



The relationships among daily exercise, sensory-processing sensitivity, and depressive tendency in Japanese university students

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ABSTRACT

Sensory-processing sensitivity (SPS), the trait of being easily affected by a variety of environmental stimuli, is considered to be related to depressive tendencies. SPS can be measured on three sub-scales: low sensory threshold (LST), ease of excitation (EOE), and aesthetic sensitivity (AES). This study investigated the relationships among the levels of SPS, its sub-scales, depressive tendencies, and the frequency of physical exercise in Japanese university students. The participants ($N = 275$; mean age = 19.4, $SD = 1.1$) completed questionnaires that included an item on the frequency of physical exercise each week, as well as the Japanese version of the 19-item Highly Sensitive Person Scale and the Self-rating Depression Scale. The results showed that LST and EOE were positively related to depressive tendencies, which were moderated by increasing the frequency of physical exercise. AES was negatively related to depressive tendencies, which was a different result from LST and EOE. Hereafter, longitudinal approaches will be needed to reveal the effects of physical exercise on the relationships between LST or EOE and depressive tendencies.

1. Introduction

1.1. Sensory-processing sensitivity

Sensory-processing sensitivity (SPS) is a trait that differentiates individuals according to the extent to which they deeply process environmental stimuli (Aron & Aron, 1997). Individuals with high SPS have a greater reactivity to internal and external stimuli (Aron, 1996). These stimuli include those with effects on mental life, such as other's emotion and subtle changes in the environment, as well as those with predominantly physical impacts, such as lights and sounds. Individuals with high SPS are easily overaroused and tend to be introvert in novel situations to avoid the excessive stimuli they perceive (Aron & Aron, 1997; Kagan, Snidman, Arcus, & Reznick, 1994). These characteristics have made it difficult to discriminate SPS from other traits, such as neuroticism and introversion. However, Aron and Aron (1997) argued that there were clear differences between SPS and these traits. First, SPS is related to both positive and negative emotions, whereas neuroticism is only related to negative ones. Second, in interviews it has been reported that there were high-SPS individuals who showed traits of extraverts. Additionally, correlation analyses showed distinctions between SPS and neuroticism or introversion in terms of quantitative studies (Aron & Aron, 1997; Grimen & Diseth, 2016; Smolewska,

McCabe, & Woody, 2006; Takahashi, 2016).

It is well known that high-SPS individuals tend to have mental health challenges, because of their ease with which they experience overarousal. Many studies have reported that SPS is positively related to perceived stress (Benham, 2006) or social anxiety (Hofmann & Bitran, 2007), and negatively related to self-esteem (Aron, 2010) or self-efficacy (Evers, Rasche, & Schabracq, 2008). The association with depression may be one of the most serious problems for high-SPS individuals (Bakker & Moulding, 2012; Liss, Timmel, Baxley, & Killingsworth, 2005). The relationship between SPS and depression that may be a risk factor for suicide behavior has been examined in terms of psychology and physiology. For instance, regarding physiological studies, it has been suggested that the level of SPS is related to the presence of neurotransmitters such as the 5-HTTLPR short-allele (Homberg, Schubert, Asan, & Aron, 2016; Licht, Mortensen, & Knudsen, 2011) and low densities of dopamine D2 receptor (Chen et al., 2011). Since these factors are related to psychological symptoms such as depression, the level of SPS is thought to be related to depressive tendencies (e.g., Caspi et al., 2003; Reijnders, Ehrt, Weber, Aarsland, & Leentjens, 2008).

Though SPS was originally considered a unidimensional concept (Aron & Aron, 1997), three sub-components are now conventionally used to investigate its relationships with several psychological factors

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(e.g., Booth, Standage, & Fox, 2015; Liss, Mailloux, & Erchull, 2008; Smolewska et al., 2006). Those are low sensory threshold (LST), which implies unpleasant sensory arousals, ease of excitation (EOE), leading to feelings of being mentally overwhelmed by environmental stimuli, and aesthetic sensitivity (AES), which implies a rich inner life (Smolewska et al., 2006; Takahashi, 2016). Although a few studies have reported inter-relationships among these sub-components and other psychological factors (e.g., Booth et al., 2015; Liss et al., 2008), further investigations are needed (Gerstenberg, 2012).

1.2. Psychological effects of daily exercise

It is well known that physical exercise can improve mental health, including alleviating such diseases as depression. Many studies on the effects of acute and chronic exercises have been conducted in terms of psychology and physiology. Acute exercise has been shown to be more effective for changing a bad mood than other methods, such as listening to music or being with someone (Thayer, 1989; Thayer, Newman, & McClain, 1994). The activation of neurotransmitters in the monoamine system, i.e., serotonin and dopamine, increases after exercise and decreases depressive tendencies (e.g., Chaoulloff, Elghozi, Guezennec, & Laude, 1985; Jacobs, 1994; Nutt, 2008). Many studies have shown that chronic exercise can reduce the levels of stress, and anxiety, as well as depressive tendencies (e.g., International Society of Sport Psychology, 1992). Additionally, it has been shown that the more frequently a person does physical exercise, the better mental health he or she has (Endo, Kanou, & Oishi, 2012; Hassmén, Koivula, & Uutela, 2000). Thus, both acute and chronic physical exercise improves mental health. However, Yano, Kimura, and Oishi (2017) suggested that high-SPS individuals tend to perform physical exercise less frequently, which may be one of the factors for their increased depressive tendencies.

1.3. Purpose of this study

Higher-SPS individuals may generally possess a higher risk of mental problems, such as depressive tendencies (e.g., Liss et al., 2005). However, there have been few studies examining such problems, especially focusing on their sub-concepts. Additionally, the higher SPS a person has, the less frequently he or she does physical exercise to improve his or her mental health (Yano et al., 2017). These findings suggest that increasing the frequency of physical exercise could decrease the levels of depressive tendencies in individuals with high SPS. For this reason, this cross-sectional study investigated the relationships among the frequency of physical exercise, the levels of SPS, its sub-concepts, and depressive tendencies (Fig. 1) in Japanese university students.

2. Methods

2.1. Participants and procedure

Three hundred and thirty Japanese university students provided their consent with pencil and paper in a central location after the

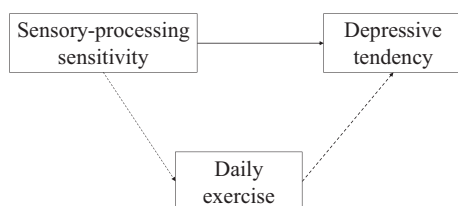


Fig. 1. Hypothetical model of sensory-processing sensitivity, daily exercise, and depressive tendencies

Note. The positive relation is represented by a solid line, and the negative ones are represented by a broken line.

purpose and the content of our questionnaire were explained. The 275 completed responses were analyzed (135 from males and 140 from females); the ages of the completing students ranged from 18 to 26 ($M = 19.4$, $SD = 1.1$). This study was approved by the ethics committee of the authors' university (No. 2016-10).

2.2. Measurements

2.2.1. Level of SPS

The level of SPS was measured using the Japanese version of the 19-item Highly Sensitive Person Scale (HSPS-J19; Takahashi, 2016). This is the revised scale of Highly Sensitive Person Scale (Aron & Aron, 1997) for Japanese and consists of 19 items in three sub-scales (Smolewska et al., 2006), i.e., the LST (seven items; e.g., Are you bothered by intense stimuli, like loud noises or chaotic scenes?), the EOE (eight items; e.g., Do you get rattled when you have a lot to do in a short amount of time?), and the AES (four items; e.g., Do you have a rich, complex inner life?) respectively. Each item is evaluated on a 7-point scale from 1 (*Not at all*) to 7 (*Extremely*), with higher scores meaning greater SPS.

2.2.2. Level of daily exercise

The level of daily exercise was evaluated by the frequency of physical exercise per week, with reference to Endo et al. (2012) and Hassmén et al. (2000). The participants were asked, "How often do you participate in physical exercise each week?"

2.2.3. Level of depressive tendency

The Japanese version of the Self-rating Depression Scale (SDS; Fukuda & Kobayashi, 1973) was used to evaluate individuals' depressive tendencies. This scale is based on SDS by Zung (1965), it has 20 items, and each item is evaluated on a 4-point scale, from 1 (*Little or none of the time*) to 4 (*Most of the time*). Higher scores mean greater depressive tendencies.

2.3. Statistical analyses

First, descriptive analyses were conducted to summarize the measurement scores. Second, Pearson product-moment correlation coefficients were calculated to confirm the mutual relationships among the levels of daily exercise, SPS, and depressive tendencies. Finally, the hypothetical model (Fig. 1) was examined using structural equation modeling (SEM). In these analyses, gender was used as a dummy variable, with "0" representing males and "1" representing females (Nozaki & Koyasu, 2013). Statistical analyses were conducted by IBM SPSS (version 21) and IBM Amos (version 21), and the level of significance was 5%.

3. Results

3.1. Descriptive statistics and reliabilities for each variable

The mean scores, standard deviations, and Cronbach's alpha coefficients for all variables are shown in Table 1. The HSPS-J19 score for assessing the level of SPS showed good reliability, and the scores of both SPS sub-scales and SDS for assessing the level of depressive tendency showed acceptable reliability, respectively.

3.2. Intercorrelations among all variables

The results of correlation analysis are shown in Table 2. In regard to relationships between gender and each variable, the frequency of physical exercise was significantly related to male gender, whereas the other variables were to female gender. SPS had significantly positive correlations with its sub-scales and depressive tendencies, and a negative correlation with the frequency of daily exercise (all $p < .01$). The sub-scales of SPS showed significantly positive correlations within each

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