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Sensory-processing sensitivity and COVID-19 stress in a young population: The mediating role of resilience

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ABSTRACT

Psychologists worldwide are becoming increasingly concerned about the negative impact of the novel coronavirus (COVID-19) pandemic on adolescents' mental health. However, compared to studies involving adults, research using a young population is limited. To further understand the mental health of older adolescents and young adults during the pandemic, the present study examined whether resilience, as a protective factor, buffers the relationship between the personality trait of environmental sensitivity and COVID-19-related distress. In total, 441 older adolescents and young adults (53.7% women, $M_{age} = 18.91$ years, $SD_{age} = 0.82$ years) living in urban Japan completed an online cross-sectional survey in October 2020. The results showed that sensitivity was positively, though weakly, correlated with COVID-19 stress and negatively correlated with resilience. Resilience was negatively correlated with COVID-19 stress. Mediation analysis showed that resilience buffered the negative relationship between sensitivity and COVID-19 stress, and its indirect effect was statistically significant, albeit close to zero. These results suggest that higher sensitivity is not necessarily a vulnerability factor, if resilience can be enhanced.

1. Introduction

As of 2019, mankind has been faced with the global spread of the novel coronavirus (COVID-19). As of April 2021, more than 129,000,000 people have been infected with COVID-19 worldwide, with more than 2,800,000 deaths (John Hopkins University, 2020; World Health Organization [WHO], 2021). Each country is implementing measures, such as lockdown and school closure, to help control the spread of COVID-19, as outbreaks not only impair physical health, but also significantly impact mental health. In fact, many studies have reported increased psychopathology amidst the COVID-19 pandemic, including anxiety, depression, traumatic stress, coronary phobia, and xenophobia (e.g., Magson et al., 2021; Mertens et al., 2020; Qi et al., 2020; Tang et al., 2021; Taylor et al., 2020; van der Velden et al., 2020; Xiong et al., 2020; Zhang et al., 2020). Many studies also point to the importance of interventions and evidence-based policy decisions on the part of health care practitioners to prevent or reduce the negative consequences of the COVID-19 pandemic. Considering these social situations and research trends, this study explores the personality traits that make people more susceptible to negative influences amidst the COVID-19 pandemic, as well as factors that may be protective.

1.1. Mental health during the COVID-19 pandemic

Although there is a limited number of related studies on adolescents and young adults (i.e., 10–24 years; Sawyer et al., 2018) compared to research on the older population, studies from around the world suggest that the youth are more likely to experience mental health problems during the COVID-19 pandemic due to school closure and reduced family well-being (e.g., Golberstein et al., 2020; Prime et al., 2020). In fact, a recent systematic review reported that membership of a younger age group (<40 years) or being a student (Xiong et al., 2020) are risk factors associated with COVID-19 distress. For example, Magson et al. (2021) demonstrated that from the pre- to pandemic period, Australian adolescents experienced increased depressive symptoms and anxiety, and decreased life satisfaction, which were particularly pronounced among girls. They also showed that increased COVID-19-related worries, online learning difficulties, and conflicts with parents predicted poorer mental health. Using a sample of Chinese adolescents, Duan et al. (2020) showed that smartphone and Internet addiction were positively associated with depression and that the tendency to use problem-focused coping styles negatively explained depression. In addition, according to Tang et al. (2021), senior secondary school

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students in China had higher levels of psychopathology and lower levels of life satisfaction than primary school students. Perceived benefits of home quarantine and parent–child discussions about COVID-19 were negatively correlated with psychopathology and positively correlated with life satisfaction. Moreover, Qi et al. (2020) found that Chinese adolescents who perceived themselves as having low social support reported higher depressive and anxiety symptoms, even after controlling for the effects of gender, grade, and degree of COVID-19 exposure.

In summary, adolescents' poor mental health during the COVID-19 pandemic, as described above, may be due to a variety of complex factors, including increased lockdown-induced social distance (e.g., from friendships, which are an important resource in adolescence), economic recession, school closure, and reduced family well-being (Golberstein et al., 2020; Prime et al., 2020).

1.2. Individual differences in environmental sensitivity

Sensitivity to environmental influences varies among people (Pluess, 2015). In other words, highly sensitive people are more likely to experience adversarial effects in stressful environments, such as the COVID-19 pandemic. Individual differences in sensitivity can be captured by the concept of *Environmental Sensitivity* or its dispositional aspect, sensory-processing sensitivity, which is defined as the ability to process and register both *positive* and *negative* environmental influences or experiences (Greven et al., 2019; Pluess, 2015).

Due to their traits, highly sensitive young people are more likely to experience poor mental health in negative environments. For example, recent evidence has shown that compared to less sensitive adolescents, highly sensitive adolescents experience lower socio-emotional well-being when the impact of negative life events experienced in the preceding week was significant (Iimura, 2021). Moreover, several cross-sectional studies have reported that high sensory-processing sensitivity in adolescents is positively correlated with depressive symptoms and anxiety (Liss et al., 2005; Liss et al., 2008).

Also due to their characteristics, highly sensitive adolescents are more likely to benefit from supportive environments. Studies have also reported that in supportive school environments, highly sensitive adolescents exhibit higher socio-emotional well-being than those with lower sensitivity (Iimura & Kibe, 2020).

Could sensitivity be a vulnerability factor during the COVID-19 pandemic? Perhaps the answer is that youth mental health can be moderated, for better or for worse, by protective factors and/or a supportive environment. According to the theory of *Environmental Sensitivity* (Greven et al., 2019; Pluess, 2015), highly sensitive youth would show a greater decline in socio-emotional well-being during a pandemic if the environmental quality is less supportive, and they would show no decline in mental health in the presence of more supportive factors.

1.3. The protective role of resilience against COVID-19 distress

Resilience is one of the most widely discussed protective factors against adversity and traumatic stress. Resilience can be defined in a variety of ways, but its central idea is to bounce back or recover from stress (Smith et al., 2008). Recently, researchers have pointed out the importance of resilience during the COVID-19 pandemic (Chen & Bonanno, 2020; Prime et al., 2020).

Although they are quite limited in number, some studies have revealed the characteristics of resilient people during the COVID-19 pandemic. For example, Killgore et al. (2020) showed that the mean score for resilience was lower than in the pre-pandemic period, but that people who tend to go outside more often, exercise more, perceive a higher degree of social support from family, friends, and significant others, and sleep better were more resilient. In addition, Verdolini et al. (2021) reported that for patients with mental illness, pursuing hobbies and structure in the family environment were associated with higher levels of resilience. Furthermore, Zager Kocjan et al. (2021) indicated

that resilience buffers the negative association between the Big Five of neuroticism and COVID-19 stress.

It is important to note that the evidence reviewed above suggests that resilience amidst a pandemic is associated with modifiable factors. Thus, individual resilience can be enhanced. For example, recent research has demonstrated that highly sensitive adolescents respond well to resilience-enhancing psychoeducational interventions; i.e., they experienced less depression and higher self-efficacy (Kibe et al., 2020; Pluess & Boniwell, 2015). Interventions to increase resilience during the COVID-19 pandemic may be beneficial to improve youth mental health.

1.4. The current study

As noted thus far, individual differences in sensory-processing sensitivity (i.e., susceptibility) and resilience (i.e., protective factors) may be important elements in further understanding youth mental health during the COVID-19 pandemic. Nonetheless, our knowledge of these factors' role is limited. Therefore, the current study aimed to examine how sensory-processing sensitivity and resilience in youth aged 18–24 years old are related to COVID-19-induced distress. This study examined the hypothetical model shown in Fig. 1 to investigate the mediating effect of resilience. The current study predicted that sensory-processing sensitivity would be positively associated with COVID-19 stress, but that the association would be buffered by resilience.

2. Method

2.1. Procedure and participants

The first author invited students enrolled in a course on self-understanding ($n = 588$) at a university in Tokyo to participate in an online cross-sectional survey. Students who expressed interest were provided with a link to complete the survey. The survey using Google Forms was administered on October 28, 2020, during the COVID-19 pandemic. Informed consent was obtained virtually on the first page of the online survey. Participation in the study was voluntary, and participants did not receive any compensation. This study was approved by the ethics review committee of the first author's institution (No. 20-374).

Although 450 students completed the survey (response rate = 76.5%), nine students' data were removed, as their responses were

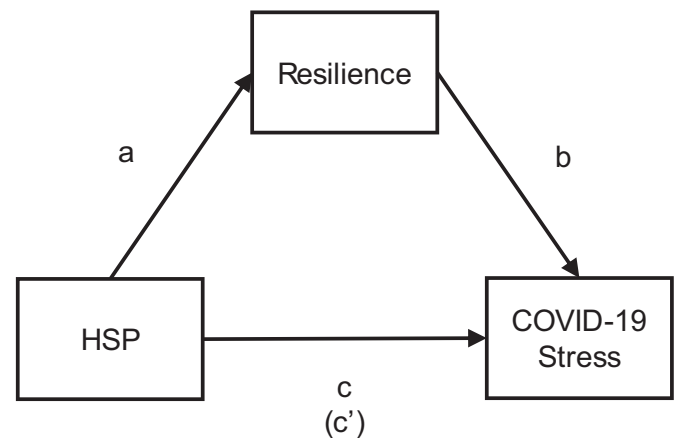


Fig. 1. Hypothetical mediation model note. Although this model controls for the effects of gender and age, these paths are drawn in abbreviated form. The coefficient “a” represents the partial regression coefficient between HSP and resilience; the coefficient “b” between resilience and COVID-19 Stress; and the coefficient “c” between HSP and COVID-19 Stress when the mediator is added. The coefficient “c’” refers to the coefficient in the model without the mediator. HSP = sensory-processing sensitivity.

inadequate (i.e., participants who were neither youth nor Japanese). Data from 441 Japanese youth were used in the analysis. Of the participants, 237 (53.7%) were women. The participants' mean age was 18.91 years ($SD = 0.82$, $MIN = 18.00$, $MAX = 24.00$). Hence, all study participants were in late adolescence and young adulthood (Sawyer et al., 2018), which is suited to the study's purpose. No missing values were included in the dataset.

2.2. Measures

The 10-item Japanese version of the Highly Sensitive Person Scale (Iimura et al., 2021) was used to measure individual differences in sensory-processing sensitivity. This scale consists of ten items that investigate sensitivity to positive environments (e.g., "Are you deeply moved by the arts or music?") and negative environments (e.g., "Are you easily overwhelmed by strong sensory input?"). Each item was rated on a 7-point Likert-type scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The items' internal consistency was good, with Cronbach's $\alpha = 0.85$.

One of the most widely used resilience scales, the Japanese version of the Brief Resilience Scale (Iimura & Taku, 2018; Tokuyoshi & Moriya, 2014), was applied to measure resilience. This scale has been used in several studies to measure resilience during the COVID-19 pandemic (e.g., Verdolini et al., 2021; Zhang et al., 2020). The scale consists of six items (e.g., "I tend to bounce back quickly after hard times" and "It does not take me long to recover from a stressful event"). Each item was rated on a 5-point Likert-type scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Internal consistency was good, with Cronbach's $\alpha = 0.85$.

The Japanese version of the COVID Stress Scale (Muta et al., 2020) was used to measure COVID-19-related distress. Participants completed this scale, reporting their level of COVID-19-related distress in the last 7 days. This scale consists of 36 items (e.g., "I am worried about contracting the virus" and "I am worried about keeping my family safe from the virus") and has five subscales: fear of danger and contamination, fear of economic consequences, xenophobia, compulsive checking and reassurance seeking, and traumatic stress symptoms related to COVID-19. Overall scores were used in this study. Each item was rated on a 5-point Likert-type scale, ranging from 0 (*not at all*) to 4 (*extremely*). The items' internal consistency was good, with Cronbach's $\alpha = 0.93$.

2.3. Data analysis

Analysis in this study consisted of two sections. (1) First is a preliminary analysis. This section aims to understand the participants' basic characteristics; here, descriptive statistics and correlation coefficients for each variable were calculated. In addition, we tested for gender differences in each variable's mean. (2) The second section is a mediation analysis (see MacKinnon et al., 2007 for details). This study analyzed the relationship between sensory-processing sensitivity, resilience (i.e., the mediator), and COVID-19 stress by examining the hypothetical model depicted in Fig. 1. Goodness of fit was evaluated based on the following three indices: comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Specifically, acceptable fit was indicated by $CFI \geq 0.90$, $RMSEA \leq 0.08$, and $SRMR \leq 0.80$ (e.g., Hu & Bentler, 1999; Schermelleh-Engel et al., 2003). To test the indirect effect (i.e., $a \times b$), a bootstrap analysis (5000 resamples) was conducted; if the upper and lower limits of the 95% confidence interval (CI) of the regression coefficient produced by the bootstrapping method do not cross 0, the indirect effect is statistically significant. All analyses in this study were performed using R version 3.6.3 (R Core Team, 2020). The significance level was set at 5%.

3. Results

3.1. Preliminary analysis

The means and standard deviations for sensory-processing sensitivity, resilience, and COVID-19 stress are shown in Table 1. Sensory-processing sensitivity was negatively correlated with resilience ($r = -0.48$, 95% CI $[-0.54, -0.40]$, $p < .001$) and positively correlated with COVID-19 stress ($r = 0.25$, 95% CI $[0.16, 0.34]$, $p < .001$). In addition, resilience was negatively correlated with COVID-19 stress ($r = -0.23$, 95% CI $[-0.31, -0.14]$, $p < .001$). Regarding these results, statistical power analysis, conducted using G*Power (Faul et al., 2009), confirmed that the current sample size had sufficient statistical power (power $[1-\beta] = 0.999$) to detect $r > |0.23|$. A scatter plot depicting the relationship between these variables can be found in Supplementary materials Figs. S1–S3 (<https://bit.ly/39gMjar>).

The t -test showed that the mean value for sensory-processing sensitivity was higher in women ($M = 4.66$) than in men ($M = 4.27$) ($t(439) = 3.72$, Cohen's $d = 0.36$, $p < .001$). The mean value for COVID-19 stress was also higher in women ($M = 0.92$) than in men ($M = 1.05$) ($t(439) = 2.64$, Cohen's $d = 0.25$, $p = .009$). There was sufficient statistical power to detect the former, $d = 0.36$ (power $[1-\beta] = 0.964$), but statistical power was somewhat weak with regard to detecting the latter, $d = 0.25$ (power $[1-\beta] = 0.743$).

3.2. Mediation analysis

The goodness of fit for the mediation model shown in Fig. 2 was excellent ($CFI = 1.00$, $RMSEA = 0.00$, $SRMR = 0.00$). In the model that did not include the mediator ($CFI = 0.96$, $RMSEA = 0.04$, $SRMR = 0.03$), sensory-processing sensitivity was positively associated with COVID-19 stress ($c' = 0.25$, $SE = 0.02$, $p < .001$). Similarly, in the model that included the mediator, the higher the sensitivity, the higher the COVID-19 stress level ($c = 0.17$, $SE = 0.03$, $p = .002$). Sensory-processing sensitivity was negatively related to resilience ($a = -0.47$, $SE = 0.03$, $p < .001$), and resilience was negatively associated with COVID-19 stress ($b = -0.14$, $SE = 0.03$, $p = .010$). Bootstrap analysis showed that the indirect effect of path $a \times b$ was statistically significant ($a \times b = 0.03$, 95% CI $[0.01, 0.06]$), and the effect of sensory-processing sensitivity via resilience on COVID-19 stress was as close to zero as possible. Thus, we can conclude that the effect of sensory-processing sensitivity on COVID-19 distress is miniscule when mediated by resilience.

4. Discussion

Previous studies have pointed out that the COVID-19 outbreak may also be a mental health crisis, especially for adolescents, but our knowledge about this is still limited. Given this background, the present study provides new evidence on the relationship between sensory-processing sensitivity, resilience, and COVID-19 stress in the young population during a pandemic. This study yielded three main findings. First, higher sensory-processing sensitivity was associated with higher COVID-19 stress levels, although the effect size was not large. Second, resilient adolescents reported lower COVID-19 stress levels, replicating previous studies' findings. Third, as expected, resilience buffered the negative association between sensory-processing sensitivity and COVID-19 stress. These findings could be useful for parents, educators, and healthcare providers in their quest to understand and support the mental health of highly sensitive youth.

The mean value of Japanese adolescents' COVID Stress Scale scores was approximately 1.00 (i.e., not very or rarely worried). In other words, evidently, several Japanese youths who participated in this study were not very worried about the COVID-19 pandemic. There are several possible reasons for this finding. One possible explanation is that Japan has a low infection rate compared to Western countries (WHO, 2021). Another possible interpretation is that compared to their feelings at the

Table 1
Descriptive statistics and correlation coefficients among variables.

	<i>M</i>	<i>SD</i>	Range	Kurtosis	Skewness	2	3	4	5
1. HSP	4.48	1.11	1.20–7.00	−0.32	−0.06	−0.48***	0.25***	−0.07	0.17***
2. Resilience	2.94	0.85	1.00–5.00	−0.69	−0.06	–	−0.23***	0.08	−0.07
3. COVID-19 stress	0.99	0.52	0.00–3.06	0.50	0.61	–	–	−0.05	0.12**
4. Age	18.91	0.82	18.00–24.00	–	–	–	–	–	−0.10*
5. Gender	–	–	–	–	–	–	–	–	–

Note. HSP = sensory-processing sensitivity; Gender was coded as 1 = men and 2 = women.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

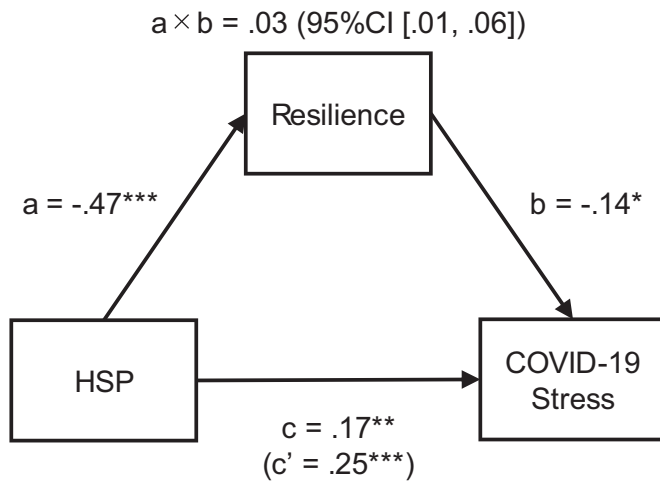


Fig. 2. Mediation model for associations between sensory-processing sensitivity, resilience, and COVID-19 stress note. This model was estimated by controlling for gender and age. HSP = sensory-processing sensitivity. * $p < .05$, ** $p < .01$, *** $p < .001$.

time of the pandemic's onset, the youth may have become accustomed to the pandemic by the time this study was conducted in October 2020. Nevertheless, approximately 3% of the sample scored an average of 2 or more on the COVID Stress Scale (i.e., somewhat or sometimes worried), and some may need support.

In this study, the mean value of the Brief Resilience Scale scores amidst the COVID-19 pandemic was 2.94. On the other hand, a pre-pandemic survey found that Japanese adolescents' average resilience score was 3.12 (Iimura & Taku, 2018). Comparing the average scores across these samples, it appears that resilience (as measured by this scale) is relatively stable despite the onset of a pandemic. However, we need to examine intra-individual variability to conclude whether resilience is stable before and after a pandemic. It is worthwhile to note that approximately 16% of the Japanese youth sample had a low mean score (i.e., 1.00–2.00), suggesting that they may benefit from support aimed at increasing their resilience.

4.1. Is sensitivity a vulnerability amidst the COVID-19 pandemic?

Given that sensory-processing sensitivity showed a positive but small association with COVID-19 stress, high sensitivity could be a risk factor during the COVID-19 pandemic. Theories and research point to the fact that high environmental sensitivity can negatively affect youths' socio-emotional development in stressful environments (Belsky & Pluess, 2009; Monroe & Simons, 1991). For example, Pluess et al. (2010) reported that individuals with the 5-HTTLPR s-allele, a genetic marker of environmental sensitivity, have a higher tendency toward developing the Big Five of neuroticism when they experience negative life events. In addition, Iimura (2021) indicated that when highly sensitive youths

have recently experienced positive life events, there is no observable decline in their socio-emotional well-being. The key implication of these findings or theories regarding environmental sensitivity is that highly sensitive youths are not necessarily *vulnerable* individuals. In other words, if we can reduce negative environmental influences or increase supportive environmental influences, highly sensitive youths can have similar or even better mental health than less sensitive youths.

The mediation analysis results showed that resilience buffered the negative relationship between sensory-processing sensitivity and COVID-19 stress. Importantly, when mediated by resilience, the indirect effect of sensory-processing sensitivity to COVID-19 stress was close to zero. Given this finding, for highly sensitive youths, resilience may be an important protective factor during the COVID-19 pandemic, as previous studies using a sample of Chinese adolescents have also shown (Zhang et al., 2020). However, the present study also found that highly sensitive youths exhibited low resilience. Therefore, when considering strategies for supporting such youths, it may be important to aim to enhance resilience.

Can resilience among the youth be enhanced? Several intervention studies have demonstrated that bolstering resilience through psycho-education and training can decrease psychopathology. For example, the SPARK resilience program (Boniwell & Ryan, 2009), which consists of several lessons, is useful for enhancing highly sensitive youths' socio-emotional well-being. Kibe et al. (2020) implemented a school-based SPARK resilience program for Japanese adolescents and reported that highly sensitive adolescents experienced decreased depression and increased self-esteem. Pluess and Boniwell (2015) also implemented this program among urban girls in the United Kingdom and saw a reduction in depressive symptoms among highly sensitive girls only. These findings suggest that highly sensitive adolescents are more likely to benefit from such interventions than less sensitive adolescents (Pluess & Belsky, 2013).

4.2. Limitations and implications

To the best of our knowledge, this is the first study to report an association between COVID-19 stress and sensory-processing sensitivity in the young population. In this sense, this study is more of a hypothesis-generating exploratory study than a hypothesis-testing one, and it has several limitations. First, as Chen and Bonanno (2020) have pointed out, although timely and informative, this study "at best, provided a snapshot of the immediate impact of COVID-19, but failed to consider the important unfolding process of psychological adjustment following stressful and potentially traumatic events" (p. S51). Following their recommendation, future research needs to examine the long-term effects of the pandemic on youth mental health. Second, the study did not control for the effects of other variables that are assumed to influence youth mental health during the COVID-19 pandemic. For example, prior research has examined a variety of factors that may be associated with psychopathology during the COVID-19 pandemic, including relationships with parents (Verdolini et al., 2021), personality traits (Zager Kocjan et al., 2021), social support (Qi et al., 2020), coping style (Zhang et al., 2020), the perceived benefits of home isolation, Internet and

smartphone addiction (Duan et al., 2020), and online learning difficulties (Magson et al., 2021). Third, this study's findings relied on youths' self-reports. The addition of parental ratings may deepen our understanding of youths' socio-emotional well-being during the pandemic. Fourth, based on the finding that youths living in urban areas report higher psychopathology during the pandemic (Duan et al., 2020), this study collected data from urban youths in Tokyo. However, youths living in rural areas of Japan may experience different pandemic-related difficulties than their urban counterparts. Finally, as very few studies have examined the correlation between sensory-processing sensitivity and resilience (within and without the context of a pandemic), researchers should address these issues in the future to further understanding of youth mental health.

5. Conclusion

Researchers around the world are increasingly interested in the impact of the COVID-19 pandemic on youth mental health. The present study collected data from Japanese youths living in urban areas to examine, for the first time, whether resilience, which is known as a protective factor, buffers the relationship between the personality trait of environmental sensitivity, which has traditionally been regarded as a vulnerability factor, and COVID-19-related distress. In light of the mediation analysis results, the most important message emerging from this study is that greater sensitivity does not necessarily equate to vulnerability, if resilience can be enhanced.

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Availability of data and material

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

CRedit authorship contribution statement

Shuhei Iimura: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

There is no conflict of interest with regard to this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.paid.2021.111183>.

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