociable multivariate brain patterns. *Elife, 5*, e15166. https://doi.org/10.7554/eLife.15166

Mehling, W. E., Price, C., Daubenmier, J. J., Acree, M., Bartmess, E., & Stewart, A. (2012). The Multidimensional assessment of interoceptive awareness (MAIA). *PLoS One, 7*(11), e48230. https://doi.org/10.1371/journal.pone.0048230

Ondobaka, S., Kilner, J., & Friston, K. (2017). The role of interoceptive inference in theory of mind. Brain and Cognition, 112, 64-68. https://doi.org/10.1016/j.bandc.2015.08.002.

Oyama, T. (2018). Longitudinal study on multidimensional empathy in junior high school students. *The Japanese Journal of Personality, 27*(1), 77-79. https://doi.org/10.2132/personality.27.1.6 (In Japanese with English abstract.)

Palmer, C. E., & Tsakiris, M. (2018). Going at the heart of social cognition: Is there a role for interoception in self-other distinction? *Current Opinion in Psychology, 24*, 21-26. https://doi.org/10.1016/j.copsyc.2018.04.008

Singer, T., Seymour, B., O'Doherty, J., Kaube, H., Dolan, R. J., & Frith, C. D. (2004). Empathy for pain involves the affective but not sensory components of pain. *Science 303*(5661), 1157-1162. https://doi.org/10.1126/science.1093535

Spinrad, T. L., & Gal, D. E. (2018). Fostering prosocial behavior and empathy in young children. *Current Opinion in Psychology, 20*, 40-44. https://doi.org/10.1016/j.copsyc.2017.08.004

Stern, J. A., & Cassidy, J. (2018). Empathy from infancy to adolescence: An attachment perspective on the development of individual differences. *Developmental Review, 47*, 1-22. https://doi.org/10.1016/j.dr.2017.09.002.

Tobari, M. (2003). The development of empathy in adolescence: A multidimensional view. *The Japanese Journal of Developmental Psychology, 14*(2), 136-148. https://doi.org/10.11201/jjdp.14.136 (In Japanese with English abstract.)

Tsakiris, M., Jiménez, A. T., & Costantini M. (2011). Just a heartbeat away from one's body: Interoceptive sensitivity predicts malleability of body-representations. *Proceedings of the Royal Society of London Series B, 278*(1717), 2470-2476. http://doi.org/10.1098/rspb.2010.2547

Yamamoto, S. (2017). Primate empathy: Three factors and their combinations for empathy-related phenomena. *Wiley Interdisciplinary Reviews Cognitive Science, 8*(3), e1431. https://doi.org/10.1002/wcs.1431

Zaki, J. (2014). Empathy: A motivated account. *Psychological Bulletin, 140*(6), 1608-1647. https://doi.org/10.1037/a0037679

（2023.1.31受稿　2023.2.24受理）