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APPLIED PSYCHOLOGY | SHORT COMMUNICATION

# Effects of yoga in a physical education course on attention control and mental health among graduate students with high sensory processing sensitivity

Rei Amemiya[1*], Genboku Takahashi[2], Randeep Rakwal[2], Midori Kahata[3], Kanako Isono[4] and Yosuke Sakairi[2]

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[*]Corresponding author: Rei Amemiya, Faculty of Health and Sport Sciences, Ibaraki, University of Tsukuba, 1-1-1, Tennodai, Tsukuba, Ibaraki, Japan, 305-8574
E-mail: amemiya.rei.km@u.tsukuba.ac.jp

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Kevin K. Byon, Kinesiology, Indiana University Bloomington School of Public Health, United States

Additional information is available at the end of the article

**Abstract:** This study aimed to examine the effects of yoga on attention control (AC) and mood states in graduate students with high and low sensory processing sensitivity (SPS) in a physical education course setting. Participants included 20 master's students in Japan who attended a yoga course for a semester and completed the Japanese version of the Highly Sensitive Person Scale, the AC subscale, and Profile of Mood States before and after the yoga course. The high SPS group students had lower AC and higher negative mood states before the course. Significant improvement in scores was observed, although differences between the two groups after the yoga course were not statistically significant. Although a positive correlation was found between SPS and variation in AC, there was a negative correlation between variation in AC and mood states. The results suggest that yoga in physical education for graduate students with high SPS promoted AC and improved mood states.

## ABOUT THE AUTHOR

Rei Amemiya is a junior assistant professor in the Faculty of Health and Sport Sciences in University of Tsukuba. He specializes in sports psychology and clinical psychology, focusing on the mental health of athletes, workers, and students. He also considers the effects of oriental practices such as mindfulness and yoga on their health and performance. In addition, as a psychologist who has worked extensively at a psychiatric clinic, he focuses on sensory processing sensitivity (SPS), a trait which is deeply associated with psychological problems, and also effective stress management methods for the individuals. The results from his research so far state that individuals with low SPS are more comfortable with physical activities that regulate their moods. Those with high SPS benefit more from light psychosomatic techniques such as yoga. Furthermore, this research group is training graduate students in yoga at the University of Tsukuba, and studying its effects on them.

## PUBLIC INTEREST STATEMENT

Graduate students worldwide are prone to psychological problems, and therefore it is important they are provided with effective stress management techniques. However, since individual characteristics determine the occurrence of psychological problems and the effects of psychological treatments, it is essential to take measures based on individual differences. In recent years, much attention has been paid to sensory processing sensitivity (SPS) as an individual characteristic associated with psychological problems. Individuals with high SPS are called Highly Sensitive Persons (HSPs) and have been observed to be more prone to depression and anxiety. In our research, we aimed to enable HSPs with helpful self-regulation techniques to manage their own mental health. By examining its effects, this study intended to investigate the relationship between psychological health and sensory processing sensitivity in graduate students. Through two months of physical education class, we also aimed to examine the effects of yoga on the mind and body as a method of self-adjustment.

**Subjects: Sports Psychology; Mental Health; Mental Health Research; School Psychology; Counseling**

**Keywords: fitness; university; graduate students; highly sensitive person; mental health; self-regulation; body and mind therapy**

## 1. Introduction and theoretical background

Mental health issues among graduate students are a global problem. A previous study revealed that approximately 41% of graduate students experienced moderate to severe anxiety symptoms and 39% had moderate to severe depressive symptoms (Evans et al., 2018). In addition, a survey of 300 graduate students indicated that they suffered from anxiety, depression, nervousness, stress, loneliness, and weight issues, potentially leading to high rates of suicidal ideation and suicide attempts (Garcia-Williams et al., 2014). Mental health issues are a concern in both Western and Eastern countries (Sasaki et al., 2015); thus, examining effective stress management methods is critical to alleviate mental health issues among graduate students worldwide.

### *1.1. Sensory processing sensitivity as a predictor of mental health problems*

To support mental health, it is crucial to identify the characteristics that lead to mental health issues and to propose effective treatment methods. Recently, sensory processing sensitivity (SPS) has been shown to predict mental health issues. SPS refers to an individual trait in which responses to internal and external stimuli are processed more strongly and deeply, as compared to most people (Aron & Aron, 1997). In Western countries, SPS has been associated with mental health problems such as anxiety and depression (Liss et al., 2008), and a positive association between SPS and depressive or neurotic characteristics has also been observed in Japanese populations (Takahashi, 2016). People with high SPS are called Highly Sensitive Persons (HSPs), and according to Aron (2010), 20% of the population are characterized as HSPs. Hence, we expect that SPS may be one source of the negative psychological effects experienced by graduate students. Therefore, it is necessary to consider measures to regulate psychological states among graduate students with high SPS.

### *1.2. Efficacious techniques for regulating mental health conditions for those with SPS*

Since SPS has been shown to affect mental health problems, it is necessary to examine and develop effective means to regulate mental health conditions for individuals with such characteristics. Although some scholars have conducted studies on mental health problems associated with SPS and their mediating factors, in practice it is not yet clear how to support individuals with high SPS. One possibility is a cognitive and/or behavioral approach. Some studies have shown improvement in depressive symptoms and maladaptive behaviors in individuals with high SPS through the SPARK resilience program, based on cognitive-behavior therapy and a preventative approach to elementary-school bullying (Nocentini et al., 2018; Pluess & Boniwell, 2015). Other possibilities are more theoretical. One study examining the relationship between SPS, Sense of Coherence (SOC), and depression confirmed that SOC coordinates the relationship between SPS and depression (Yano et al., 2019); however, there are few approaches to increasing SOC, and it is not realistic to expect individuals with high SPS to raise SOC for their mental health. Life Skills Training, however, may be a practical approach, and according to a study that investigated the relationship between SPS, Life Skills Training, and depression, specific life skills such as emotional coping modulated the relationship between SPS and depression; even if SPS was high, better life skills resulted in significantly lower scores for depression (Yano et al., 2020). However, many studies on these topics have been speculative, and there are few studies on the practical relationships between SPS, mental health, and its moderator/mediator variables. The mechanisms of the effects derived from the practice of psychological techniques on people with high SPS have not yet been studied.

Cognitive-behavioral approaches and Life Skills Training may allow practitioners to help HSPs, and Aron (2010) has pointed out that practitioners' own interpersonal factors (their degree of sensitivity) also affect HSPs. While practitioner-provided psychological techniques are expected to be effective for HSPs, there are many factors practitioners must consider for helping HSPs in the face-to-face setting, such as the impact of practitioner's own sensitivity and other environmental factors. Therefore, self-

regulation methods are also necessary and useful. Such self-regulation techniques include physical activity and have been introduced worldwide. Several studies have examined the effects of specific activities and SPS on mood states. However, physical activity, traditionally effective for regulating mood, is more stressful for individuals with high SPS and does not appear to produce the expected effects (e.g., it does not regulate momentary psychological mood; Amemiya & Sakairi, 2018). Therefore, individuals with high SPS are likely to become physically inactive, resulting in depressive symptoms (Yano & Oishi, 2018). However, one study confirmed that for HSPs, momentary mood regulation effects can be obtained using psychological techniques (Amemiya et al., 2017). Thus, activities that are less intense and have a conditioning effect on one's psychological state (e.g., psychophysiological techniques) rather than more intense activities (e.g., physical activity) are required to improve the mental health conditions of individuals with high SPS.

### *1.3. Yoga and its effect on mental health*

Aron (2010) suggests that psychosomatic techniques such as meditation are effective for regulating mental health among individuals with high SPS. Yoga, a form of meditational movement, or moving meditation, has been endorsed as an effective psychophysical therapy, and numerous studies have examined its effects on mental and physical health conditions (Büssing et al., 2012). Research indicates that immediate and long-term mood regulation effects are associated with yoga (Yoshihara et al., 2011). Further, its effects on attention control (AC) problems—which are associated with mental health difficulties—have also been observed (Gothe & McAuley, 2015); yoga leads to improvements in AC problems and changes in executive function (Diamond & Lee, 2011; Hagen & Nayar, 2014). Given that AC is associated with emotional control, improvement in AC can contribute to improvements in mood states (Tang et al., 2015). Therefore, practicing yoga may regulate AC among graduate students and improve their mental health conditions. To our knowledge, however, no study has examined the effects of yoga on graduate students with high SPS.

### *1.4. Hypotheses and purpose of present study*

The present study investigated the effects of practicing yoga on AC and mood states among graduate students in a physical education setting. A previous study indicated that physical activity in individuals with high SPS generated negative results (Amemiya & Sakairi, 2018), contrary to expectations. We hypothesized that the intensity of the physical activity would influence those results, and that the relatively low intensity of yoga would have positive effects on individuals with high SPS (Hypothesis 1).

Aron (2010) suggested that individuals with high SPS may be overwhelmed by stimuli and face difficulties in paying attention, similar to individuals with attention deficit hyperactive disorder (ADHD) (Aron, 2010). Since it has been reported that individuals with ADHD who practice yoga and meditation have improved attention function (Chimiklis et al., 2018; Cohen et al., 2018), yoga may facilitate attention regulation for individuals with high SPS as well, regulating their mental health. Further, yoga's mechanism of change on emotional regulation and mental health may improve AC (Menezes et al., 2015). Therefore, we hypothesized that by practicing yoga, graduate students with high SPS would increase their AC, and yoga-influenced AC would lead to mood state regulation (Hypothesis 2).

## 2. Methods

### *2.1. Participants and procedure*

The participants in this study were 20 master's students (female = 13, male = 7; $M_{age}$ = 25.65; *SD* = 8.62) who completed an elective yoga course in physical education and responded to a pre-post questionnaire. The participants voluntarily registered for the yoga course as part of their graduate-level general education courses. From April to June, 2019, lectures were given twice per week every other week; each of the twelve lectures lasted two hours. At each lesson, participants gathered in the same classroom and received a yoga lecture and philosophical instruction from experts with over 20 years of experience in yoga practice and instruction.

Using a group survey method, in the first and last lectures the participants answered a questionnaire consisting of various measures. The purpose and content of the lectures were explained during the class and in the course syllabus that was distributed to the students before the lectures began. In addition, participants were told that anonymity and protection of personal information would be maintained and that all data scores would be averaged. Furthermore, they were informed that participation was optional and would have no effect on their final grade. Informed consent was obtained from all participants. All procedures were performed in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

### *2.2. Measures*

#### *2.2.1. Highly sensitive person scale*

The Japanese version of the Highly Sensitive Person Scale-19 (HSPS-J19; Takahashi, 2016) was used to measure the degree of SPS in the graduate students. The HSPS-J19 is a Japanese version of the 27-item Highly Sensitive Person Scale developed by Aron and Aron (1997), which was back-translated into Japanese. The scale consists of 19 items across three factors: low sensory threshold, ease of excitation, and aesthetic sensitivity. In the present study, we used the total score of the three factors to measure the degree of SPS. Cronbach's alpha coefficient for the full scale was.79.

#### *2.2.2. Attention control scale*

To assess changes in AC before and after attending the yoga course, we used the scores on the AC subscale from the Japanese version of the Effortful Control Scale for Adults (Yamagata et al., 2005), which was based on the Adult Temperament Questionnaire developed by Rothbart et al. (2000). Previously, a factor analysis yielded three components, one of which was an attentional control factor, which was correlated with response time in a Stroop task (Yamagata et al., 2005). Cronbach's alpha coefficient was .74.

#### *2.2.3. Profile of mood states, 2nd edition*

The Profile of Mood States, 2nd Edition, short form (POMS2) was used to measure changes in mood states before and after attending the yoga classes (Heuchert & McNair, 2012). This scale can assess total stress status, or Total Mood Disturbance (TMD), and multiple stress responses, such as Anger-Hostility (AH), Confusion-Bewilderment (CB), Depression-Dejection (DD), Fatigue-Inertia (FI), Tension-Anxiety (TA), Vigor-Activity (VA), and Friendliness (F) over the previous week. Cronbach's alpha coefficient for each subscale and TMD score ranged from .75 to .91.

### *2.3. Data analysis*

To test for potential differences in the effects of SPS on AC and mood states as a result of the yoga course, we calculated Pearson's product-moment correlation coefficient and conducted two-factor analysis of variance (ANOVA) tests and subsequent multiple comparisons. The participants were divided into two groups based on their average SPS score; those with a higher than average score were assigned to the High SPS group, and the others were defined as the Low SPS group. We used HAD (Shimizu, 2016), SPSS, and G*power3 (Faul et al., 2007) for our analyses.

## 3. Results

### *3.1. Preliminary analysis*

In a preliminary analysis, we calculated Pearson's product-moment correlation coefficients between our variables before the yoga course began. In addition to AC ($r = -.62$, $p < .05$), SPS scores displayed significant positive and negative correlations with all POMS2 subscales and total scores (p values ranging from < .01 to .05). Furthermore, AC was also significantly correlated with POMS2 subscales and total scores (p values ranging from < .01 to .05). The results are shown in Table 1.

**Table 1. Correlation analysis results for all variables**

| Variables | | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | SPS | — | | | | | | | | |
| 2. | AR | −.62 * | — | | | | | | | |
| 3. | AH | .49 ** | −.49 ** | — | | | | | | |
| 4. | CB | .63 ** | −.77 ** | .57 ** | — | | | | | |
| 5. | DD | .59 ** | −.57 ** | .58 ** | .83 ** | — | | | | |
| 6. | FI | .65 ** | −.76 * | .48 * | .83 ** | .72 ** | — | | | |
| 7. | TA | .58 ** | −.49 ** | .47 * | .69 ** | .59 ** | .78 ** | — | | |
| 8. | VA | −.60 * | .58 ** | −.33 | −.67 ** | −.64 ** | −.61 ** | −.34 | — | |
| 9. | F | −.52 ** | .52 * | −.24 | −.56 * | −.55 * | −.61 ** | −.39 † | .89 ** | — |
| 10. | TMD | .72 ** | −.74 ** | .66 ** | .94 ** | .89 ** | .91 ** | .78 ** | −.75 ** | −.68 ** |

Note †p <.10, *p <.05, **p <.01

SPS = Sensory Processing Sensitivity, AC = Attention Control, AH = Anger-Hostility, CB = Confusion-Bewilderment, DD = Depression-Dejection, FI = Fatigue-Inertia, TA = Tension-Anxiety, VA = Vigor-Activity, F = Friendliness, TMD = Total Mood Disturbance



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### *3.2. Variations of each variable before and after the yoga course, as related to SPS differences*

We conducted a two-way ANOVA with group (High and Low SPS) × time (pre- and post-yoga course assessment) as the independent variables to examine differences in each variable over the entire yoga course among participants with high SPS. Significant interaction effects were confirmed in DD: $F(1, 18) = 4.96$, $p < .05$, $\eta_p^2 = 0.22$; FI: $F(1, 18) = 5.39$, $p < .05$, $\eta_p^2 = 0.23$; and TMD: $F(1, 18) = 4.97$, $p < .05$, $\eta_p^2 = 0.22$ for POMS2. Furthermore, interaction effects for AC by POMS2 and CB by POMS2 were marginally significant: $F(1, 18) = 3.54$, $p < .10$, $\eta_p^2 = 0.16$; and $F(1, 18) = 3.48$, $p < .10$, $\eta_p^2 = 0.16$, respectively. To verify statistical power for a two-way ANOVA, we conducted a post-hoc power analysis using G*power3. Based on our results, given effect size [*f*] was = .40, $\alpha = 0.05$, and sample size [*N*] was 20, with 2 × 2 repeated measures ANOVA design by means of G*power3 (Faul et al., 2007) that results in an achieved power [$1 - \beta$] of 0.96. The results of the two-way ANOVA are presented in Table 2.

Given that the interaction effects were significant or marginally significant, we then examined the simple main effects. The results showed a significant improvement in AC, and the subscales and total score of POMS were examined among the High SPS group from pre- to post-assessment: (AC: $p < .01$, $d = 2.55$; CB: $p < .05$, $d = 0.92$; DD: $p < .01$, $d = 1.21$; FI: $p < .05$, $d = 1.46$; TA: $p < .10$, $d = 0.76$; VA: $p < .10$, $d = 0.85$; F: $p < .10$, $d = 0.69$; TMD: $p < .01$, $d = 1.07$). Results indicated that CB ($p < .05$, $d = 0.92$), DD ($p < .05$–01, $d = 1.21$), FI ($p < .05$, $d = 0.91$) and TMD scores ($p < .01$, $d = 2.55$) were significantly higher in the High SPS group than in the Low SPS group in the pre-assessment, but there were no significant differences between the groups in the post-assessment. Furthermore, regarding AC, the High SPS group scored lower than the Low SPS group at the time of pre-assessment ($p < .01$, $d = 2.55$), but the High SPS group scored significantly higher at post-assessment ($p < .05$, $d = 1.31$), and there was no difference between the groups at that time (n. s., $d = .46$). The results of the simple main effects on AC and TMD scores are shown in Figure 1 and 2.

### *3.3. Relationships between SPS score, AC, and mood state variations*

We examined the relationship between SPS scores and variations in AC and POMS2 scores during the yoga course. The results showed a moderate positive correlation between SPS scores and variations in AC ($r = .55$, $p < .05$) and a significant moderate negative correlation between variations in AC, CB, DD, TA, and TMD (r scores ranging from −.49 to −.53; p scores ranging from < .01 to .05). The results are shown in Table 3.

## 4. Discussion

This study examined the differences in the effects of a physical education yoga course on AC and mood states among high- and low-SPS graduate students. Our results showed that SPS scores and several negative mood states were positively associated. Therefore, the results suggest that individual characteristics of SPS may be related to mental health difficulties in graduate students. In addition, results showed that practicing yoga during one semester of a physical education course could improve AC in graduate students with high SPS who initially exhibited poor psychological conditions, possibly leading to improvement in mental health conditions.

### *4.1. Theoretical implications*

We confirmed the relationship between AC, mental health conditions in graduate students, and SPS. Previous studies reported that high SPS scores were positively associated with mental health problems such as depression and anxiety (Ahadi & Basharpoor, 2010; Bakker & Moulding, 2012); however, those studies focused mainly on university students and younger people (e.g., Takahashi, 2016). Further, although high SPS is associated with mental health problems, the mechanisms involved have not been fully investigated. High SPS may be associated with attention control, since individuals with high sensitivity often encounter concentration problems when overwhelmed by stimuli (Aron, 2010). In addition, a relationship between AC and mental health has been reported (Tang et al., 2015).

**Table 2. Two-way ANOVA results between High and Low SPS**

| | | AR | | | AH | | | CB | | | DD | | | FI | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **High SPS** | | **Low SPS** | **High SPS** | | **Low SPS** | **High SPS** | | **Low SPS** | **High SPS** | | **Low SPS** | **High SPS** | | **Low SPS** |
| Pre | Mean | 24.90 | | 33.20 | 5.00 | | 2.80 | 10.10 | | 5.20 | 8.60 | | 3.70 | 11.80 | | 6.50 |
| | *SE* | (1.62) | | (1.62) | (1.03) | | (1.03) | (1.30) | | (1.30) | (1.49) | | (1.49) | (1.38) | | (1.38) |
| Post | Mean | 31.10 | | 33.20 | 4.90 | | 2.60 | 7.00 | | 5.50 | 4.50 | | 3.80 | 8.50 | | 8.00 |
| | *SE* | (2.31) | | (2.31) | (1.26) | | (1.26) | (1.54) | | (1.54) | (1.36) | | (1.36) | (1.67) | | (1.67) |
| Variables | | *F value* | | $\eta_p^2$ | *F value* | | $\eta_p^2$ | *F value* | | $\eta_p^2$ | *F value* | | $\eta_p^2$ | *F value* | | $\eta_p^2$ |
| Group × Time | | 3.54 | † | 0.16 | 0.01 | | 0.00 | 3.48 | † | 0.16 | 4.96 | * | 0.22 | 5.39 | * | 0.23 |
| Group | | 5.14 | * | 0.22 | 2.22 | | 0.11 | 3.18 | † | 0.15 | 2.46 | | 0.12 | 2.31 | | 0.11 |
| Time | | 3.54 | † | 0.16 | 0.06 | | 0.00 | 2.36 | | 0.12 | 4.50 | * | 0.20 | 0.76 | | 0.04 |
| | | TA | | | VA | | | F | | | TMD | | | | | |
| | | High SPS | | Low SPS | High SPS | | Low SPS | High SPS | | Low SPS | High SPS | | Low SPS | | | |
| Pre | Mean | 10.80 | | 6.70 | 6.40 | | 12.10 | 7.90 | | 13.70 | 39.90 | | 12.80 | | | |
| | *SE* | (1.45) | | (1.45) | (1.42) | | (1.42) | (1.39) | | (1.39) | (6.21) | | (6.21) | | | |
| Post | Mean | 7.90 | | 7.70 | 9.40 | | 13.40 | 10.10 | | 13.60 | 23.40 | | 14.20 | | | |
| | *SE* | (1.75) | | (1.75) | (1.55) | | (1.55) | (1.32) | | (1.32) | (6.81) | | (6.81) | | | |
| Variables | | *F value* | | $\eta_p^2$ | *F value* | | $\eta_p^2$ | *F value* | | $\eta_p^2$ | *F value* | | $\eta_p^2$ | | | |
| Group × Time | | 2.81 | | 0.14 | 0.69 | | 0.04 | 1.71 | | 0.09 | 5.47 | * | 0.22 | | | |
| Group | | 1.21 | | 0.06 | 6.94 | * | 0.28 | 7.47 | * | 0.29 | 4.68 | * | 0.21 | | | |
| Time | | 0.67 | | 0.04 | 4.43 | * | 0.20 | 1.43 | | 0.07 | 3.89 | † | 0.18 | | | |

Note †p <.10, *p <.05, **p <.01

SPS = Sensory Processing Sensitivity, AR = Attention Regulation, AH = Anger-Hostility, CB = Confusion-Bewilderment, DD = Depression-Dejection, FI = Fatigue-Inertia, TA = Tension-Anxiety, VA = Vigor-Activity, F = Friendliness, TMD = Total Mood Disturbance



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**Table 3. Correlation analysis results between SPS and variation in each variable**

| Variables | | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | SPS | — | | | | | | | | |
| 2. | ΔAR | .55 * | — | | | | | | | |
| 3. | ΔAH | −.02 | −.29 | — | | | | | | |
| 4. | ΔCB | −.38 + | −.58 ** | .28 | — | | | | | |
| 5. | ΔDD | −.38 | −.52 * | −.01 | .78 ** | — | | | | |
| 6. | ΔFI | −.35 | −.38 + | .18 | .63 ** | .72 ** | — | | | |
| 7. | ΔTA | −.31 | −.49 * | .34 | .67 ** | .48 * | .64 ** | — | | |
| 8. | ΔVA | .16 | −.06 | .38 | −.28 | −.45 * | −.27 | .01 | — | |
| 9. | ΔF | .23 | .06 | .39 + | −.28 | −.48 * | −.33 | −.11 | .68 ** | — |
| 10. | ΔTMD | −.40 + | −.53 * | .26 | .88 ** | .86 ** | .86 ** | .77 ** | −.43 + | −.41 + |

Note †p <.10, *p <.05, **p <.01

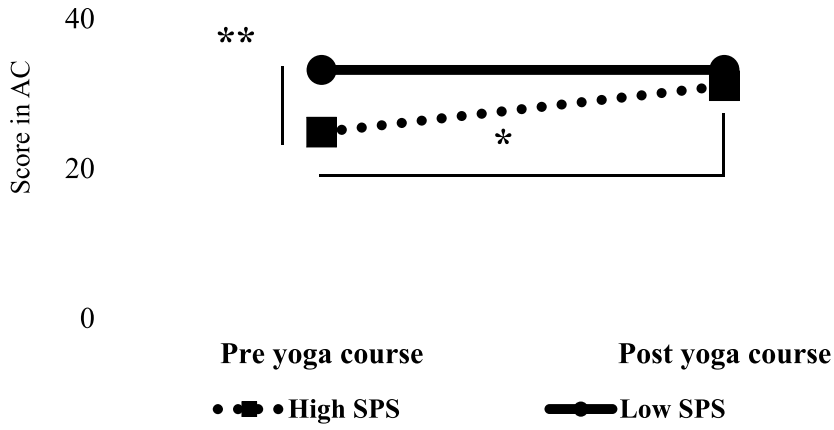
Δ = Change in score from pre to post assessment

SPS = Sensory Processing Sensitivity, AR = Attention Regulation, AH = Anger-Hostility, CB = Confusion-Bewilderment, DD = Depression-Dejection, FI = Fatigue-Inertia, TA = Tension-Anxiety, VA = Vigor-Activity,

F = Friendliness, TMD = Total Mood Disturbance

**Figure 1. Simple main effect results in AC.**

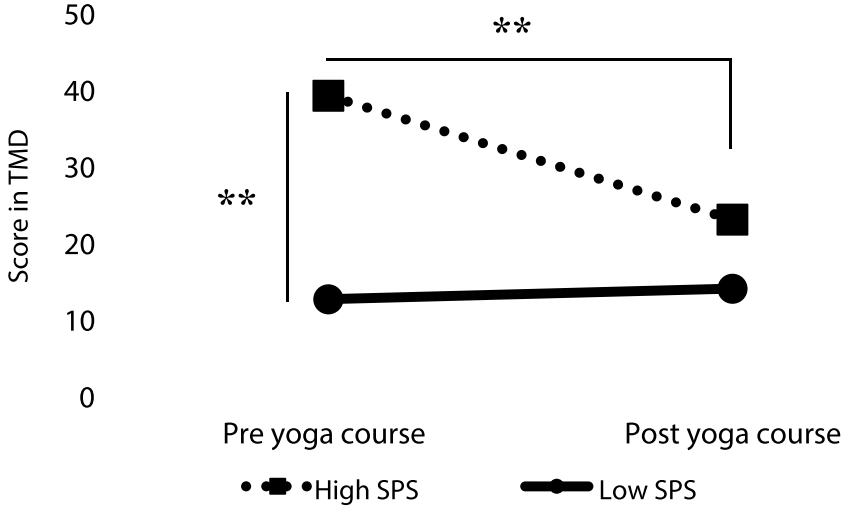
SPS = Sensory Processing Sensitivity, AC = Attention Control




Note *p < .05, **p < .01

**Figure 2. Simple main effect results in TMD.**

SPS = Sensory Processing Sensitivity, TMD = Total Mood Disturbance




Note **p < .01

Ours is the first study to examine the relationship between SPS and mental health conditions among graduate students, and our results indicate that SPS is also associated with AC and mental health problems in this population. These results are consistent with results of studies of SPS that examined the relationships between SPS and mental health problems with non-graduate students. In addition, our findings suggested that individuals with high SPS have AC problems, which may be associated with mental health problems.

Many studies have demonstrated that physical exercise, a popular stress management method, has a positive effect on physical and mental conditions, which is why Japanese universities provide physical education classes for their students. However, exercise that is beneficial for most individuals can actually decrease positive psychological states in individuals with high SPS (Amemiya & Sakairi, 2018). Further, SPS characteristics are negatively associated with exercise habits and are indirectly positively associated

with depression resulting from physical inactivity (Yano & Oishi, 2018). Thus, it can be inferred that individuals with SPS are prone to psychological problems, as are graduate students generally, and they may have difficulty using exercise as a stress management technique. Therefore, the results of the present study are similar to those from other studies (Ahadi & Basharpoor, 2010; Bakker & Moulding, 2012) suggesting that graduate students with high SPS tend to have serious mental health problems and need preventive support.

In the present study, graduate students with high SPS practiced yoga, a relatively low-intensity psychophysiological activity, and exhibited significantly decreased scores on depression, tension, and overall stress response scores in the POMS; had increased AC scores; and had no significant differences from graduate students with low SPS at post-assessment after completing the yoga course. Positive correlations were also found between SPS scores and variations in AC, in addition to a negative correlation between variations of AC and mood state. Studies examining the effects of yoga have found that long-term practitioners have significantly lower POMS scores in areas such as anger and fatigue (Yoshihara et al., 2011), reduced scores in depression and confusion, improved AC, and reduced mental health problems (Razza et al., 2020; Yoshihara et al., 2014). The ability to maintain and guide flexible attention shifts is a component of adaptive emotional regulation that contributes to improved mental health (Tang et al., 2015). Furthermore, enhanced AC may affect yoga-induced emotional regulation (Menezes et al., 2015). Although people with high SPS may experience increased negative mood by doing exercise (Amemiya & Sakairi, 2018), yoga is a comprehensive psychophysical method that includes low-intensity exercise, meditation, and rest. Because yoga is not as high-intensity as other common exercises, it may facilitate regulation of mental health status even for those with high SPS. Our results were similar to a study that reported temporary mood regulation effects of psychophysiological techniques on individuals with high SPS (Amemiya & Sakairi, 2018), demonstrating the effectiveness of psychosomatic techniques for long-term mood regulation. Hence, our results confirmed that practicing yoga as part of physical education may regulate the mental health and improve the AC of graduate students with high SPS.

### *4.2. Practical implications*

Our results confirmed that graduate students with high SPS are more likely to experience mental health problems. Using psychological scales to identify such individuals should enable schools and clinicians to provide support at an early stage. Approximately 40% of graduate students with mental health problems receive support, but 60% do not, suggesting that time constraints may affect their ability to seek help (Evans et al., 2018; Lipson et al., 2016). Graduate students who are prone to mental health problems can, however, regulate their mental health conditions in a daily setting such as a physical education class. Yoga is a technique for self-regulation, and once students learn the skills from an expert, they can practice it by themselves. Hence, even for individuals who are vulnerable to mental health problems associated with SPS, practicing yoga in a physical education course can provide an opportunity to acquire self-regulation skills to adjust mood states while earning course credits. Such a method allows individuals with high SPS to regulate their own mood states without being affected by the sensitivities of practitioners or environmental factors of the face-to-face setting.

## 5. Limitations and further research directions

The results of this study suggest that, by practicing yoga through physical education, graduate students can regulate their mood states and improve AC. However, as this was a pilot study and our sample size was consistent with enrollment in a typical college course, our numbers were somewhat small for statistical testing. A previous study examined differences in severity of mental health problems among Japanese and international students in several academic majors (Sasaki et al., 2015); future research should examine the effects observed here with larger samples from various regions using different groups, including doctoral students, as our participants were master's students. Additionally, other variables may have caused mood state changes through yoga (e.g., the individual's motivation for yoga, or past yoga and meditation experiences). Moreover, we did not compare control and treatment groups; researchers should employ other methods, techniques, and variables in the future.

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**Author details**
Rei Amemiya[1]
E-mail: amemiya.rei.km@u.tsukuba.ac.jp
Genboku Takahashi[2]
E-mail: zgenboku@gmail.com
Randeep Rakwal[2]
E-mail: plantproteomics@gmail.com
Midori Kahata[3]
E-mail: midori.91g@gmail.com
Kanako Isono[4]
E-mail: wakame914@gmail.com
Yosuke Sakairi[2]
E-mail: sakairi.yosuke.fn@u.tsukuba.ac.jp
[1] Faculty of Health and Sport Sciences, University of Tsukuba, Ibaraki, Japan.
[2] Zen Yoga Institute, Nagano, Japan.
[3] Sendai University, Miyagi, Japan.
[4] Graduate School of Comprehensive Human Sciences, University of Tsukuba, Ibaraki, Japan.

**Competing interest**
The authors declare no competing interest.

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