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Abstract

Some researchers indicate that the transition to high school deflects adolescent developmental trajectories. Others assert it provides a new possibility for the promotion of adolescents’ socioemotional well-being. One critical view missing in such claims is that individual variabilities interact with environmental influences. We employed the framework of Differential Susceptibility Theory, which postulates that individual susceptibilities moderate external influences for better and for worse. In order to clarify the mechanism of adolescents’ differential adjustments, this paper investigated the role of sensory-processing sensitivity using the Japanese version of Highly Sensitive Child Scale for Adolescence (J-HSCS), and tested whether the diathesis-stress model or the differential susceptibility model best describes students’ socioemotional adjustment across their high school transition. The current paper used the two-wave data collected from Japanese adolescents aged from 14 to 15 years (n = 412, 50% girls). In Study 1, we investigated the replicability of psychometric properties of J-HSCS. The results supported previous findings, indicating its validity for the bifactor model. In Study 2, we utilized confirmatory competitive model testing, which maximizes statistical power by parameterizing the crossover point to allow a direct comparison of alternative models. The results indicated that neither the diathesis-stress nor the differential susceptibility models fitted the data. Rather, a strong vantage sensitivity model was revealed, suggesting that highly susceptible adolescents disproportionately benefitted from a positive school transition over their counterparts. This finding signified the role of adolescents’ sensitivity to environmental influences and the importance of considering its moderation under person x environment interactions.

Keywords: differential susceptibility, highly sensitive adolescents, school transition, sensory-processing sensitivity, Highly Sensitive Child Scale, vantage sensitivity

Adolescence is a unique transitional phase of human development. It bridges childhood to adulthood and incorporates major change, not only at the organismic end (e.g. neurobiological development, physiological growth spurt) but also at the contextual end (e.g. shifts in extrafamilial relationships and organization). These dynamic interactions often amplify instability; hence, an elevated risk of mismatch would occur between the needs of the development stage and environmental opportunities (Eccles et al., 1993). Partly for this reason, many unhealthy behaviors (e.g. smoking, drinking, substance abuse) and mental health issues (e.g. anxiety, depression, eating disorders) begin at adolescence. Furthermore, these conditions predict later morbidity and poor social adjustment to adulthood (Kerig, Ludlow, & Wenar, 2012; WHO, 2017).

A significant environmental change that most adolescents experience is school transition. Research indicates that this shift can disrupt students’ well-being as they experience a higher level of academic hassle and stress (Seidman, Aber, Allen, & French, 1996), anxiety and depression (Barber & Olsen, 2004; Benner & Graham, 2009; Newman, Newman, Griffen, O’Connor, & Spas, 2007), and a decline of their sense of self-worth (Barber & Olsen, 2004). These findings also suggest that students’ perceptions of change in the environment, such as social support and the quality of the school environment, decrease across school transitions, corresponding with poor academic and socioemotional adjustment (Barber & Olsen, 2004; Newman et al., 2007). Additionally, for some, this corresponds with truancy and dropping out of school (Eccles & Roeser, 2011). Traditionally, these developmental challenges during adolescence have conceptually been described as “storm and stress”.

However, while it may be plausible for some to view this transitional period as a deflection of the developmental trajectory, adolescents may experience relative stability despite the environmental changes, or even an enhancement of their performance (Benner, 2011; Cicchetti & Rogosch, 2002; Roeser, Eccles, & Freedman-Doan, 1999). These positive aspects of youth adjustment can be illuminated by positive youth development perspectives (PYD: Lerner, Brentano, Dowling, & Anderson, 2002; Lerner, Almerigi, Theokas, & Lerner, 2005). PYD perspectives contrast a traditional view of stress-laden adolescence and postulate that all individuals possess the potential to undergo a systematic change allowing them to thrive (i.e.
plasticity) by capitalizing on their assets to direct their development toward the promotion of desired outcomes (Lerner et al., 2005).

**Understanding “Why” of Person-Environment Interactions**

Although the abovementioned perspectives enhance our understanding of how youth adjustment varies and what matters when optimizing its development, the underlying question of “why” such differences emerge remains unanswered. Why do some adolescents respond poorly to their environmental changes while others cope well or even thrive, if all individuals are plastic? Or, more specifically, why do individuals differ both negatively and positively in their adjustment, even if under the effects of the same environmental changes?

In fact, these differential responses to seemingly common environmental effects have been extensively studied in developmental sciences within the diathesis-stress framework, which elucidates the mechanism of awry in the person x environment interaction due to the presence of dual risk (e.g. Cicchetti & Rogosch, 2002; Cumming, Davies, & Campbell, 2000; Kerig et al., 2012; Monroe & Simons, 1991). The dual risk paradigm claims, “some individuals, due to a vulnerability in their make-up, are disproportionately or even exclusively likely to be affected adversely by an environmental stressor” (Belsky & Pluess, 2009 p.885). Research suggest such individual vulnerability includes, but is not exclusive to, race/ethnicity (e.g., Benner & Graham, 2007; Benner Boyle, & Bakhtiari, 2017; Gillock & Reyes, 1996; Witherspoon & Ennett, 2011), temperament and personality (e.g. Chess & Thomas, 1987; Krueger, Caspi, Moffitt, Silva, & McGee, 1996), and genetic compositions (e.g. Caspi et al., 2003; Caspi & Moffit, 2006).

Nonetheless, despite the established contribution of the dual risk paradigm, there still lacks a theoretical explanation of “why” some individuals present more favorable outcomes than others as exemplified in PYD perspectives. Besides, some at-risk adolescents may show positive school transition, implying intraindividual variances in adaptation. Thus, it would be feasible to state that the dual risk model has failed to illustrate the possibility that individual differences may be pronounced in the promotion of favorable outcomes (Pluess & Belsky, 2013; Pluess, 2017).

**Differential Susceptibility to Environmental Influences**

Perhaps, it may be more reasonable to view individual “vulnerability” as neutral “susceptibility” to environmental influences. Therefore, the same individual can respond both positively and negatively in accordance with the environmental quality (Belsky, 1997; Belsky,
Bakermans-Kranenburg, & van IJzendoorn, 2007). This reconceptualization of vulnerability was first introduced by Belsky (1997; 2000) as a notion of differential susceptibility in his evolutionary inspired developmental consideration, which envisaged the conditional and alternative strategy of evolution. He argues that since the goal of evolution is the survival and enhancement of reproductive fitness in nature, humans developed two strategies in an essentially unpredictable environment to serve such purposes. Hence, while individual phenotypic variations can be conditioned by environmental influences for some, it may be genetically prepared as alternative evolitional strategies for others. Notably, the latter strategy (which can be considered a “bet-hedging strategy”) includes, 1) a plastic strategy characterized with high susceptibility, and 2) a fixed strategy with low susceptibility. Founded on this idea of evolution, Belsky theorized the Differential Susceptibility Theory (DST: Belsky, 1997; 2000; Belsky et al, 2007).

On the other hand, the Biological Sensitivity to the Context Theory (BSCT: Boyce et al., 1995; Boyce & Ellis, 2005) coincidently shares the theoretical rationale of an evolutionary mechanism of person x environment interactions. The BSCT (Boyce & Ellis, 2005) posits that early exposure to extreme environmental conditions, both negative and positive, enhances an individual’s neurobiological susceptibility (i.e., heightened reactivity). Therefore, regarding the function of contextual influences, individual differences in the stress response system regulate one’s adaptation, ranging from harmful to protective in a form of “conditional adaptation” (Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011; Ellis & Del Giudice, 2019). Though the BSCT differs in its emphasis on the role of the environment, as opposed to Belsky’s emphasis on the role of individual predisposition, both theories are underpinned by evolutionary thinking. In short, both theories share their primary concerns of individual differences regarding susceptibility to environmental information: some individuals are more susceptible to both the negative and the positive effects of environmental influences, and highly susceptible individuals are more responsive in both for better and for worse manners (Belsky et al., 2007; Ellis et al., 2011).

Such commonality in theoretical predispositions led to an integrated model of the Differential Susceptibility Theory, proposed as an evolutionary-neurodevelopmental theory (Ellis et al., 2011). Employing DST perspectives guides us to further our understanding of “why” heterogeneous outcomes occur during the adolescent school transition. As stated above, individual susceptibility plays a pivotal role in the adaptation mechanism determining prototypic
strategies (i.e., responsive vs resistant). Thus, youth susceptibility may also be playing a vital role in the environment.

**Sensory-Processing Sensitivity as a Susceptible Marker in Personality**

Since the theoretical inception of DST, substantial evidence has been reported from the fields of developmental psychology, molecular psychiatry, and neuroscience (e.g., Homberg, Schubert, Asan, & Aron, 2016; Pluess & Boniwell, 2015; Van IJzendoorn, Belsky, & Bakermans-Kranenburg, 2012). These findings indicate that factors traditionally labeled as vulnerability factors can function as plasticity factors under the positive environment (Belsky & Pluess, 2009). The indices of such individual susceptibilities range from genetic to phenotypic markers, e.g. genetic polymorphism and child temperament (Belsky & Pluess, 2009).

Notably, individual differences in sensitivity have also been investigated separately in the field of personality study. Aron and Aron (1997) examined phenotypic, highly sensitive personality in adults and suggested that Sensory-Processing Sensitivity (SPS) contributes to the basis of individual differences in sensitivity to the environmental stimuli. SPS is a personality trait that involves low threshold and high sensitivity to subtle stimuli, deep cognitive processing of external information that associates with behavioral inhibition in novel situations, and elevated physiological and emotional reactivity to the environmental influences (Aron & Aron, 1997; Aron, Aron, & Jagiellowicz, 2012). SPS is also reported to have a neurobiological basis that involves the evolutionarily adaptive central nervous system, which determines individual response strategies on whether to approach or withdraw from novel situations.

While it is conceivable that shy, socially introvert, or even emotionally dysregulated individuals are, in part, a representation of the susceptible phenotypic personality with high SPS, research indicates that SPS is a conceptually independent characteristic of social introversion, shyness, or negative affectivity (e.g., Aron & Aron, 1997; Aron et al., 2012). Furthermore, whereas SPS has been found to relate to a range of psychopathological outcomes when interacting with negative environment (e.g., alexithymia, anxiety, depression) (Bakker & Moulding, 2012; Liss, Mailloux, & Erchull, 2008; Liss, Timmel, Baxley, & Killingsworth, 2005), one systematic literature review of SPS, including psychological, biological, and psychiatric perspectives, suggested SPS functions as a neutral cross-disorder (or transdiagnostic) trait that is “uniquely suited to bridge psychiatric disorders with biological substrates of behavior” (Greven et al., 2019 p. 301). Taking this view with its theoretical resemblance, SPS
would be deemed to function as a susceptible marker in personality traits from a DST’s perspectives.

**Measuring Sensory-Processing Sensitivity in Developmental Contexts**

As described above, the theoretical foundation of SPS and the conceptual approach in attempting to elucidate the role of sensitivity in sharing common ground with DST’s perspectives. Thus, as predicted by Ellis et al. (2011), both have been recently discussed within an integrated model of person x environment interaction (Aron et al., 2012; Pluess, 2015; Pluess et al., 2018).

Such an endeavor has been particularly accelerated by the development of the Highly Sensitive Child Scale (HSCS: Pluess et al., 2018). By employing the Highly Sensitive Person Scale for adults (HSPS: Aron & Aron, 1997), Pluess et al. (2018) developed a 12-item HSCS with a total sample of 3,581 persons (aged 8 to 19) and confirmed the validity of its bifactor model as found in the HSPS. Also, the construct validity of SPS, measured with these two scales, has been demonstrated. For example, both the HSCS and the HSPS are positively correlated to the behavioral inhibition system (BIS) and behavioral activation system (BAS) (e.g., Pluess et al. 2018; Şengül-İnal & Sümer, 2017; Smolewska, McCabe, & Woody, 2006; Sobocko & Zelenski, 2015) and neuroticism in the Big Five personality, however, openness is associated with adults only (Lionetti et al., 2019).

Subsequent to the development of the HSCS, empirical studies to test DST in children and adolescents have been promoted further. One example is from the Dutch longitudinal survey consisting of 264 kindergarteners. Researchers compared child negative emotionality and the SPS as susceptible markers and stated that the SPS (but not negative emotionality) interacted with positive and negative parenting changes that predict child externalizing problems (Slagt, Dubas, van Aken, Ellis, & Deković, 2018). Furthermore, Pluess and Boniwell (2015) investigated the role of SPS in the effects of a school-based intervention, targeting an at-risk population in the United Kingdom. Results showed that girls with a high SPS benefitted from the intervention (i.e. decreased symptoms of depression), whereas girls with a low SPS did not. Furthermore, results indicate that the empirical evidence of vantage sensitivity, the “bright side” of the DST (Pluess & Belsky, 2013), is a function of individual SPS. As such, concurrent with growing research attention, HSP and HSCS are now translated into multiple languages, such as Dutch (Weyn et al., 2019), Italian (Nocentini, Menesini, Lionetti, & Pluess, 2017), German
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(Konrad & Herzberg, 2017; Tillmann, El Matany, & Duttweiler, 2018), Turkish (Şengül-İnal & Sümer, 2017), and Japanese (Kibe & Hirano, 2019). However, evidence from multicultural contexts is yet to fortify the theoretical underpinning of HSP and HSCS.

Testing the Competing Models

As described previously, the diathesis-stress and differential susceptibility models seem to depict the mechanism of heterogeneous youth adjustment. Thus, it would be important to question as to how we distinguish which model would adequately describe actual person x environment interaction. Furthermore, as the DST has drawn substantial research interest, methodological refinements to distinguish the DST model have been recommended by several scholars (e.g., Belsky et al., 2007; Belsky & Pluess, 2009; Belsky & Widaman, 2018; Widaman et al., 2012). To resolve such issues, Widaman and his colleagues (Widaman et al., 2012; Belsky & Widaman, 2018) proposed a new approach to test these competing models. They argued that under the traditional slope testing approach, the predicted slopes of the DST model might look identical to those of the diathesis-stress model; nonetheless, what differentiates these competing models would be the crossover point in the interaction.

Under their new competitive-confirmatory model testing approach, they proposed to parameterize crossover point which would inform the investigators to lead judgment whether the data fits more consistently with the diathesis-stress model or differential susceptibility model (Widaman et al., 2012; see Figure 1). For example, if the differential susceptibility model is demonstrated, susceptibility factors reflect the crossover interaction that covers environmental variation across negative-to-positive poles (i.e., “for better and for worse”). Hence, the crossover point sits near the median value of the environmental variables. On the other hand, if the crossover point sits closer to the positive end of the environmental predictor range, meaning the larger area for worse, the data support diathesis-stress model.

In contrast to traditional (exploratory) regression analysis with a statistical significance test of interaction, the confirmatory and competitive approach can evaluate alternative models directly and maximize statistical power by optimizing the analysis (reparameterization) in response to hypotheses of interest (Belsky, Pluess, & Widaman, 2013). However, to date, this competitive model testing approach has not yet been implemented in many studies because it was proposed relatively recently (Belsky & Widaman, 2018; Widaman et al., 2012). One such
attempt was found in Jolicoeur-Martineau et al. (2020), which indicated its effectiveness in a small sample (N ≥ 250) with large effect size, or in a large sample (N ≥ 500) with moderate effect size. Nonetheless, despite the statistical benefits of this approach, when considering SPS as an adolescent susceptibility marker in the face of school transition, no study has yet to investigate its effects and test the competitive models.

Overview of the Present Study

Thus far, we described current issues surrounding studies on adolescent school transition from developmental perspectives. Firstly, there has been a theoretical gap when illuminating the comprehensive picture of the “why” of inter- and intra-individual differences in youth adjustment (both positive and negative). Nevertheless, deploying DST perspectives would help to clarify such a mechanism and provide insight through evolutionary reasoning. However, while DST perspectives would offer useful insight to illuminate the adolescents’ transition, distinguishing competitive models (i.e., diathesis stress, differential susceptibility) is of the utmost importance. On such occasions, a new competitive confirmatory model testing (Belsky & Widaman, 2018; Widaman et al., 2012) would contribute towards identifying a suitable model by evaluating the crossover point of interaction. Secondly, when measuring adolescent susceptibility, the SPS would make an excellent observable variable as a phenotypic marker to capture individual sensitivity, and the recently developed HSCS would serve this purpose. Particularly, HSCS is translated into multiple languages, including Japanese. An investigation from a multicultural perspective would help theoretical refinement.

To address the abovementioned issues, we used two-wave longitudinal data collected from a total sample of 412 Japanese students (aged 14–15), conducting two studies. Study 1 tested the validity of the Japanese version of the Highly Sensitive Child Scale for Adolescence (J-HSCS: Kibe & Hirano, 2019) and examined the psychometric properties of the scale. Then, Study 2 investigated the model of adolescent school transition by utilizing the competitive confirmatory model testing approach (Widaman et al., 2012) to evaluate which model of diathesis-stress or differential susceptibility would best explain the current data. To test these competing models, we hypothesized that students’ sensitivity would moderate the effects of their perceived change in the school environment on their well-being across school transition. In other words, highly sensitive adolescents who perceived school transition positively would increase their well-being, while less sensitive adolescents would not show change to the same degree. To
our knowledge, empirical research from DST perspectives in Japanese adolescents is scarce. Therefore, the present investigation would help to advance our understanding of youth school transition and the role of individual susceptibility from multicultural perspectives.

Study 1

In Study 1, we began by determining whether the psychometric properties of the HSC scale, reported in previous studies (e.g., Pluess et al., 2018), could be reproduced in a sample of Japanese adolescents—because the evidence of SPS in Eastern countries (including Japan) is limited. First, we conducted confirmatory factor analysis using two timepoint data to evaluate the factorial validity of the 3-factor and bifactor models. Next, bivariate correlation coefficients between J-HSCS and related psychological concepts, including temperament and affect, were calculated to test convergent validity.

Method

Participants. We conducted two-wave longitudinal research, named Adolescent Development during Transition to High School Project (Iimura, 2020; Iimura & Taku, 2018). At Time 1 (T1), before the transition to high school, the participants included 412 students (206 girls and 206 boys) in Japan who were 14–15 years old. At Time 2 (T2), after the transition to high school, 344 students (170 girls and 174 boys, attrition rate = 17%) who were 15–16 years old participated in our survey again.

Procedure. In Japan, students graduate from junior high school in March and enter high school in April. As such, the survey at T1 was conducted in March 2018, one month before the school transition; the survey at T2 was performed two months later in May, one month after the transition to high school. This time interval was planned with reference to previous studies that captured adolescent adjustment during the transition (Benner & Graham, 2007; Iimura & Taku, 2018).

Before the primary survey, informed consent was obtained on an online form from students and their guardians. Guardians (227 mothers, 185 fathers, mean age = 46.25 years old, SD = 4.99 years old) were asked to report their family’s socio-demographic status; 72% of the families had a household income range from 2,000,000 to 10,000,000 Japanese yen (the median household income in Japan is approximately 4,300,000 Japanese yen), which is approximately $18,000 to $91,000 as of 2019. Additionally, 6% of the guardians were unmarried. The
institutional review board of Chuo University approved all procedures in the present study (approval number: 2017-4).

**Measures.** Students rated their traits of sensory-processing sensitivity at T1 and T2, using the J-HSCS (Kibe & Hirano, 2019). The J-HSCS was developed with the data collected from 942 students (7th to 10th grades: age 12 to 16) and was reported to have the same three-factor structure that fits the bifactor model, similarly as the original HSCS (Pluess et al., 2018): five items on Ease of Excitation (EOE; e.g., “I get nervous when I have to do a lot in little time”), four items on Aesthetic Sensitivity (AES; e.g., “Some music can make me really happy”), and two items on Low Sensory Threshold (LST; e.g., “Loud noises make me feel uncomfortable”). While the original HSCS (Pluess et al., 2018) has 12 items, the J-HSCS consists of 11 items because one item of LST (“I do not like watching TV programs that have a lot of violence in them”) failed to yield sufficient factor loading. Each item was rated on a 7-point scale, ranging from 1 (not at all) to 7 (extremely). The internal consistency of the 11 items was good, with Cronbach’s $\alpha = .78$ for both T1 and T2.

In order to examine the association with the J-HSCS, students’ affective status was measured at T1 and T2, using the 16-item Japanese version of the Positive and Negative Affect Schedule (PANAS-J; Sato & Yasuda, 2001). This scale included two subscales: Eight items on Positive Affect (PA; e.g., “enthusiastic,” “interested”), and eight items on Negative Affect (NA; e.g., “scared,” “afraid”). Students scored the items on a 6-point scale, ranging from 1 (not at all) to 6 (extremely). The internal consistencies of PA and NA were good with Cronbach’s $\alpha = .84$ and .86, respectively.

The 20-item Japanese version of the BIS/BAS scales (Takahashi et al., 2007) was used at T2 to investigate its association with the J-HSCS. The 7-item BIS scale includes items such as “I worry about making mistakes,” and the 13-item BAS scale includes items such as “When I get something I want, I feel excited and energized.” Items were rated on a 4-point scale, ranging from 1 (strong disagreement) to 4 (strong agreement). Cronbach’s $\alpha$ was .64 for the BIS and .83 for the BAS.

**Data Analysis.** To confirm whether the 3-factor and bifactor models of HSCS reported in previous studies (Lionetti et al., 2018; Pluess et al., 2018) fit the Japanese two-wave data, we performed a longitudinal confirmatory factor analysis (CFA; Widaman, Ferrer, & Conger, 2010). The 3-factor model consists of five items on EOE, two items on LST, and four items on AES; the
bifactor model includes three factors plus a general factor that affects all items (see Figure 2).

Since recent findings suggest that the bifactor model is better fitted than the 3-factor model (Lionetti et al., 2018; Pluess et al., 2018), we examined whether it can be reproduced in this study. To compare and evaluate the goodness of fit of the two models, we referred to comparative fit index (CFI), root mean square error of approximation (RMSEA), standardized root mean square residuals (SRMR), Bayesian information criterion (BIC), and Akaike information criterion (AIC), which are commonly used in many research studies. For CFI, >.90 is acceptable; for RMSEA and SRMR, <.08 is acceptable. BIC and AIC were used to evaluate which alternative model fits the data best; a lower value is a better model.

Longitudinal CFA can investigate factorial invariance over time, that is, whether we are assessing the “same” construct at each occasion. Because the concept of the SPS is proposed as a phenotypic trait, the factor structure of the HSCS is expected to be stable over time. To examine this, we compared four levels of factorial invariant models based on the Widaman et al. (2010) approach. Model 1 is a configural invariance that assumes the same pattern of fixed and free factor loadings across time. Model 2 is a weak factorial invariance that assumes the invariant factor loadings across time. Model 3 is a strong factorial invariance that assumes the invariant factor loadings and intercepts across time. Model 4 is a strict factorial invariance that assumes invariant factor loadings, intercepts, and unique factor variances across time. In comparing the best fit across models, BIC, AIC, and chi-square difference tests were used. The chi-square difference tests selected a less constrained model if the differences in chi-square (Δχ²) between the more and the less constrained models’ increased significantly. The full information maximum likelihood estimation was used as a method of longitudinal CFA.

Next, bivariate correlation coefficients between J-HSCS and related psychological constructs (i.e., BIS/BAS, PA/NA) were then calculated and, as in the original study, evaluated to see if they were positively correlated. All analyses were conducted on R, version 3.4.4 (R Core Team, 2018) and its interface RStudio, version 1.2.5001. The level of significance for all analyses was set at α = .05.

**Missing data.** To identify the missing value patterns, we tested mean differences in T1 variables between students who participated in both surveys and students who participated only in the first survey, using multivariate analysis covariance. Results showed no significant mean differences between these participants (Pillai’s trace = 0.01, F(6, 405) = 0.70, p = .647).
suggesting that missing value patterns in the current study were considered as missing completely at random (Little, 1988).

Results

Descriptive statistics. Table 1 shows the means and standardized deviations of the 11-item J-HSCS and all other variables used in this study\(^3\). The ceiling effect and floor effect for all measures were not confirmed.

[Table 1]

Confirmatory factor analysis and factorial invariance. Figure 2 shows the path diagram for the 3-factor model and the bifactor model of the J-HSCS. The 3-factor model indicated an almost acceptable fit (CFI = 0.89, RMSEA = 0.06, SRMR = 0.04, BIC = 27637220, AIC = 27636382). The bifactor model also showed better model fit (CFI = 0.90, RMSEA = 0.07, SRMR = 0.04, BIC = 27624249, AIC = 27623224). The two relative fit statistics (BIC and AIC) suggested that the bifactor model is better fitted than the 3-factor model.

For testing factorial invariance, the configural invariance model was the best fit for both the 3-factor model and the bifactor model (see Supplementary Table S1 and S2), suggesting that the J-HSCS assessed the “same” structure over two-time points. The means and standard deviations for each item are shown in Supplementary Table S3.

[Figure 2]

Bivariate correlations. Bivariate correlations between all measures are shown in Table 1. The results indicate that greater BIS was associated with greater values of J-HSCS and the three subscales (\(r = .16\)–.51). Similarly, greater BAS was associated with greater J-HSCS and AES (\(r = .12\)–.39), but there were no significant correlations in EOE and LST. While greater PA was found to be associated with less J-HSCS, EOE, and LST (\(r = -.12\) to \-.26), it was associated with greater AES (\(r = .19\)–.25). Although greater NA was related to greater J-HSCS, EOE, and LST (\(r = .21\)–.35), it was not associated with AES.

Discussion

Study 1 suggested that the Japanese version of the HSC scale had good psychometric properties similar to those of the original HSCS created using UK-based samples (Pluess et al., 2018). The factor structure of J-HSCS better fitted the bifactor model, which assumes a general sensitivity factor in addition to the three factors of EOE, LST, and AES. Therefore, as with the original HSC scale, we can also use the total mean score of the J-HSCS to capture SPS.
Additionally, longitudinal CFA confirmed the factorial invariance of the measure over time, supporting the robustness of the factor structure in the current Japanese sample. Furthermore, as with the Western findings (e.g., Pluess et al., 2018; Slagt et al., 2018), the J-HSCS subscales correlated with both negative and positive emotionality and affect. For example, greater EOE and LST were associated with greater BIS and NA, and greater AES was associated with greater BAS and PA. As a result, the convergent validity of J-HSCS was also supported.

Study 2

The purpose of Study 2 was to investigate which model of differential susceptibility or diathesis-stress would best reflect the development of socioemotional well-being across school transition. As detailed in the earlier section of this paper, theoretical advancement offers two distinct yet interrelated models to illuminate the mechanism of individual differences in person x environment interactions. Traditional stress-laden adolescent adjustment is construed from the diathesis-stress model, while differential susceptibility explained that highly sensitive adolescents are more affected — “for better and for worse” — by environmental quality. In an attempt to clarify the mechanism of adolescent socioemotional adjustment, this study employed Widaman’s confirmatory model testing approach (2012) to elucidate the “why” of individual differences, witnessed during the phase of high school transition.

Method

Participants and procedures. The participants were the same as in Study 1 including \( n = 412 \) (50% girls) at T1 and \( n = 344 \) (49% girls) at T2, which tested the psychometric properties of the J-HSCS (see Study 1 for detailed procedures). However, Study 2 specifically analyzed longitudinal data collected before and after the transition to high school to identify the individual differences in changes in socioemotional well-being.

Measures. As a susceptibility predictor, we used the Japanese version of the HSCS, measured at T1. This measure has sufficient factorial and convergent validity and internal consistency, as demonstrated in Study 1.

As a predictor of the school environment, participants completed the unpublished 11 items of the Perceived Change in School Environment scale (PCSE) after high school transition (T2). This scale measures students’ perception regarding how the school environment has changed (i.e., positively or negatively) compared to the junior high school. As mentioned earlier,
perceptions of the school environment after school transition have been found to predict students’ academic as well as socioemotional adjustment (e.g., Wang & Holcombe, 2010). For example, predictors include perceived teacher-student relationships (e.g., Barber & Olsen, 2004; Roeser, Midgley, & Urdan, 1996), school climate (e.g., Felner, Ginter, & Primavera, 1982), and autonomy (e.g., Wang & Holcombe, 2010). Based on prior research on school environment conducted in the United States and Japan (Barber & Olsen, 2004; Felner et al., 1982; Hirata & Sako, 1998; Roeser et al., 1996; Wang & Holcombe, 2010), the first author and three developmental researchers created the original 11 items (e.g., “school climate,” “number of students in the whole school,” “relationship with teachers”; see Supplementary Table S4). The instruction was, “when you compare your experiences in junior high school and high school, how do you consider the changes listed below?” Students scored the items on a 7-point scale (1 = it changed considerably in a bad direction, 4 = it was not different from junior high school, 7 = it changed considerably in a good direction). As a result of exploring the factor structure of the PCSE, Velicer’s minimum average partial test recommended that the optimal number of factors for the scale is a one-factor solution in the current study. Table S4 shows the final factor loadings and commonalities of each item resulting from exploratory factor analysis with the maximum likelihood method. Three items were eliminated because of low factor loadings (< .32; Howard, 2016; Yong & Pearce, 2013), and therefore we finally used eight items for the analysis. The internal consistency was good (α = .88).

To measure students’ socioemotional well-being across school transition, the Japanese version of the World Health Organization’s Five Well-Being Index (WHO-5-J; Awata et al., 2007) was used at T1 and T2 as a developmental outcome. Students scored five items (e.g., “I have felt cheerful and in good spirits,” “I have felt calm and relaxed”) on a 6-point scale, ranging from 1 (at no time) to 6 (all of the time). These items had good internal consistency; Cronbach’s α was .88 at T1 and .89 at T2.

Data analysis. Before comparing models of differential susceptibility and diathesis-stress, a latent change score model (LCM; for details, see McArdle & Nesselroade, 1994) was used to calculate individual changes in socioemotional well-being over school transition adequately. Like the well-known latent growth model, LCM is a statistical technique based on the structural equation modeling (SEM) of longitudinal data. The path diagram is shown in Supplementary Figure S1. As with the latent growth model, LCM captures the mean level (i.e.,
intercept) and mean change (i.e., slope) of the two-time point data. Unlike paired t-test, LCM has
the following advantages to quantify difference score: 1) The mean scores of the estimated
change represent the difference in “true” (latent) scores from T1 to T2 that are controlled for
measurement error. 2) It can evaluate not only the mean level of intercept and slope over time
but also its variance (i.e., interindividual variation). 3) This model can be estimated using the full
information maximum likelihood methods, which is a recommended method for handling
missing data (Arbuckle, 1996). CFI, RMSEA, and SRMR were used to evaluate model fit.

Next, exploratory and confirmatory analytic approaches (Belsky et al., 2013) were
applied to determine the optimal models of person x environment interactions. In the first step,
we conducted standard exploratory regression analysis to predict the latent change score for
socioemotional well-being. The main effects model included the J-HSCS and the perceived
change in the school environment as the predictors. The interaction model further added their
interaction term. Based on Belsky and Widaman (2018), if the F ratio was greater than 1.0 when
the interaction was added, this would suggest the need to proceed to the confirmatory (re-
parameterized regression) analysis to test the interaction as a second step. A nonlinear regression
program must be used to estimate the parameters of the regression model; to do this, the “nls”
function of R was used for the analysis (Widaman et al., 2012). For verification, we used the
LEGIT package recently developed by Jolicoeur-Martineau et al. (2018, 2020) and the
“GxE_interaction_test” function. The equation for the re-parameterized regression model can be
written as:

\[ Y = B_0 + B_1(X_1 - C) + B_2((X_1 - C)X_2) + E, \]

where \( Y \) is the dependent variable (i.e., change score of socioemotional well-being), \( X_1 \) is the
environment predictor (i.e., perceived change in school environment), \( X_2 \) is the sensitivity
predictor (i.e., 11-item J-HSCS), \( C \) is the point on \( X_1 \) at which the slopes for the high sensitivity
group and low sensitivity group cross, \( B_0 \) is the intercept representing the estimated \( Y \) score on \( C \),
\( B_1 \) and \( B_3 \) are the coefficients for the predictors, and \( E \) is a stochastic error term.

As shown in Figure 1, the position of \( C \) on \( X_1 \) distinguishes between differential
susceptibility and diathesis-stress (Widaman et al., 2012). If \( C \) is within the range of the values
on \( X_1 \), observed in the current study, the model is consistent with differential susceptibility (i.e.,
lower part of Figure 1). If \( C \) is at or above the most positive values on \( X_1 \) in this study (i.e., \( C = \max(X_1) \)), the model reflects diathesis-stress (i.e., the upper part of Figure 1). Additionally, the
regression model described above can compare alternative models (i.e. strong or weak models). The strong model can be tested by fixing the slope for the non-sensitivity group at 0 (i.e., $B_1 = 0$). In contrast, the weak model does not impose such constraints on the slope for the non-sensitivity group (i.e., $B_1 \neq 0$). Study 2 compared 4 regression models: strong differential susceptibility (Model 1a), weak differential susceptibility (Model 1b), strong diathesis-stress (Model 2a), and weak diathesis-stress (Model 2b). We evaluated the best fit model based on BIC and AIC (the lower the value, the better the model). In addition, pseudo $R^2$ squared for each model was estimated by using the “soilphysics” package (de Lima, da Silva, da Silva, Leão, & Mosaddeghi, 2016) for the model evaluation.

Results

Change in socioemotional well-being. The latent change score model was performed to quantify the change in socioemotional well-being across the school transition. Fit indices indicated good model fit (CFI = 0.93, RMSEA = 0.09, SRMR = 0.06). The estimated mean for latent change score was 0.42 ($p < .001$), and mean-variance was 1.01 ($p < .001$), suggesting that students improved in well-being across the transition on average, and there were individual differences in well-being changes. A histogram of the change score in socioemotional well-being is depicted in Figure 3.

Standard exploratory analysis. First, we tested the effects of the interaction of SPS x perceived changes in school environment on socioemotional well-being using standard exploratory regression analysis. As shown in Table 2, the main effects model showed a significant $R^2$ of 0.07 ($p < .001$), with only the main effect of the perceived changes in school environment proving significant ($\beta = 0.26$, $p < .001$); the BIC was 788.27 and the AIC was 773.52. The interaction model produced a non-significant $\Delta R^2$ of 0.01 ($p = .246$), with BIC = 792.59 and AIC = 774.16. However, it is important to note that the $F$ ratio was greater than 1 ($F > 1.35$) when the interaction term was added. According to Belsky and Widaman (2018), this suggests the need to proceed to the competitive and confirmatory testing step to further analyze the interaction.

Differential susceptibility vs. diathesis-stress. Table 3 shows the estimated parameters and fit indices for confirmatory (re-parameterized) regression models. The information criterion,
BIC and AIC, suggested that the strong version of the differential susceptibility model (BIC = 917.68, AIC = 902.32) fitted better than the strong and weak versions of the diathesis-stress model (BIC = 925.52, AIC = 914.00; BIC = 919.50, AIC = 904.14, respectively). In the strong differential susceptibility model, low-sensitivity students showed no change in socioemotional well-being regardless of the quality of perceived school environmental changes ($B_1 = 0$), while high-sensitivity students developed their socioemotional well-being in a “for better and for worse” manner, depending on environmental quality ($B_3 = 0.06, SE = 0.01, p < .001$). The crossover point on the environment predictor was $C = 2.86$ ($SE = 1.06, p = .007$) and the latent change score of socioemotional well-being on $C$ was not statistically significant ($B_0 = -0.03, SE = 0.28, p = .898$).

Given that the possible range of perceived changes in the school environment is 1 to 7 (cf. $M = 4.53, SD = 0.87$), we can interpret these results as indicating that although $C$ in the strong differential susceptibility model is located within the observed range of environmental variables, its value is located more toward the worse end of the range. Importantly, this suggests that differential susceptibility also may not yet adequately explain the mechanism of individual differences in socioemotional adaptation across school transition. Therefore, this motivated us to undertake a post hoc analysis to examine the vantage sensitivity model which closely associated with the “better” area of differential susceptibility to the current data.

Figure 4 depicts the difference between vantage sensitivity, differential susceptibility, and diathesis-stress. Vantage sensitivity assumes that, in contrast to diathesis-stress, only highly sensitive students benefit from supportive environmental influences. Therefore, if $C$ is at or below the lowest values on $X_1$, the model is consistent with vantage sensitivity (i.e., $C = \min (X_1)$). Also, by using differential slope constraints for the low sensitivity group, it is possible to discriminate both strong (upper part) and weak (lower part) versions of each model with reference to the comparative slope (i.e., low sensitivity group).

Table 3 [Figure 4]

Vantage sensitivity (post hoc analysis). As shown in Table 4, the smallest BIC supported the strong vantage sensitivity model (Model 3a; BIC = 914.17) as the best fit for the data. This model indicated the lowest level of AIC similar to those of the weak vantage sensitivity model and the strong differential susceptibility model (AIC = 902.65, 902.59, and 902.32, respectively). While considering these findings, the strong vantage sensitivity model was
identified as the model that best explained the sensitivity x environment interactions. The crossover point in this model was the minimum value ($C = \min(X_1) = 1$) of the environmental variables observed in this study. The estimated latent change score of socioemotional well-being on $C$ was $B_0 = -0.39$ ($SE = 0.16, p = .017$). The slope for the low-sensitivity students ($B_1$) was fixed at 0. The slope coefficient for the high sensitivity students was $B_3 = 0.05$ ($SE = 0.01, p < .001$). Figure 5 shows different patterns of socioemotional adaptation in students with high sensitivity (top 97.5 percentile), middle sensitivity (50 percentile), and low sensitivity (bottom 2.5 percentile).

[Table 4] [Figure 5]

**Discussion**

Study 2 tested and compared alternative regression models directly, based on Widaman et al. (2012) confirmatory approach, to determine the optimal shape of the person x environment interactions. Although the results appeared to support the differential susceptibility model rather than the diathesis-stress model, as shown in Table 3, the crossover point was located toward the negative end of the environmental predictor range (i.e., perceived changes in school environment) rather than the center; this suggests the feasibility of an alternative model of vantage sensitivity, which is closely related to the “better” area of differential susceptibility (cf. Figure 1 and 4). In fact, the post hoc analysis supported vantage sensitivity rather than differential susceptibility as the best framework for explaining the development of socioemotional well-being across the school transition with the current Japanese data. Vantage sensitivity is the concept that reflects individual differences in response to exclusively environmental advantages and positive experiences (Pluess & Belsky, 2013): In this framework, individuals who benefit disproportionately from supportive environments are described as “vantage sensitive” while those who do not respond to supportive influences are explicated as a “vantage resistant”. Although the evidence is limited because of the relatively recent introduction of the framework, its advisability has been reported in several studies (de Villiers, Lionetti, & Pluess, 2018; Pluess, 2017). For example, two school-based intervention studies have recently demonstrated that only children who scored higher on the HSC scale benefited from the intervention (e.g., low depression and victimization), and children characterized by low sensitivity showed resistance to the intervention effect (Nocentini, Menesini, & Pluess, 2018; Pluess & Boniwell, 2015). Although the school transition may be different from the intervention,
it is possible that supportive changes in the school environment were driven predominantly by students with high sensitivity in the current study.

General Discussion

Adolescents’ socioemotional adjustment in school transition signifies dynamic interaction between individual differences and environmental influences. It often entails heterogenous outcomes due to the magnitude of variability, of which description ranges from “storm and stress” to “thriving youth”. The present paper investigated “why” such heterogenous adjustments occur at the phase of high school transition from DST perspectives. The first purpose of this paper was to examine the psychometric properties of 11 item J-HSCS using two-wave longitudinal data obtained from Japanese high school students. The second purpose was to clarify which of the diathesis-stress or differential susceptibility models would best describe adolescents’ socioemotional adjustment across high school transition by employing Widaman’s confirmatory competitive model testing approach. This paper presented three major findings: 1) confirmation of replicability of psychometric properties of J-HSCS, 2) efficacy of the confirmatory competitive model testing approach, and 3) an indication of vantage sensitivity rather than diathesis-stress and differential susceptibility models across the high school transition.

Psychometric Properties of J-HSCS

In Study 1, we examined the replicability of the psychometric properties of J-HSCS (Kibe & Hirano, 2019). The results yielded the same factor structure with the original U.K. version (Pluess et al., 2018) with three subscales of EOE, LST, and AES, which fits best with a bifactor model that has one orthogonal general sensitivity factor (Figure 2). These results indicated J-HSCS is a valid scale with robust factor structure to measure adolescents’ SPS (Aron & Aron, 1997). Further, the bifactor structure suggested that SPS is a construct that has multiple subscales along with one general latent sensitivity factor. Interestingly, the factor loading from the latent general sensitivity yielded all positive loadings, which implied SPS registers external stimuli regardless of the contextual quality differences (i.e., both positive and negative).

With respect to the construct validity, although SPS was found to be distinct from other measures (i.e., PA/NA and BIS/BAS) with the correlation coefficient ranging from |.13| ~ |.51| (Table 1), the results are somewhat inconsistent with the previous studies. First, Pluess et al.
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(2018) reported that more of the HSCS and its three subscales were related to more of the BIS/BAS, whereas the current study did not replicate such associations between two of the J-HSCS subscales (i.e., EOE and LST) and the BAS. Second, prior research has shown that greater positive affect was associated with greater total HSCS, but this study indicated a negative correlation with the J-HSCS total. It is unclear whether such results reflect cultural or ethnic differences between British and Japanese adolescents. In order to clarify the cause of this difference, it may be necessary to consider how much the development of individual sensitivity is explained by culture or ethnicity (e.g., Bakermans-Kranenburg & Van IJzendoorn, 2011).

While the current paper confirmed the replicability of the psychometric properties of J-HSCS, there emerged two questions regarding variability and stability: 1) the developmental mechanism of, and 2) cultural/ethnic differences of SPS as a personality trait. The first question resonates with Thomas and Chess’s classification of infant temperament in nine dimensions (1977). Their view on temperament was formed on “how” infants behave; for instance, whether approach or withdraw to new stimuli, the intensity of reaction, the sensory threshold of responsiveness, adaptability, and attention span. Such expressions of child temperament highlight striking resemblance with characteristics of SPS, though it originated from the study of adult personality (Aron & Aron, 1997). Although previous studies reported conceptual distinction from temperamental subcategories (e.g., Pluess et al., 2018), a comprehensive study has not yet been conducted. Therefore, its developmental mechanism remains unclear. Notably, from the perspective of neurophysiological development, it is reported that sensitivity to environmental stimuli increases in adolescence (Galván, & Tottenham, 2016; Schriber & Guyer, 2016). Furthermore, research suggests that the dominant personality traits have some patterns of peak, plateau, and trait consistency (Roberts & Del Vecchio, 2000), which raises another research interest whether the SPS shows a similar developmental pattern.

The other inquiry regarding the culture/ethnic differences of the SPS would warrant theoretical enhancement too. As mentioned above, association with other measures found in this paper revealed somewhat different relationships between those of the U.K. Further, the mean scores of HSCS seem to be higher in Japanese adolescents ($M = 4.58, SD = 0.80$; Table 1; $M = 5.02, SD = 0.77$; Kibe & Hirano, 2019) than British adolescents ($M = 3.98, SD = 0.96$; Pluess et al., 2018 Study 4). While the reason for the putative cultural difference is unclear, two potential reasonings can be explored. One is from a cultural difference in related personality traits; some
research suggested Japan scored the highest neurotic trait among 56 countries (Schmitt, Allik, McCrae, & Benet-Martínez, 2007), and neuroticism was found to have association with SPS (e.g., Lionetti et al., 2019; Pluess et al., 2018; Kibe & Hirano, 2019), which implies contextual influences in SPS differences. Second, potential association with the population distribution of serotonin transporter gene polymorphism (5-HTTLPR). Because the short allele of 5-HTTLPR is associated with less transcription of the serotonin transporter compared with the long allele (Culverhouse et al., 2018), researchers have suggested that individuals carrying one or more copies of the 5-HTTLPR short allele show heightened amygdala activation, negative affect, and anxiety toward environmental threats (e.g., Hariri et al., 2002; Hariri & Holmes, 2006; Munafò, Brown, & Hariri, 2008), therefore the short allele of 5-HTTLPR may contribute to environmental sensitivity (e.g., Belsky & Pluess, 2009; Homberg et al., 2016; Pluess, 2015). Importantly, research has revealed that the share rates of this short-allele gene are higher in East Asians, including Japanese, than in Americans (Chiao & Blizinsky, 2009). For instance, about 80% of Japanese carry the short allele of 5-HTTLPR; in contrast, only about 40% of Americans do so (Chiao & Blizinsky, 2009). While it is plausible to view SPS as a multiple-gene expression with accumulated small effects, such a culture-genetic background may be reflected in the different results between Japan and the U.K.

As such, though the SPS is reported to be a common personality trait that relates to a neurobiological base, a multicultural consideration would enhance a theoretical refinement and help us advance our knowledge in individual sensitivity and person x environment interactions.

**Efficacy of Confirmatory Competitive Model Testing**

In Study 2, we aimed to compare diathesis-stress and differential susceptibility models by utilizing Widaman’s confirmatory competitive approach. Interestingly, the results indicated that neither of the models sufficiently described the data. Consequently, we ran a secondary analysis, which revealed that a strong vantage sensitivity model fitted the current data best. These results indeed confirmed the efficacy of the confirmatory competitive approach by distinguishing three interrelated yet distinct models.

The methodological advantage of Widaman’s confirmatory competitive approach is that while it maximizes statistical power by re-parameterizing the regression model, it allows direct comparison of alternative models based on information criterion rather than statistical tests. Thus, it bears notable benefits to clear some hurdles of school-based studies. Particularly where
obtaining large data set is often challenging (e.g., quasi-experimental or intervention design).

Furthermore, this methodology allows the addressing of the problem of low reproducibility of psychological findings (e.g., Button et al., 2013; Open Science Collaboration, 2015), which often derives from statistical underpower. For instance, if a study yielded a null outcome due to the statistical underpower or Type II error, then it is unlikely that the researchers would publish their results (e.g., “file-drawer problem”). Alternatively, the worst-case scenario is that it would lead the researchers to undertake “p-hacking” (Wicherts et al., 2016). To prevent such issues (i.e., manipulation of p-value) and ensure statistical robustness, traditional exploratory approach requires 1) test of statistical significance of interaction term, and 2) test the shape of the interaction; however, this multi-step statistical operations may eventually raise likelihood to jeopardize reproducibility, or from a broader point of view, Questionable Research Practices (QRP). As reported in Jolicoeur-Martineau et al. (2020), the confirmatory competitive model testing is an excellent approach to distinguish the models with a rather small sample size (< 500) with higher sensitivity than exploratory approach.

This paper presented the first empirical report that implemented and confirmed its effectiveness to distinguish three distinct yet interrelated models deploying SPS as a moderator. Since its inception, the DST has drawn unprecedented attention, and the findings of vantage sensitivity particularly highlight the promising implication for theoretical application in an educational context (e.g., intervention strategy). Thus, this model testing approach would pave the way to design and implement efficient strategies to support adolescent development.

**Vantage Sensitivity Across High School Transition**

Another important finding is that our results indicate that the strong vantage sensitivity model is preferred over the diathesis-stress and differential susceptibility models, with the current data depicting Japanese students’ high school transition. This result seems to have exemplified the promotion of adolescents’ well-being (i.e., PYD: Lerner et al., 2005) mainly for susceptible adolescents, which traditional dual-risk paradigm has failed to illuminate. Although PYD is observable in various contexts, if the school transition could successfully provide a favorable environment for the sensitive adolescents, then it would allow reciprocal interaction that leads to positive youth development (Eccles et al., 1993). However, to our knowledge, no research has attempted to elucidate the mechanism of PYD from vantage sensitivity perspectives. Nevertheless, it may be possible to explain, at least partially, the theoretical reasoning for “why”
individual differences are observable even under PYD perspectives.

However, adolescents’ school adjustment is multifaceted (Benner, 2011; Cicchetti & Rogosch, 2002); other psychosocial constructs, as well as academic aspects, need to be examined. Additionally, follow-up assessments would inform us to clarify the mechanism of adolescent developmental trajectories. Particular interest is whether the high SPS (vantage sensitivity) adolescents in this study would develop disproportionately negative outcomes under the adverse contexts (e.g., bullying, exam stress, peer pressure) since SPS may function as a transdiagnostic personality trait that bridges clinical and non-clinical expression (Greven et al., 2019). Or, as DST posits, so long as the environment is supportive, are outcomes of such stressful effects moderated? Further longitudinal testing would clarify the role of individual sensitivity in the adaptation system across school transition and subsequent adjustment.

Nonetheless, why were diathesis-stress or differential susceptibility model not supported within the current study? One possible explanation is environmental variability; though the students reported their subjective experience of school transition, the school environment in this study might not have provided sufficient negative contexts. Unless negative contextual influence is present, neither the diathesis-stress nor differential susceptibility model would have been adequately addressed. As reported in Table 1, the mean values of PCSE and Δwell-being were positive, which indicated students overall experienced positive school transition; and thus, such experiences might have contributed to the strong vantage sensitivity model with the current sample. Another possibility is an interplay of cultural factors. Unlike schools in other developed countries (e.g., U.S., U.K.), little diversity is observable in Japanese high schools. For example, there were less than 3,000 students whose first language was not Japanese out of 3,300,000 high school students as a whole in 2016 (Japan Ministry of Education, Culture, Sports, Science, and Technology, 2017). Meaning the vast majority of Japanese high schools consist of solely Japanese nationals. Also, the high school transition is marked with a competitive entrance examination, yet the high school entrance rate is nearly 97% as of 2017 (Iimura & Taku, 2018), which exemplifies the high homogeneity in Japan. Stability might have contributed to an overall positive high school transition thus yielding a strong vantage sensitivity model.

On the other hand, this study might have captured a case of the “honeymoon period”, an initial part of the U-curve adjustment model in school transition. The U-curve adjustment model was proposed originally from immigrants’ acculturation and assimilation studies. When entering
a new environment, people attend to positive information more carefully than negative ones and overly appreciate their new environment (Black & Mendenhall, 1991; Teske & Nelson, 1974). Then, this initial stage is followed by three distinct stages; hostile stage where individuals become more critical or resentful to the new environment, adjustment stage to attempt to adjust in the new environment more objectively, then assimilation stage where individuals assimilated into their new home environment, which leads to greater well-being presumably with the enhancement of their sense of belonging. Though the U-curve model had not been investigated empirically in the context of school transition, the putative “honeymoon period” was reported in Benner and Graham’s study (2009). They conducted a 4-year longitudinal study including high school transition (7th to 10th grade) with 1,979 participants of ethnically diverse American urban adolescents and reported that immediately after the high school transition (i.e., Fall of 9th grade), the students reported a significant increase in school liking. However, this positive trend did not continue, rather, it declined following a quadratic growth curve indicating it stabilized its trend by the 10th grade (Benner & Graham, 2009 p.365). This attitude change appears to illustrate the first half of the U-curve adjustment model, and our finding of the strong vantage sensitivity across the high school transition might have depicted such an initial euphoric adjustment.

Nonetheless, the finding of the vantage sensitivity model accentuated the highly sensitive adolescents’ disproportionate enhancement of well-being, because highly susceptible adolescents register external information more attentively than the less sensitive peers. Therefore, they might have been positively affected by the overall optimistic atmosphere of their peers. Such socioemotional adjustment indeed represents DST perspectives where individual differences in susceptibility moderates the effects of person x environment interaction. Furthermore, it may be possible that the U-curve adjustment is more evident for the highly sensitive adolescents across school transition, which implies higher crest yet deeper trough with their adjustment curve. Therefore, the critical implication for educational practitioners would be the importance of considering support strategies with the scope of adolescents’ differential susceptibility and its interaction effects across school transition.

Limitations

While this paper presented the first evidence of vantage sensitivity in the context of Japanese high school transition, several limitations need to be addressed for future advancement. First, all the measures used in this paper were obtained from students’ self-reports. Also, the
environmental measure was taken retrospectively through a newly developed scale, which showed a weak correlation with the outcome measure \( r = .27, p < .01 \). Given that discrepancies in the respondents’ rating data on personality development was pointed out (e.g., Costa, McCrae, & Löckenhoff, 2019), multi-informant assessments are necessary to resolve such issues. Second, although the participants of this study were randomly recruited through online survey across Japan (see sampling details Iimura & Taku, 2018), those who participated in this study might have done so because they had positive experiences. Hence, sampling bias needs to be considered as well. Therefore, it is necessary to replicate this study using other samples, including different nationalities, to make our findings more robust because this is the first attempt that has focused on the role of individual sensitivity in adjustment across the transition to high school. Third, while this study was conducted with a longitudinal design, the results are limited to the short time spans just before and after school transition. Follow-up studies may help us to better understand the role of differential susceptibility in school transition and, subsequently, socioemotional adjustment. Finally, it should be noted that the approaches we have used are rather exploratory and the evidence for the interaction is suggestive at best.

**Conclusion**

In this paper, we reported on two studies. Study 1 examined the psychometric properties of the J-HSCS and confirmed its validity. Study 2 investigated the role of SPS by utilizing Wideman’s competitive confirmatory approach to test whether the diathesis-stress or differential susceptibility model best describes students’ socioemotional adjustment across the high school transition. Interestingly, results indicated that neither the diathesis-stress model nor the differential susceptibility model sufficiently explained the data. Instead, a strong vantage sensitivity was revealed. That is, highly sensitive adolescents reported a greater increase in their well-being after the school transition, corresponding to their perceived environmental change, whilst peers with low sensitivity did not show such well-being enhancement. Although the evidence for the interaction is suggestive, this finding signifies adolescents’ susceptibility to environmental influences and the importance of considering individual differences in the context of a school transition.
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Footnote

1 Contrary to the diathesis-stress model, there is apparent individual susceptibility in response to the positive environment as illustrated in the better area of Figure 1. This conceptual expansion was recently introduced under the theoretical elaboration of the “vantage sensitivity” notion (Pluess & Belsky, 2013; Pluess, 2015; de Villiers et al., 2018), which represents the general propensity of some individuals to benefit from environmental advantages.

2 PANAS was measured at T1 because it was expected to be affected by the school transition; in contrast, BIS/BAS were measured at T2 because it is temperament and expected to be less susceptible to the transition.

3 Detailed information regarding the distribution of SPS as measured by the J-HSCS can be found at the Open Science Framework (https://osf.io/wkuz5/?view_only=5e9cbc6857de46448d3ac388a6a672d7).
### Table 1

**Means, Standard Deviations, and Bivariate Correlations of All Measures**

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<td>1.</td>
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<td>3.</td>
<td>HSC-EOE T1</td>
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<td>.37 **</td>
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<td>4.</td>
<td>HSC-EOE T2</td>
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<td>.80 **</td>
<td>.49 **</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>HSC-LST T1</td>
<td>4.38 (1.20)</td>
<td>.81 **</td>
<td>.38 **</td>
<td>.50 **</td>
<td>.29 **</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>6.</td>
<td>HSC-LST T2</td>
<td>4.33 (1.13)</td>
<td>.32 **</td>
<td>.81 **</td>
<td>.27 **</td>
<td>.54 **</td>
<td>.42 **</td>
<td>–</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>HSC-AES T1</td>
<td>4.94 (1.03)</td>
<td>.67 **</td>
<td>.23 **</td>
<td>.28 **</td>
<td>.07</td>
<td>.24 **</td>
<td>.00</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>HSC-AES T2</td>
<td>4.95 (0.89)</td>
<td>.28 **</td>
<td>.60 **</td>
<td>.05</td>
<td>.24 **</td>
<td>.09</td>
<td>.15 **</td>
<td>.48 **</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Well-Being T1</td>
<td>3.50 (1.04)</td>
<td>-1.12 *</td>
<td>-1.13 *</td>
<td>-2.66 **</td>
<td>-2.29 **</td>
<td>-1.11 *</td>
<td>-1.12 *</td>
<td>.09</td>
<td>.13 *</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Well-Being T2</td>
<td>3.89 (0.93)</td>
<td>-0.02</td>
<td>-0.05</td>
<td>-2.20 **</td>
<td>-2.25 **</td>
<td>-0.04</td>
<td>-1.12 *</td>
<td>.20 **</td>
<td>.29 **</td>
<td>.41 **</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>ΔWell-being</td>
<td>0.41 (0.88)</td>
<td>.10 *</td>
<td>.10</td>
<td>.09</td>
<td>.05</td>
<td>.06</td>
<td>.02</td>
<td>.06</td>
<td>.15 **</td>
<td>-.62 **</td>
<td>.48 **</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>PCSE T2</td>
<td>4.53 (0.87)</td>
<td>.04</td>
<td>.07</td>
<td>-.06</td>
<td>-.07</td>
<td>.00</td>
<td>-.03</td>
<td>.13 *</td>
<td>.28 **</td>
<td>.01</td>
<td>.31 **</td>
<td>.27 **</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>PA T1</td>
<td>3.30 (0.70)</td>
<td>-.01</td>
<td>-1.13 *</td>
<td>-1.18 **</td>
<td>-2.26 **</td>
<td>-0.09</td>
<td>-.19 **</td>
<td>.25 **</td>
<td>.19 **</td>
<td>.42 **</td>
<td>.33 **</td>
<td>-.17 **</td>
<td>.14 **</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>NA T1</td>
<td>2.87 (0.79)</td>
<td>.22 **</td>
<td>.26 **</td>
<td>.35 **</td>
<td>.33 **</td>
<td>.21 **</td>
<td>.21 **</td>
<td>-.06</td>
<td>.02</td>
<td>-.41 **</td>
<td>-.29 **</td>
<td>.18 **</td>
<td>-.06</td>
<td>-.04</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>BIS T2</td>
<td>2.60 (0.45)</td>
<td>.34 **</td>
<td>.47 **</td>
<td>.33 **</td>
<td>.51 **</td>
<td>.29 **</td>
<td>.36 **</td>
<td>.16 **</td>
<td>.18 **</td>
<td>-.13 *</td>
<td>-.21 **</td>
<td>-.06</td>
<td>-.12 *</td>
<td>-.11 *</td>
<td>.23 **</td>
<td>–</td>
</tr>
<tr>
<td>16.</td>
<td>BAS T2</td>
<td>5.02 (0.70)</td>
<td>.12 *</td>
<td>.14 *</td>
<td>-.01</td>
<td>-.04</td>
<td>-.02</td>
<td>-.01</td>
<td>.32 **</td>
<td>.39 **</td>
<td>.16 **</td>
<td>.37 **</td>
<td>.17 **</td>
<td>.28 **</td>
<td>.32 **</td>
<td>.00</td>
<td>.08</td>
</tr>
<tr>
<td>17.</td>
<td>Gender T1 (0 = boy, 1 = girl)</td>
<td>.14 **</td>
<td>.21 **</td>
<td>.09</td>
<td>.11 *</td>
<td>.06</td>
<td>.15 **</td>
<td>.17 **</td>
<td>.22 **</td>
<td>.00</td>
<td>.01</td>
<td>.00</td>
<td>-.06</td>
<td>.12 *</td>
<td>.13 **</td>
<td>.18 **</td>
<td>.09</td>
</tr>
</tbody>
</table>

**Note.** HSC = The Japanese version of the Highly Sensitive Child Scale for Adolescence; EOE = Ease of Excitation; LST = Low Sensitivity Threshold; AES = Aesthetic Sensitivity; ΔWell-being = latent change score for socioemotional well-being from before to after school transition; PCSE = 8-item Perceived Change in School Environment Scale; PA = Positive Affect; NA = Negative Affect; BIS = Behavioral Inhibition System; BAS = Behavioral Activation System; Bold values represent statistically significant results.

* *p < .05. ** *p < .01.
Table 2

**Standard Parameterized Regression for Changes in Socioemotional Well-Being**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Step 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff. (SE)</td>
<td>p</td>
<td>Coeff. (SE)</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>$B_0$</td>
<td>0.43 (0.05)</td>
<td>&lt;.001</td>
<td>0.43 (0.05)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>$B_1$</td>
<td>0.26 (0.06)</td>
<td>&lt;.001</td>
<td>0.26 (0.06)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>$B_2$</td>
<td>0.11 (0.07)</td>
<td>.085</td>
<td>0.12 (0.07)</td>
<td>.060</td>
<td></td>
</tr>
<tr>
<td>$B_3$</td>
<td>0.09 (0.07)</td>
<td>.246</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIC</td>
<td>788.27</td>
<td></td>
<td>792.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>773.52</td>
<td></td>
<td>774.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.07</td>
<td></td>
<td>0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$F$ (df)</td>
<td>11.80 (2, 292)</td>
<td>&lt;.001</td>
<td>8.32 (3, 291)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td></td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$F$ (df)</td>
<td>1.35 (1, 291)</td>
<td>.246</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. $B_0$ = intercept; $B_1$ = main effect of environment variable (i.e., perceived changes in school environment); $B_2$ = main effect of sensitivity variable (i.e., sensory-processing sensitivity); $B_3$ = interaction effect of the environment and sensitivity variables. BIC = Bayesian Information Criterion. AIC = Akaike Information Criterion. Coeff. = coefficient.*
**Table 3**

*Results of Alternative Regression Models for Changes in Socioemotional Well-being*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Differential Susceptibility</th>
<th></th>
<th>Diathesis-Stress</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strong: Model 1a</td>
<td>Weak: Model 1b</td>
<td>Strong: Model 2a</td>
<td>Weak: Model 2b</td>
</tr>
<tr>
<td></td>
<td>Coeff.</td>
<td>SE</td>
<td>p</td>
<td>Coeff.</td>
</tr>
<tr>
<td>$B_0$</td>
<td>-0.03</td>
<td>(0.28)</td>
<td>.898</td>
<td>.01</td>
</tr>
<tr>
<td>$B_1$</td>
<td>0.00</td>
<td>(-)</td>
<td>NA</td>
<td>-0.03</td>
</tr>
<tr>
<td>$C$</td>
<td><strong>2.86</strong></td>
<td><strong>(1.06)</strong></td>
<td>.007</td>
<td>3.03</td>
</tr>
<tr>
<td>$B_3$</td>
<td><strong>0.06</strong></td>
<td><strong>(0.01)</strong></td>
<td>&lt;.001</td>
<td>0.07</td>
</tr>
<tr>
<td>pseudo $R^2$</td>
<td>0.07</td>
<td>0.07</td>
<td>0.04</td>
<td>0.07</td>
</tr>
<tr>
<td>BIC</td>
<td>917.68</td>
<td>923.51</td>
<td>925.52</td>
<td>919.50</td>
</tr>
<tr>
<td>AIC</td>
<td>902.32</td>
<td>904.31</td>
<td>914.00</td>
<td>904.14</td>
</tr>
</tbody>
</table>

*Note.* $B_0$ = intercept representing the estimated $Y$ score (change in socioemotional well-being) on $C$ (crossover point); $B_1$ = slope for the low sensitivity group; $C$ = the point on $X_1$ (perceived change in the school environment), where the slopes for the high sensitivity group and low sensitivity group cross; $B_3$ = slope for the high sensitivity group; BIC = Bayesian Information Criterion; AIC = Akaike Information Criterion; Coeff. = coefficient; SE = standard error; NA = not available.

Values in bold are statistically significant parameters.

*Parameter fixed at reported value (SE is not applicable).*
### Table 4

**Vantage Sensitivity Model for Changes in Socioemotional Well-being**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Strong: Model 3a</th>
<th>Weak: Model 3b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff.</td>
<td>SE</td>
</tr>
<tr>
<td>$B_0$</td>
<td>-0.39 (0.16)</td>
<td>0.017</td>
</tr>
<tr>
<td>$B_1$</td>
<td>0.00</td>
<td>NA</td>
</tr>
<tr>
<td>$C$</td>
<td>1.00</td>
<td>NA</td>
</tr>
<tr>
<td>$B_3$</td>
<td>0.05 (0.01)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>pseudo $R^2$</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>BIC</td>
<td>914.17</td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>902.65</td>
<td></td>
</tr>
</tbody>
</table>

*Note. $B_0 =$ intercept representing the estimated $Y$ score (change in socioemotional well-being) on $C$ (crossover point); $B_1 =$ slope for the low sensitivity group; $C =$ the point on $X_1$ (perceived change in the school environment), where the slopes for the high sensitivity group and low sensitivity group cross; $B_3 =$ slope for the high sensitivity group; BIC = Bayesian Information Criterion; AIC = Akaike Information Criterion; Coeff. = coefficient; SE = standard error; NA = not available. Values in bold are statistically significant parameters.

* Parameter fixed at reported value (SE is not applicable).
Figure 1. Models displaying prototypical diathesis-stress and differential susceptibility. $X_1$ represents the predictor of environmental variable; $X_2$ represents the predictor of the susceptibility variable; $Y$ indicates the developmental outcome (i.e., dependent variable); and $C$ is the point on $X_1$ at which the slope for the highly sensitive person and non-highly sensitivity person cross.
Figure 2. Graphical illustration of the 3-factor model and the bifactor model in longitudinal confirmatory factor analysis. EOE = Ease of Excitation; LST = Low Sensory Threshold; AES = Aesthetic Sensitivity; HSC = general sensitivity factor. The values are, from left to right, the coefficients Time1 and Time2. The paths indicated by dashed lines fixed factor loadings at 1. Bifactor model was fitted better (CFI = 0.90, RMSEA = 0.07, SRMR = 0.04, BIC = 27624249, AIC = 27637220) than 3-factor model (CFI = 0.89, RMSEA = 0.06, SRMR = 0.04, BIC = 27637220, AIC = 27636382).
Figure 3. Histogram of latent change score in socioemotional well-being across the high school transition. The fit indices of latent change score model was CFI = 0.93, RMSEA = 0.09, SRMR = 0.06. *Mean* = 0.42, *SD* = 1.01.
Figure 4. Model displaying prototypical strong and weak models of diathesis-stress, differential susceptibility, and vantage sensitivity. The dots indicate a crossover point on the environment variable. While the strong model imposes the constraint that the slope for the low-sensitivity group is parallel to environmental quality, the weak model imposes no such constraint. This figure was adapted from Figure 1 in “Distinguishing differential susceptibility, diathesis-stress, and vantage sensitivity: Beyond the single gene and environment model.” by Jolicoeur-Martineau, A., Belsky, J., Szekely, E., Widaman, K. F., Pluess, M., Greenwood, C., & Wazana, A. 2020, Development and Psychopathology, 32, 73-83. doi: 10.1017/S0954579418001438. Copyright 2019 by Cambridge University Press. Reproduced with permission.
Figure 5. Sensory-processing sensitivity-x-perceived change in school environment interaction for difference in socioemotional well-being across high school transition. The median value of the environment variable (x axis) is 4 representing students’ perception of no change in environmental quality from junior high to high school. HSC indicates the distribution of the Highly Sensitive Child Scale scores.
Supplementary Materials


Shuhei Iimura, The University of Tokyo
Chieko Kibe, Ochanomizu University

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Table S1

*Comparison of Models in 3-Factor Structure of the Japanese Version of HSC scale*

<table>
<thead>
<tr>
<th>Model</th>
<th>BIC</th>
<th>AIC</th>
<th>$\chi^2$ (df)</th>
<th>$\Delta \chi^2$ (df)</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: configural invariance</td>
<td>27637221</td>
<td>27636382</td>
<td>142144 (82)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2: weak factorial invariance</td>
<td>27640436</td>
<td>27639691</td>
<td>145469 (90)</td>
<td>3324 (8)</td>
<td>***</td>
</tr>
<tr>
<td>3: strong factorial invariance</td>
<td>27640924</td>
<td>27640272</td>
<td>146066 (98)</td>
<td>597 (8)</td>
<td>***</td>
</tr>
<tr>
<td>4: strict factorial invariance</td>
<td>27647639</td>
<td>27647115</td>
<td>152931 (109)</td>
<td>6865 (11)</td>
<td>***</td>
</tr>
</tbody>
</table>

*Note.* Model 1 = invariant factor structure across time; Model 2 = Model 1 + invariant factor loadings across time; Model 3 = Model 2 + invariant intercepts across time; Model 4 = Model 3 + invariant unique factor variances across time; BIC = Bayesian Information Criterion; AIC = Akaike Information Criterion; NA = not available
### Table S2
Comparison of Models in Bifactor Structure of the Japanese Version of HSC scale

<table>
<thead>
<tr>
<th>Model</th>
<th>BIC</th>
<th>AIC</th>
<th>$\chi^2$ (df)</th>
<th>$\Delta\chi^2$ (df)</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: configural invariance</td>
<td>27624250</td>
<td>27623225</td>
<td>128955 (66)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2: weak factorial invariance</td>
<td>27627700</td>
<td>27626885</td>
<td>132651 (84)</td>
<td>3696 (18)</td>
<td>***</td>
</tr>
<tr>
<td>3: strong factorial invariance</td>
<td>27628203</td>
<td>27627469</td>
<td>133249 (91)</td>
<td>598 (7)</td>
<td>***</td>
</tr>
<tr>
<td>4: strict factorial invariance</td>
<td>27634924</td>
<td>27634318</td>
<td>140120 (102)</td>
<td>6871 (11)</td>
<td>***</td>
</tr>
</tbody>
</table>

*Note.* Model 1 = invariant factor structure across time; Model 2 = Model 1 + invariant factor loadings across time; Model 3 = Model 2 + invariant intercepts across time; Model 4 = Model 3 + invariant unique factor variances across time; BIC = Bayesian Information Criterion; AIC = Akaike Information Criterion; NA = not available
Table S3
Factor Structures, Factor Loadings, and Means and Standard Deviations of the Japanese Version of the Highly Sensitive Child Scale for Adolescence Across the Transition to High School

<table>
<thead>
<tr>
<th>Item</th>
<th>Time 1 / Time 2</th>
<th>Time 1 / Time 2</th>
<th>Time 1 / Time 2</th>
<th>Time 1 / Time 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. I am annoyed when people try to get me to do too many things at once.</td>
<td>.67*** / .67***</td>
<td>4.82 (1.35)</td>
<td>4.80 (1.25)</td>
<td></td>
</tr>
<tr>
<td>8. I find it unpleasant to have a lot going on at once.</td>
<td>.65*** / .65***</td>
<td>4.40 (1.30)</td>
<td>4.50 (1.18)</td>
<td></td>
</tr>
<tr>
<td>12. When someone observes me, I get nervous. This makes me perform worse than normal.</td>
<td>.61*** / .61***</td>
<td>4.17 (1.46)</td>
<td>4.22 (1.22)</td>
<td></td>
</tr>
<tr>
<td>4. I get nervous when I have to do a lot in little time.</td>
<td>.53*** / .53***</td>
<td>4.17 (1.46)</td>
<td>4.22 (1.22)</td>
<td></td>
</tr>
<tr>
<td>9. I don’t like it when things change in my life.</td>
<td>.40*** / .40***</td>
<td>4.14 (1.25)</td>
<td>4.17 (1.15)</td>
<td></td>
</tr>
<tr>
<td>11. I don’t like loud noises.</td>
<td>.60*** / .50***</td>
<td>4.62 (1.36)</td>
<td>4.61 (1.35)</td>
<td></td>
</tr>
<tr>
<td>2. Loud noises make me feel uncomfortable.</td>
<td>.58*** / .58***</td>
<td>4.15 (1.49)</td>
<td>4.05 (1.29)</td>
<td></td>
</tr>
<tr>
<td>5. Some music can make me really happy.</td>
<td>.70*** / .68***</td>
<td>5.21 (1.49)</td>
<td>5.27 (1.38)</td>
<td></td>
</tr>
<tr>
<td>10. I love nice tastes.</td>
<td>.64*** / .65***</td>
<td>5.61 (1.49)</td>
<td>5.60 (1.28)</td>
<td></td>
</tr>
<tr>
<td>3. I love nice smells.</td>
<td>.49*** / .50***</td>
<td>4.69 (1.43)</td>
<td>4.70 (1.28)</td>
<td></td>
</tr>
<tr>
<td>1. I notice it when small things have changed in my environment.</td>
<td>.32*** / .20***</td>
<td>4.24 (1.25)</td>
<td>4.22 (1.05)</td>
<td></td>
</tr>
</tbody>
</table>

Correlation between factors

<table>
<thead>
<tr>
<th>F1</th>
<th>—</th>
<th>F2</th>
<th>F3</th>
<th>—</th>
<th>—</th>
</tr>
</thead>
<tbody>
<tr>
<td>.73*** / .73***</td>
<td>—</td>
<td>.34*** / .34***</td>
<td>.24*** / .20***</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

Note. EOE = Ease of Excitation; LST = Low Sensory Threshold; AES = Aesthetic Sensitivity. *** p < .001
Table S4

*Factor Structure of the Perceived Changes in School Environment Scale*

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor loadings</th>
<th>$h^2$</th>
<th>$M$ (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Classroom climate</td>
<td>0.89</td>
<td>0.78</td>
<td>4.74 (1.20)</td>
</tr>
<tr>
<td>1. School climate</td>
<td>0.83</td>
<td>0.68</td>
<td>4.88 (1.21)</td>
</tr>
<tr>
<td>6. Relationship with friends</td>
<td>0.79</td>
<td>0.62</td>
<td>4.61 (1.16)</td>
</tr>
<tr>
<td>3. Number of students in the whole school</td>
<td>0.71</td>
<td>0.51</td>
<td>4.76 (1.23)</td>
</tr>
<tr>
<td>5. Relationship with teachers</td>
<td>0.70</td>
<td>0.49</td>
<td>4.33 (1.06)</td>
</tr>
<tr>
<td>4. Number of students in the classroom</td>
<td>0.66</td>
<td>0.44</td>
<td>4.54 (1.08)</td>
</tr>
<tr>
<td>11. School rules</td>
<td>0.53</td>
<td>0.28</td>
<td>4.42 (1.36)</td>
</tr>
<tr>
<td>8. Difficulty of class</td>
<td>0.35</td>
<td>0.12</td>
<td>3.93 (1.37)</td>
</tr>
</tbody>
</table>

*Note.* $h^2$ = communality; deleted items were: “Amount of homework,” “Commuting time,” and “Method of transportation to school” because of low factor loadings (<.32); The instruction of the scale was “when you compare your experiences in junior high school and high school, how do you consider the changes listed below?”
Figure S1. Path diagram showing latent change score model. The “LCS” represents a latent construct of the change score. Variables, “it1\textsubscript{tn}” to “it5\textsubscript{tn},” indicate socioemotional well-being item scores observed at two-time points. The arrows with “a” to “j” indicate coefficients at T1 and T2, constraining to be equal over time. The path coefficients from T1 to T2 and from LCS to T2 were fixed as 1.