



# Sensory-processing sensitivity moderates the association between childhood experiences and adult life satisfaction



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## ABSTRACT

There are few studies testing the differential susceptibility hypothesis (DSH: hypothesizing that some individuals are more responsive to both positive and negative experiences) with adult personality traits. The current study examined the DSH by investigating the moderating effect of sensory-processing sensitivity (SPS) on childhood experiences and life satisfaction. A total of 185 adults completed measures of SPS, positive/negative childhood experiences and life satisfaction. SPS did moderate the association between childhood experiences and life satisfaction. Simple slopes analysis compared those reporting high and low SPS ( $\pm 1$  SD) and revealed that the difference was observed only for those who reported negative childhood experiences; with the high SPS group reporting lower life satisfaction. There was no difference observed in those reporting positive childhood experiences, which supported a diathesis-stress model rather than the DSH.

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## 1. Introduction

The quest to identify the precursors and predictors of adult mental wellbeing is an important one. In the most general terms, life events – positive and negative – as well as inherited factors are likely to play an influential role in determining and modifying mental wellbeing throughout the lifespan. It is no surprise then that gene-by-environment ( $G \times E$ ) research designs are commonly used to investigate research questions in this field (Bakermans-Kranenburg & van IJzendoorn, 2014). While genes and life events can jointly, as well as independently affect mental wellbeing, a growing body of research is emerging that shows that these effects may also be observed in trait-by-environment ( $T \times E$ ) designs (Aron, Aron, & Jagiellowicz, 2012). In other words, individual differences in personality traits can influence the impact of different life events on a person's wellbeing.

Evidence from evolutionary biology suggests that a fundamental personality trait that occurs across nonhuman and human species involves individual differences in responsiveness, reactivity, flexibility and sensitivity to the environment (Wolf, Van Doorn, & Weissing, 2008). There is a growing consensus among personality researchers that “a fundamental factor structuring [animal] personality differences is the degree to which individual behaviour is guided by environmental stimuli” (p. 15,835). Aron and colleagues have conceptualized this trait

in humans as relating to *sensory-processing sensitivity* (SPS: Aron & Aron, 1997; Aron et al., 2012), which they see as being a reflection of one of two strategies that has evolved in many species: a strategy of either responding more to the environment or responding less. High SPS has been compared to the personality trait *introversion* (Eysenck, 1981) and the *behavioural inhibition system* (Gray, 1981). The responsive strategy, or high SPS, is characterized by a tendency to “pause to check” in novel situations, greater sensitivity to subtle stimuli, and the engagement of deeper cognitive processing strategies for employing coping actions, all of which is driven by heightened emotional reactivity, both positive and negative (Aron & Aron, 1997; 2012). Thus, some individuals are simply more responsive and reactive to stimulation from the environment than others.

This assumption relates to the *differential susceptibility hypothesis* (DSH: Belsky, 1997), which states that there are some inherent characteristics which make individuals more responsive to their environment, be that positive or negative. In combination with negative stressful experiences, individuals who possess these characteristics are likely to become overwhelmed and display poor outcomes, whereas these same individuals are likely to flourish under positive and enriching experiences. While the non-responsive characteristics may be beneficial to buffer against the effects of negative environmental stress – the responsive characteristics may provide an advantage in positive environments. Belsky and Pluess (2009) argue that many of these responsive characteristics have been misrepresented in the literature as risk alleles, or diathesis-stress models (Zuckerman, 1999) – predisposing individuals to mental disorders – because previous research has failed to assess the interaction between individual differences and

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positive environments, which is a direction for future research. If certain characteristics are able to show both a disadvantage in combination with negative experiences and an advantage in combination with positive experiences, then they should be considered a plasticity factor – rather than a risk.

There has been some evidence to suggest that SPS is a plasticity factor. Using their measure of SPS – the Highly Sensitive Person Scale (HSPS) (Aron & Aron, 1997) – Aron, Aron, and Davies (2005) were able to show that high SPS university students reported a greater increase in negative affectivity after a difficult scholastic test, whereas they also showed a greater reduction in negative affectivity after an easy test – compared to their low SPS colleagues. In another study, high SPS children – as measured by the HSPS for children (Pleuss & Boniwell, 2015) – showed advantageous outcomes in terms of reduced depression symptoms, while their low SPS counterparts showed no improvement (Pleuss & Boniwell, 2015). This finding was stable at 6 and 12 month follow-up assessments. The authors suggested that a possible reason for this advantage was due to the nature of high SPS, which is characterized by a sensitive nervous system and the processing of information more deeply, which may have led to greater internalization of the intervention. This is supported by studies which find that SPS is related to cognitive advantages, such as greater detection of subtle changes in visual scenes (Jagiellowicz et al., 2011) and faster reaction times and fewer errors in a visual detection task (Gerstenberg, 2012).

Despite this evidence suggesting that SPS may be a plasticity factor, a number of studies have documented negative associations with SPS (Ahadi & Basharpour, 2010; Liss, Timmel, Baxley, & Killingsworth, 2005). In a cross-sectional study assessing parental bonding an interaction was found between parental care and SPS; as high SPS individuals reported more depression symptoms than low SPS individuals when care was low, but the two groups did not differ in depression symptoms when care was high, supporting a diathesis-stress model (Liss et al., 2005). This finding suggests that SPS is a risk factor, especially since a correlation was found between SPS and depression ( $r = .22, p < .001$ ). However, the authors failed to assess any positive outcomes that could have differentiated high and low SPS individuals under positive experiences. This is a major flaw in the literature, which has not provided a balanced view of positive and negative outcomes and biases certain traits as being risk factors rather than potential plasticity factors (Belsky & Pleuss, 2009; Manuck, 2010).

Another potential reason that SPS has been associated with negative outcomes is that the HSPS may be primarily measuring negative reactivity in response to overstimulation (Aron et al., 2012). The 27-item scale is replete with items concerning being “overwhelmed... bothered... made uncomfortable... annoyed” by different types of stimulation. A psychometric evaluation of the scale has found a clear three-factor structure (Smolewska, McCabe, & Woody, 2006) consisting of i) *Ease of Excitation* (EOE; e.g. “do you find it unpleasant to have a lot going on at once?”), ii) *Low Sensory Threshold* (LST; e.g. “are you made uncomfortable by loud noises?”), and iii) *Aesthetic Sensitivity* (AES; e.g. “do you seem to be aware of the subtleties in your environment?”). The former two were found to correlate highly with *Neuroticism*, while the latter was found to correlate most with *Openness to Experience* (NEO-FFI; Costa and MacCrae, 1992), which is the personality dimension most associated with aesthetic sensitivity, attentiveness to inner feelings and intellectual curiosity. Despite finding evidence for a three-factor structure of the HSPS, it was concluded that high intercorrelations between factors and the overall scale suggested that it was an adequate measure of the higher-order trait of SPS (Smolewska et al., 2006). As yet, there has not been a research study to investigate possible plasticity effects for these factors individually, despite different results being shown between the factors, such as the correlations with different personality traits (Smolewska et al., 2006) and performance on a cognitive task (Gerstenberg, 2012).

The aims of the current study were threefold – i) to assess a continuous predictor and outcome variable that would be able to differentiate

positive and negative extremes, which would correct for previous studies that failed to do so (Belsky & Pleuss, 2009; Liss et al., 2005), ii) to assess possible plasticity effects for the three factors within SPS (Smolewska et al., 2006), and iii) to use a heterogeneous adult community sample (Aron et al., 2005). In this study, we investigated whether SPS would moderate the association between childhood experiences (positive & negative) and current life satisfaction. We hypothesized that high SPS individuals would show both the best and worst outcomes relative to their childhood experiences. We had no clear hypotheses for whether the three factors would interact differently with childhood experiences.

## 2. Method

### 2.1. Participants & procedure

A total of 185 participants (67% female) responded to the study through a website that had been advertised at the University of Essex and the University of Oxford. Participants were fairly heterogeneous with regard to age, which ranged from 16–68 ( $M = 31, SD = 10.91$ ). Participants were all volunteers and were not paid for participation. Participants who responded to the advertisement were directed to a website that displayed a participant information sheet, which explained the nature of the study, including the time it would take and information about their confidentiality and right to withdraw at any time. Participants agreed to take part by clicking ‘next’, which directed them to the Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985), followed by the HSPS (Aron & Aron, 1997) and finally the Risky Families Questionnaires (RF-Q; Taylor et al., 2006). After completing all of the questionnaires, a debriefing page was shown, which explained the nature of the study and provided contact information.

### 2.2. Measures

#### 2.2.1. The Satisfaction with Life Scale

The SWLS (Diener et al., 1985) was the first questionnaire shown to participants completing the online study. It was shown first in order to reduce the risk of the outcome variable being affected by demand characteristics or priming effects from the other measures. The SWLS is a 5-item measure of global life satisfaction, which asks respondents to rate how much they agree with each statement using a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*). High numbers reflect high levels of life satisfaction. Examples of the statements include “In most ways my life is close to ideal” and “I am satisfied with my life”. It does not assess separate domains of life satisfaction, but allows respondents to give weight to these as they choose. The SWLS is unidimensional and shows good concurrent validity, as well as good reliability, as it has a two-month test–retest correlation of .87 (Diener et al., 1985).

#### 2.2.2. The Highly Sensitive Person Scale

The HSPS (Aron & Aron, 1997) was the second measure shown to participants. It is a 27-item questionnaire, with questions such as, “Are you made uncomfortable by loud noises?” and “Do other people's moods affect you?” Participants are asked to rate each statement using a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Aron and Aron (1997) developed the scale over a series of qualitative and quantitative investigations and found good internal consistency (alphas) for the final modified version of between .87 and .85. They also found that the HSPS was unidimensional, however more recently different authors found a three-factor structure consisting of Ease of Excitation (EOE), Low Sensory Threshold (LST) and Aesthetic Sensitivity (AES), yet they concluded that the HSPS was an adequate overall measure of the higher-order construct SPS (Smolewska et al., 2006).<sup>1</sup>

<sup>1</sup> Our principal component analysis also supported this three-factor structure, which can be seen in Appendix A.

### 2.2.3. The Risky Families Questionnaire

The RF-Q (Taylor et al., 2006) was used to measure childhood experiences related to interactions with a primary caregiver. It was developed from the adverse childhood experiences study (Felitti et al., 1998), but was created to represent both positive and negative experiences. It is an 11-item measure, with questions, such as “How often did a parent or guardian make you feel loved and cared for?” and “How often did a parent or guardian swear at you, insult you or put you down?” Participants were asked to rate each question using a 5-point scale from 1 (*never*) to 5 (*most of the time*). High numbers reflect positive childhood experiences, while low numbers reflect negative childhood experiences. This questionnaire has been validated against clinical interviews, and demonstrates high agreement and reliability (Taylor, Lerner, Sage, Lehman, & Seeman, 2004) and internal consistency at .86 (Taylor et al., 2006).

## 3. Results

We conducted some preliminary analyses including correlations between variables, a check for normal distributions, an assessment of reliability for each scale (Cronbach's alpha), as well as a factor analysis of the 27-item HSPS. Correlations, means, standard deviations, and Cronbach's alphas are shown in Table 1. All variables displayed a fairly normal distribution, except for childhood experiences, which showed a negative skew, indicating that the majority of the sample reported positive childhood experiences. There was, however, sufficient variability to allow for the investigation of negative childhood experiences. We also conducted a principal component analysis with varimax rotation to substantiate the three-factor model of the HSPS found by Smolewska et al. (2006). We found a similar three-factor structure, with seven items loading onto LST, ten items loading onto EOE, and four items loading onto AES (21 out of the 27 items from the HSPS), which accounted for 40% of variance. Individual items were retained as indicators of a component if their loading on that component was greater than .30. These results should be considered valid since the items relating to each component were largely identical to the previous authors; however our version of LST and EOE had two new items from the HSPS, whereas no items loaded onto a different factor, e.g. no items from their EOE appeared in our version of LST. These results are shown in Appendix A.

In order to investigate the effects of SPS and childhood experiences on current life satisfaction we conducted a moderated regression. After centering SPS and childhood experiences and computing the SPS-by-experiences interaction term (Aiken & West, 1991), the two predictors and interaction term were entered into a simultaneous regression model. Results indicated that positive childhood experiences ( $b = .567$ ,  $SE_b = .107$ ,  $\beta = .354$ ,  $p < .001$ ) and low SPS ( $b = -.389$ ,  $SE_b = .120$ ,  $\beta = -.215$ ,  $p = .001$ ) were both associated with higher life satisfaction. The interaction between childhood

experiences and SPS was also significant ( $b = .250$ ,  $SE_b = .117$ ,  $\beta = .140$ ,  $p = .033$ ) suggesting that the effect of childhood experiences was moderated by different levels of the trait SPS. We then conducted simple slopes analysis using the standard method for testing the interaction of two continuous predictors (Aiken & West, 1991). High SPS was represented by 1 SD above the mean and low SPS was represented by 1 SD below the mean. The effect of childhood experiences was significant for both high SPS individuals,  $\beta = .77$ ,  $t(181) = 5.82$ ,  $p < .001$ , and low SPS individuals,  $\beta = .36$ ,  $t(181) = 2.41$ ,  $p = .017$ . However, as can be seen from the standardized slope coefficients, the effect of childhood experiences on life satisfaction was significantly stronger for high SPS individuals, as predicted by a diathesis-stress model. An interaction plot of these effects can be found in Fig. 1. We then conducted a further simple slopes analysis with childhood experiences as the moderator to probe these findings, which revealed a significant relationship between SPS and life satisfaction only for those reporting negative childhood experiences,  $\beta = -.62$ ,  $t(181) = -4.01$ ,  $p < .001$ , with no significant relationship between SPS and life satisfaction for those reporting positive childhood experiences,  $\beta = -.16$ ,  $t(181) = -0.97$ ,  $p = .332$ . Thus, high SPS individuals reported lower life satisfaction compared to low SPS individuals only if childhood experiences had been negative. No significant differences in current life satisfaction were apparent between low and high SPS individuals if childhood experiences had been positive. These results show that while high SPS individuals were more affected by negative experiences they did not benefit more from positive experiences.

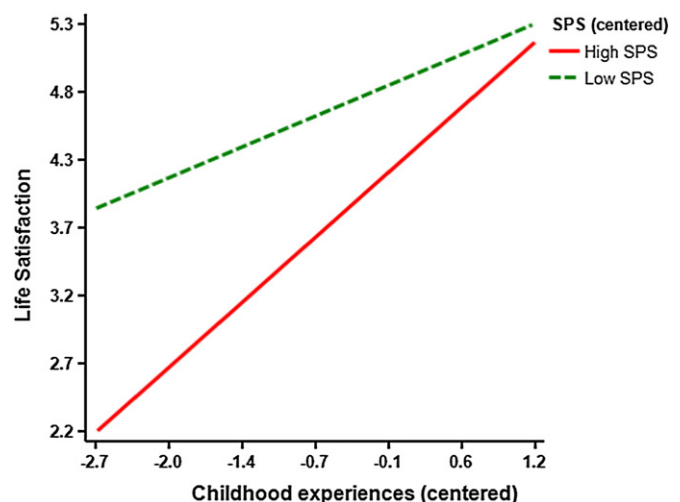
In order to assess whether these interactive results would vary across the three factors within SPS (EOE, LST, AES) we conducted three separate regression models with each of the factors entered as a moderator variable. No interaction was found between childhood experiences and AES, as there were no differential results found between high and low AES individuals, suggesting that it is neither a risk nor plasticity factor. However, similar effects were found for LST and EOE, with the interaction between childhood experiences and EOE ( $b = .234$ ,  $SE_b = .097$ ,  $\beta = .153$ ,  $p = .017$ ) being more significant than that of childhood experiences and SPS, suggesting that the diathesis within SPS comes mainly from the factor EOE. Simple slopes analysis revealed that high EOE (+1SD) individuals were significantly affected by childhood experiences,  $\beta = .77$ ,  $t(181) = 5.82$ ,  $p < .001$ , whereas low EOE (−1SD) individuals were not significantly affected by childhood experiences,  $\beta = .27$ ,  $t(181) = 1.74$ ,  $p = .08$ . These result

**Table 1**  
Summary of intercorrelations, means and standard deviations for all measures.

	1	2	3	4	5	M	SD	Cronbach's $\alpha$
1 SWLS						4.50	1.45	.89
2 RF-Q	.43*					3.77	.91	.89
3 HSPS	−.31*	−.23*				4.48	.81	.87
4 LST	−.22*	−.27*	.86*			3.91	1.25	.83
5 EOE	−.40*	−.24*	.85*	.60*		4.52	1.03	.82
6 AES	−.04	−.08	.51*	.32*	.24*	5.18	1.04	.74

Note: The Satisfaction with Life Scale (SWLS; Diener et al., 1985), the Risky Families Questionnaire (RF-Q; Taylor et al., 2006), the Highly Sensitive Person Scale (HSPS; Aron & Aron, 1997); Low Sensory Threshold (LST), Ease of Excitation (EOE), Aesthetic Sensitivity (AES).

\*  $p < .01$ .



**Fig. 1.** Simple slopes for moderated regression of SPS (1 SD above and below the mean) and childhood experiences interaction predicting life satisfaction.



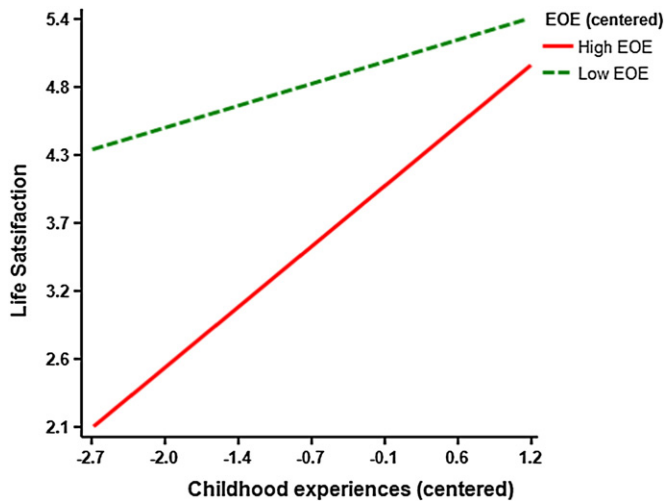


Fig. 2. Simple slopes for moderated regression of EOE (1 SD above and below the mean) and childhood experiences interaction predicting life satisfaction.

are shown in Fig. 2. This finding further corroborates the evidence that the diathesis within SPS is largely driven through the factor EOE.

#### 4. Discussion

In this study we assessed whether the personality trait of sensory processing sensitivity (SPS) moderates the association between childhood experiences and life satisfaction. The results revealed that high SPS individuals were more affected by negative childhood experiences than low SPS individuals in terms of their levels of adult life satisfaction, providing partial support for our hypothesis. However, no differential effects under positive childhood experiences were found for high and low SPS, which is not consistent with the differential susceptibility model (Belsky, 1997), but supported a diathesis-stress model (Zuckerman, 1999).

More detailed analyses of the three factors underlying SPS found that the two factors that relate to neuroticism (Smolewska et al., 2006) – LST and EOE – produced the same significant interaction and supported a diathesis-stress model. EOE was the factor that seemed to be primarily driving the interactive results in our data indicating that the diathesis within SPS comes from items clustered around EOE (see Appendix A). This conclusion is further supported by the strong negative correlation found between EOE and life satisfaction ( $r = -.40$ ,  $p < .001$ ). In contrast, the factor AES was not correlated with life satisfaction and did not produce any interactive results with childhood experiences, suggesting that it is neither a risk nor plasticity factor. This is supported by a previous study, which found that EOE and LST were related to symptoms of autism, anxiety and depression, whereas AES was related to attention to detail and anxiety, but not depression (Liss, Mailloux, & Erchull, 2008).

We failed to support the notion that SPS is a plasticity trait. It is possible that SPS is primarily a risk factor and that high SPS individuals are not differentially sensitive to highly positive life experiences. Or it could be that negative childhood experiences cause individuals to become more sensitive, as measured by the HSPS. However, it is also possible that our study was underpowered to detect a differential susceptibility effect. For instance, in a recent review of  $G \times E$  studies (Bakermans-Kranenburg & van IJzendoorn, 2014) it has been argued that correlational designs are underpowered for at least three reasons: i) the skewed distribution of experiences with most people reporting positive childhood experiences, which was also the case in the current study, ii) The underlying correlation between life experiences and SPS ( $r_{TE}$ ), as high SPS

individuals are more likely to report negative childhood experiences, and iii) measurement error, as childhood experiences were assessed by self-report and retrospectively, which may not have been accurate. All of these are factors that are likely to have affected the current results. Future research is needed to induce experimental manipulations of both negative and positive experiences, to correct for the problems discussed. This would require a more elaborate research design, but would need fewer participants, have higher statistical power, and may well allow differential susceptibility effects to emerge. A recent study found that high SPS children were the only ones to respond positively to a school-based mood intervention, suggesting greater internalization of coping strategies (Pleuss & Boniwell, 2015).

It is important to note, however, that SPS has been consistently associated with negative outcomes (Ahadi & Basharpour, 2010; Aron & Aron, 1997; Aron et al., 2005; Liss et al., 2005) and therefore may not be an important factor for higher levels of mental wellbeing. This could be explained by the fact that the HSPS is replete with items measuring affectively negative reactions, such as being overwhelmed, and may therefore measure mostly susceptibility to negative experiences, because susceptibility to positive experiences is not represented in the scale. Therefore, it is important to look for different individual measures of reactivity to the environment, which might be more balanced. Differential susceptibility theory is informed by an evolutionary perspective, which assumes that any trait that is widespread in the population must confer some adaptive advantage, or else it would be naturally selected out of the population (Belsky & Pleuss, 2013). There is no reason to think that self-reported wellbeing is the only adaptive outcome associated with SPS. We should now look towards other outcomes of interest, such as intellectual capabilities and cognitive biases, which are related to mental wellbeing. Previous research has shown that high SPS individuals perform better at cognitive tasks (Gerstenberg, 2012; Jagiellowicz et al., 2011) and respond better to interventions (Pleuss & Boniwell, 2015), therefore we might assume that these individuals learn at a faster rate. If this is the case then they should show some advantage in terms of responding to interventions, such as therapy or cognitive bias modification (CBM). Individual differences predicting responding to treatment is a growing new field (Beevers & McGeary, 2012). One such study found that carriers of the low expression serotonin transporter gene (often considered to be a risk allele) are quicker to develop both negative and positive biases in attention (supporting differential susceptibility) relative to those who carry the long allele (Fox, Zougkou, Ridgewell, & Garner, 2011). More research is needed to assess trait variability in predicting responding to interventions.

To conclude, we found no evidence of differential susceptibility when assessing the moderation of SPS on childhood experiences and life satisfaction. This may have been due to the fact that we used a self-report measure of childhood experiences, which is problematic due to skewed distribution and reporting bias (Bakermans-Kranenburg & van IJzendoorn, 2014). Future studies should assess how high and low SPS individuals respond to a positive and negative experimental manipulation (Pleuss & Boniwell, 2015), which would provide a more powerful research design to find differential susceptibility effects. However, it should be noted that SPS has been consistently related to lower wellbeing, therefore we should also aim to find new phenotypes that produce “for better and for worse” effects, which can match the findings from genotypic research (Belsky & Pleuss, 2013). Therefore, more work is needed to understand how life events and inherited factors interact to produce the wide array of mental outcomes that are present in the population.

#### Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## Appendix A. Principal component analysis with VARIMAX rotation (pattern matrix): component loadings, alphas and mean inter-item correlations for the HSPS (N = 185)

Item	Components	LST	EOE	AES
25	Are you bothered by intense stimuli, like loud noises or chaotic scenes? (LST)	0.77		
7	Are you easily overwhelmed by things like bright lights, strong smells, coarse fabrics, or sirens close by? (LST)	0.76		
9	Are you made uncomfortable by loud noises? (LST)	0.72		
1	Are you easily overwhelmed by strong sensory input? (new)	0.61		
18	Do you make a point to avoid violent movies and TV shows? (LST)	0.58		
19	Do you become unpleasantly aroused when a lot is going on around you? (LST)	0.57		
13	Do you startle easily? (new)	0.42		
23	Do you find it unpleasant to have a lot going on at once? (EOE)		0.71	
16	Are you annoyed when people try to get you to do too many things at once? (EOE)		0.67	
5	Do you find yourself needing to withdraw during busy days, into bed or into a darkened room or any place where you can have some privacy and relief from stimulation? (new)		0.63	
21	Do changes in your life shake you up? (EOE)		0.62	
14	Do you get rattled when you have a lot to do in a short amount of time? (EOE)		0.61	
11	Does your nervous system sometimes feel so frazzled that you just have to go off by yourself? (new)		0.58	
20	Does being very hungry create a strong reaction in you, disrupting your concentration and mood? (EOE)		0.37	
3	Do other people's moods affect you? (EOE)		0.41	
26	When you must compete or be observed while performing a task, do you become so nervous or shaky that you do much worse than you would otherwise? (EOE)		0.44	
24	Do you make it a high priority to arrange your life to avoid upsetting or overwhelming situations? (EOE)		0.34	
10	Are you deeply moved by the arts or music? (AES)			0.79
22	Do you notice and enjoy delicate or fine scents, tastes, sounds, works of art? (AES)			0.76
2	Do you seem to be aware of subtleties in your environment? (AES)			0.66
8	Do you have a rich complex inner life? (AES)			0.63
Coefficient alpha		0.83	0.82	0.74
Mean inter-item correlation		0.63	0.51	0.71

Note: Low Sensory Threshold (LST), Ease of Excitation (EOE) and Aesthetic Sensitivity (AES) are factors from the 27-item Highly Sensitive Person Scale (HSPS: Aron & Aron, 1997).

( ) after each component indicates which factor that item loaded onto from the factor analysis of Smolewska et al. (2006), but (new) indicates an item from the HSPS that didn't load onto one of their factors.

## Appendix B. Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.paid.2015.07.020>.

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