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The Pathway from Sensory Processing Sensitivity to Physical Health: Stress as a Mediator

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Abstract

Sensory processing sensitivity (SPS) has been proposed as an innate trait associated with differences in the processing and reactivity to internal and external stimuli. To date, there has been limited research on the association between SPS and physical health and only one study examining mediators of this relationship. The aim of this study was to examine psychological stress as a mediator of the SPS-health relationship in a predominately Hispanic sample of 923 adult undergraduates attending university between 2018 and 2020. We identified three SPS factors, each of which were associated with poorer physical health as assessed through two psychometrically validated self-report measures of physical symptoms. Additionally, we demonstrate that this relationship is mediated by perceived stress, suggesting that treatments focused on stress reduction might be an avenue through which the impact of SPS on physical health can be modified.

Keywords: sensory processing sensitivity, stress, physical symptoms, physical health, stress reduction

The Pathway from Sensory Processing Sensitivity to Physical Health: Stress as a Mediator

Sensory processing sensitivity (SPS) is proposed to be an innate, heritable, trait associated with individual differences in processing of stimuli, resulting in a greater reactivity to both internal and external stimuli (Acevedo et al., 2014; Aron & Aron, 1997). Those with higher overall SPS have been found to be more emotionally reactive, empathetic, easily overstimulated, and possess greater environmental awareness due to the increased depth of information processing that occurs. This trait has been framed within an evolutionary biologic model of general responsivity or sensitivity that occurs in a minority of individuals across species, proposing that it may provide survival advantages that outweigh the potential negative biological costs (Aron et al., 2012). SPS was conceptualized by Aron & Aron (1997) who, through a series of studies, developed the Highly Sensitive Person Scale (HSPS). Although the measure is based on heterogenous items (such as ‘‘*Are you easily overwhelmed by strong sensory input?*’’, ‘‘*Are you deeply moved by the arts or music?*’’, and ‘‘*Do you tend to be more sensitive to pain?*’’), Aron & Aron provided evidence that SPS is best viewed as a unidimensional construct. However, as identified below, subsequent research has proposed that a multidimensional model of SPS may be more appropriate.

Research on SPS and Physical Health using Unidimensional and Multidimensional SPS Models

Despite the proposed survival advantages of greater SPS (Aron et al., 2012), research has found it to be related to a number of negative outcomes, including poorer physical health (Greven et al., 2019). The first study to examine the association between SPS and health demonstrated that SPS was a more powerful predictor of self-reported poor health than was psychological stress (Benham, 2006). In that study, based on two separate health measures, the Pennebaker Inventory of Limbic Languidness (PILL; Pennebaker, 1982) and the Cohen-

Hoberman Inventory of Physical Symptoms (CHIPS; Cohen & Hoberman, 1983), SPS independently predicted 16-18% of the variance in self-reported physical symptoms. Scores from both of these measures are based on a compendium of varying physical symptoms, with many similar items across the two measures (e.g., dizziness, constipation). However, because the PILL instructs individuals to indicate the *frequency* with which they had experienced the symptoms, while the CHIPS asks individuals to rate the *extent to which they had been recently bothered* by the symptoms, their simultaneous use allowed for a slightly broader perspective on the generalizability of the SPS-health relationship.

Benham's (2006) study was based on a single (total) score of SPS, following the unidimensional model proposed by the authors of the HSPS. Around the same time that the Benham study was published, however, Smolewska et al. (2006) published the first challenge to this unidimensional model, proposing that SPS might be better understood as multidimensional in nature. Their factor analysis resulted in a three-factor model that divided SPS into separate, but correlated, components: Ease of Excitation (EOE; related to becoming mentally overwhelmed by external and internal demands, such as being startled easily), Low Sensory Threshold (LST; related to unpleasant sensory arousal to external stimuli, such as being overwhelmed by bright lights or strong smells), and Aesthetic Sensitivity (AES; related to aesthetic awareness, such as being deeply moved by the arts or music). As a result of this, many subsequent studies have examined SPS as a multidimensional construct, some simply relying on Smolewska et al.'s (2006) three-factor scoring[1] (e.g., Ahadi & Basharpoor, 2010) and others based on independent factor analyses. Multifactorial models of SPS have ranged from two to five factors (e.g., Montoya-Perez et al., 2019; Smolewska et al., 2006; Sengul-Inal, 2017; May, 2020). It is likely that this variability in multidimensional structure is due in

[1] It's worth noting that HSP item 5 was incorrectly listed under AES in the Smolewska et al. (2006) article, when it actually loaded on LST (K. Smolewska, personal communication, July 7, 2007), introducing additional error for those who might rely solely on the original article for their factor scoring.

part to the varying approaches used by researchers in their factor analyses, including inconsistency in the criteria used and options selected along the multiple steps in analysis. There is also variability in the populations studied, and it is interesting to note that the large majority of studies demonstrating four- or five-factor solutions appear to be based on translated versions of the SPS measure (e.g., Sengul-Inal, 2017; Chacon, 2021), or on administration of the original scale to participants whose home-language was not English (May, 2020). Additionally, as indicated by Smith et al., (2019) in their review of factor structure analyses conducted on the measure between 1997 and 2017, a number of the studies appear to be underpowered for factor analysis, with insufficiently large sample sizes. Based on their examination of 21 articles, the authors concluded that the unidimensional and the three-factor models were the ones best supported by evidence.

Although there have been a limited number of studies examining the SPS-health relationship since Benham's initial investigation, the majority of these studies have taken the additional step of considering SPS as potentially multidimensional in nature. In a study of 180 college students in Iran, Ahadi and Basharpoor (2010) relied on Smolewska et al.'s (2006) existing component scoring and found that EOE and LST (but not AES) were positively correlated with physical symptoms. The measure of symptoms was based on a subfactor of the General Health Questionnaire, which generates a cumulative score in relation to whether certain symptoms had recently been experienced as better or worse than usual. In a subsequent study of 563 young adults living in Japan, Takahashi et al. (2020) used a 19-item Japanese version of the HSPS, with a 3-factor structure previously identified during the version's development (Takashi, 2016). Health was assessed using 15 items selected from a Japanese version of the Hopkins Symptom Checklist, described by the authors as frequency of symptoms during the prior week, such as "headaches" and "faintness and dizziness". AES was not examined, but EOE and LST were found to be significantly correlated with physical

symptoms. The overall score on the Japanese version of the HSPS was also found to correlate with self-reported gastrointestinal symptoms in a sample of 863 non-student adults living in Japan (Iamura & Takasugi, 2022). Although the study didn't examine SPS factors, it showed that SPS (total HSPS score) was significantly associated with five distinct gastrointestinal symptom clusters (reflux, constipation, diarrhea, indigestion, and abdominal pain), even after controlling for socioeconomic characteristics.

An exception to these statistically significant findings is the result of Grimen and Diseth's (2016) study of 167 undergraduates. The authors created a Norwegian translation of the HSPS and examined its relationship to health using the Health Behavior in School-Aged Children symptom checklist. Scores on the symptom checklist were based on the frequency with which students had experienced specific physical symptoms during the preceding six months, with analysis based on a combination of just three items (headache, backache, and pain in neck and shoulder). Conducting an independent factor analysis, the authors' resultant three-factor SPS solution mapped onto Smolewska et al.'s (2006) previously proposed components. However, none of the three factors (nor the total HSPS score) were significantly correlated with physical symptoms.

The Current Study

Given the paucity of research on the association between SPS and physical health, with only one conducted in a U.S. sample, a primary aim for this study was to further examine this relationship. Additionally, we sought to identify a potential mechanism through which such an association might develop. We are aware of only one study to date that has examined mediators of this relationship (Takahashi et al., 2020). Based on the 19-item Japanese HSPS translation, dispositional mindfulness was shown to be a statistically significant mediator of the SPS-health relationship for both EOE and LST (AES was not

assessed). Takahashi et al. recognized SPS as an inherited trait (Aron & Aron, 1997) and the importance of identifying mediators that might be targeted for intervention.

In keeping with this perspective, our study focused on psychological stress as a mediator of the SPS-health relationship. Our hypothesis was driven by the well-established association between psychological stress and physical health (O'Connor et al., 2021) and previous findings linking SPS to higher stress in a variety of populations (Benham, 2006; Redfearn et al., 2020). Additionally, because of previously demonstrated associations between negative affect (NA) and SPS, NA and stress, and NA and physical health symptoms (Benham & Charak, 2019; Brindle et al., 2015; Sobocko & Zelenski, 2015), and the recommendation by Aron et al. (2012) to control for neuroticism in studies of SPS, we elected to control for NA in our study.

Although numerous studies have demonstrated SPS to be multidimensional, the variability in findings requires careful consideration of this issue. As Smolewska et al. (2006) note in their presentation of the three-factor model: "*The positive intercorrelations among these factors, however, are consistent with a general, higher-order construct of SPS.*" (p. 1276). To provide a more comprehensive picture of the SPS-health relationship, we include the total score of the HSPS in our analyses, alongside factor scores. The purpose of this study, therefore, was three-fold: (i) to examine the factor structure of the HSPS, (ii) to examine whether the HSPS (total score) and HSPS factors (if present) are associated with physical health, and (iii) to examine whether the relationships between SPS and health (based on HSPS total score and identified factors) are mediated by psychological stress, controlling for negative affect.

Methods

Participants

A convenience sample of undergraduates (N = 923) participated. The study was approved by the university's Institutional Review Board and participants were recruited on a voluntary basis in return for course credit. Participants ranged in age from 18 to 50 (M = 20.64, SD = 4.19), 67.8% were female, and 93.3% identified as Hispanic.

Measures

Sensory Processing Sensitivity (SPS). SPS was measured using the Highly Sensitive Person scale (HSPS; Aron & Aron, 1997), a Likert-type scale that includes a broad range of items related to sensitivity, including ''Are you easily overwhelmed by strong sensory input?'', and ''Do you have a rich, complex inner life?'' Response options range from (1) ''Not at All'' to (5) ''Extremely''. Scores are based on the average of the 27 ratings. McDonald's ω was 0.93 for the present sample.

Stress. Stress was measured using the Perceived Stress Scale (PSS; Cohen et al., 1988), a 10-item Likert-type scale that asks respondents ''In the last month, how often have you . . .'' and includes items such as ''felt nervous and stressed?'', ''felt that you were unable to control the important things in your life?'' Response choices range from (0) ''Never'' to (4) ''Very Often''. Scores are calculated by summing up the 10 item ratings (after reverse scoring specific items). McDonald's ω was .79 for the present sample.

Negative Affect. We used the negative affect scale from the International Positive and Negative Affect Schedule – Short Form (I-PANAS-SF; Thompson, 2007). The scale consists of five negative affect descriptors which participants rate on a scale that ranges from "never" (1) to "always" (5) in answer to the question "*Thinking about yourself and how you normally feel, to what extent do you generally feel:*". Possible scores range from 5 to 25 and are calculated by summing the five item responses. McDonald's ω was .83 for the present sample.

Physical Symptoms/Health. Physical symptoms/health was measured through two self-report measures. Although the two measures are highly (negatively) correlated, they approach measurement in slightly different ways and thus provide a richer assessment of subjective health.

The Cohen–Hoberman Inventory of Physical Symptoms (CHIPS; Cohen & Hoberman, 1983) was used to assess physical *symptoms*. The CHIPS is a 33-item Likert-type scale that asks respondents to rate how much various symptoms have *bothered or distressed them* during the last month and includes items such as "Back pain" and "Diarrhea". Responses range from (0) "not been bothered by the problem" to (4) "the problem has been an extreme bother". The CHIPS is scored as the sum of the 33 item ratings, with higher scores represent greater physical symptom reporting. In the present study, McDonald's ω was .94 for the present sample.

The Physical Health Questionnaire (Schat et al., 2005) was used to assess physical *health*. The scale consists of 14-items asking respondents to rate *how often* they have experienced symptoms in the areas of sleep disturbances, headaches, gastro-intestinal problems, or respiratory infections. Responses range from 1 (not at all) to 7 (all of the time) with all items being reverse coded with the exception of Item 4. Scores are calculated by averaging all items in the scale and higher scores are indicative of better physical health. The overall scales subcomponents have been reported to have good internal consistency. McDonald's ω was .87 for the present sample.

Procedure

The study was approved by the university's Institutional Review Board and participants were recruited on a voluntary basis in return for course credit. All participants completed an online survey, hosted through Qualtrics (www.qualtrics.com). The survey

included an informed consent statement, a number of demographic questions, including ethnicity/race, age, and sex, and the aforementioned measures.

Statistical Analyses

Statistical analyses were performed using SPSS 26 (IBM Corp., 2019). Missing data analysis was carried out to examine if data were missing completely at random (MCAR). Across all the variables, 0-0.1% of data were missing. Values were missing completely at random, X^2 (11) = 3.16, p = 0.99, and were substituted with values using the expectation-maximization (EM) algorithm. All measured study variables were normally distributed except for age (positively skewed [3.52] and leptokurtic [15.37]) and CHIPS physical symptoms (positively skewed [1.00]). Multivariate outlier detection was conducted prior to analyses, resulting in the identification and removal of 18 participants from the dataset. Bivariate correlation analyses were based on the Pearson correlation coefficient, using 5,000 bootstrapped samples. Mediation analyses were based on ordinary least squared regression, conducted using Hayes' PROCESS Macro V3.5 using 5,000 bootstrapped samples and controlling for age, gender, and negative affect.

Results

Factor Structure of the SPS

To investigate the structure of the SPS, the 27-items were examined using exploratory factor analysis (EFA). All SPS items showed univariate normality (skewness < 1 and kurtosis < 2). However, Mardia's test (Mardia & Zemroch, 1975) indicated a statistically significant deviation from multivariate normality of the total item set for both skewness (53.60) and kurtosis (961.53). Analyses were therefore based on a generated Spearman's correlation matrix using principal axis factors for extraction. The Bartlett sphericity test and the Kaiser-Meyer-Olkin measure of sampling adequacy were calculated prior to conducting the EFA, with both showing acceptable values ($\chi^2(351) = 9{,}448.74$, $p < 0.001$ and KMO = 0.93).

An estimate of the number of factors to extract was determined by Velicer's MAP test (Horn, 1965) using SPSS syntax developed by O'Conner (2000), which suggested three factors. Given that prior research has proposed a broader range of possible factors, models with one, two, three, and four factor(s) were sequentially evaluated for their interpretability and theoretical meaningfulness.

EFA using principal axis extraction for one, two, three, and four factor(s) indicated that these models predicted 30.0%, 36.0%, 40.0%, and 43.0% of variance, respectively. An oblique rotation method (Promax) was used to interpret the loadings of the EFA solutions. Based on these values, the pattern of factor loadings, and findings from sufficiently powered prior research (Smith et al., 2019), we determined that the three-factor model provided the optimal balance between comprehensiveness and parsimony. Items from the pattern matrix of the initial three-factor model were omitted if an item displayed low communality (< .20), one or more high cross-loadings (> .30), or all (absolute) loadings under .30. This process was carried out sequentially with the EFA (with rotation) refitted to the remaining items until all remaining items loaded above .30 with no cross-loadings. In total, four sequential three-factor EFAs were conducted, resulting in the removal of a total of nine items. The factor loadings and coefficient omegas based on the remaining eighteen items are shown in Table 1. In keeping with the three-factor solution initially proposed by Smolewska et al. (2006), the resultant three factors were labeled Ease of Excitation (EOE; seven items), Aesthetic Sensitivity (AES; four items), and Low Sensory Threshold (LST; seven items) and explained 38.9% of the variance.

Descriptive Statistics and Correlations

Descriptive statistics for, and correlations between, all variables are shown in Table 2. The measure of physical health (PHQ) was strongly negatively correlated with the measure of physical symptoms (CHIPS) ($r(903) = -.700$, $p < .001$). SPS total score was positively

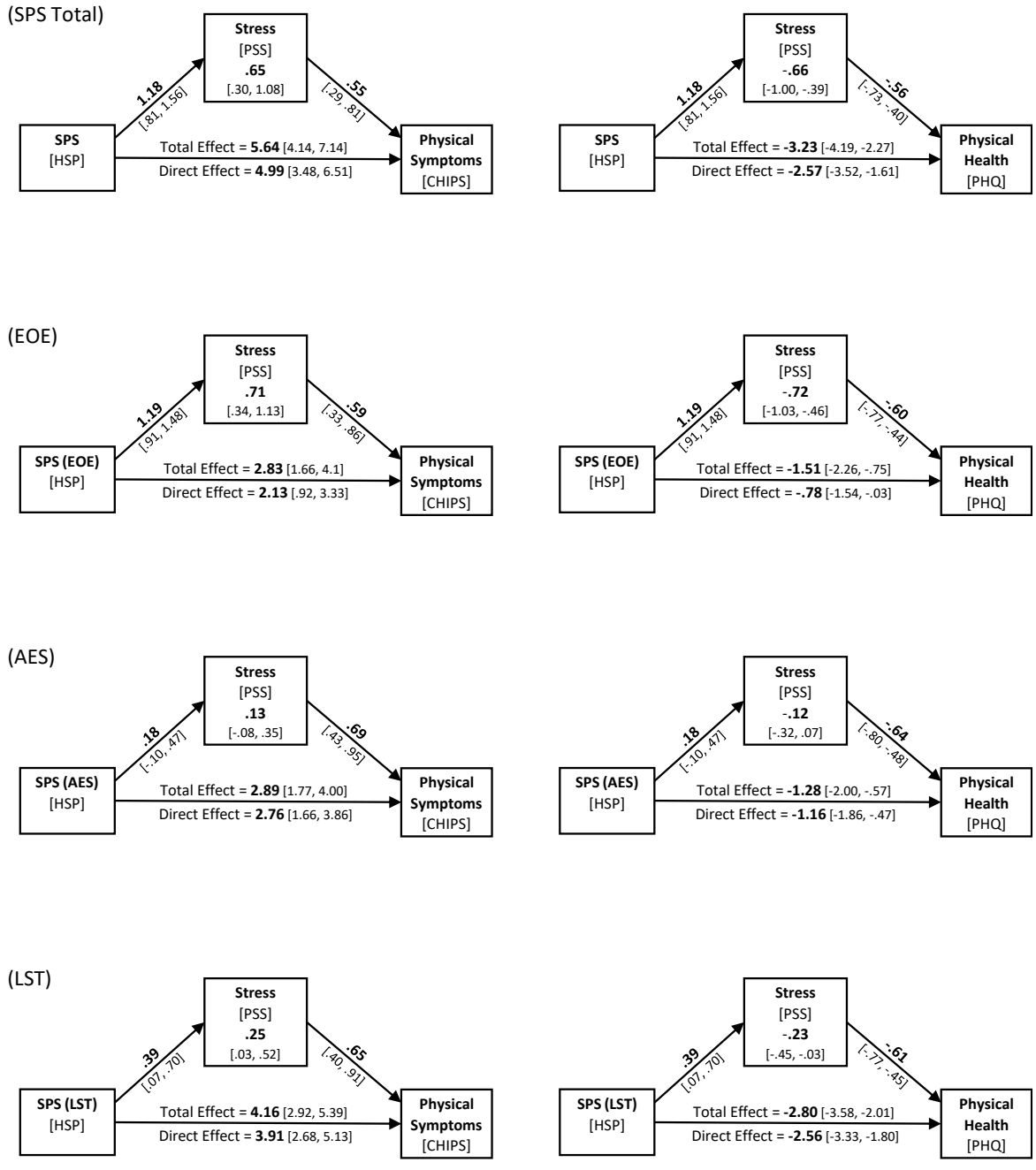
correlated with self-reported physical symptoms (CHIPS; $r(903) = .452$, $p < .001$) and negatively correlated with self-reported physical health (PHQ; $r(903) = -.426$, $p < .001$). Similar patterns of association were also found between each of the three SPS factors and the physical symptoms/health measures, with the strongest correlations shown for low sensory threshold and the weakest correlations shown for aesthetic sensitivity.

Mediation Analyses

Based on the total SPS score, stress mediated the SPS-health relationship for both physical symptoms (unstandardized indirect effect = .65, SE = .20, 95% CI [.30, 1.08]) and physical health (unstandardized indirect effect = -.66, SE = .15, 95% CI [-.99, -.39]). The nature of the mediation was "complementary", with a significant mediated effect and direct effect that pointed in the same direction (Zhao et al., 2010).

Because we had identified a three-factor structure for SPS, we also examined mediation for each of the SPS factors. Significant complementary mediation was found for both Ease of Excitation and Low Sensory Threshold, based on both physical symptoms (EOE: unstandardized indirect effect = .71, SE = .20, 95% CI [.34, 1.13]; LST unstandardized indirect effect = .25, SE = .12, 95% CI [.03, .52]) and physical health (EOE: unstandardized indirect effect = -.72, SE = .15, 95% CI [-1.03, -.46]; LST unstandardized indirect effect = -.23, SE = .11, 95% CI [-.45, -.03]). However, stress was not shown to significantly mediate the relationship between Aesthetic Sensitivity and health for either physical symptoms (AES: unstandardized indirect effect = .13, SE = .11, 95% CI [-.08, .35]) or physical health (AES: unstandardized indirect effect = -.12, SE = .10, 95% CI [-.32, .07]), indicative of direct-only nonmediation (Zhao et al., 2010). Mediation model paths and statistics are shown in Figure 1.

Figure 1. Illustration of mediation model paths and statistics for stress as a mediator of the relationship between SPS and physical symptoms and physical health. Values represent coefficients and 95% confidence intervals.



Note: SPS = Sensory Processing Sensitivity; HSP = Highly Sensitive Person scale; PSS = Perceive Stress Scale, CHIPS = Cohen-Hoberman Inventory of Physical Symptoms; PHQ = Physical Health Questionnaire.

Discussion

In keeping with Smolewska et al.'s (2006) original findings, our factor analysis of the HSPS suggested a three-factor structure that mapped onto the constructs of EOE, AES, and LST. Higher SPS, based on the overall HSPS score and on each of the three factors, was shown to be significantly correlated with poorer health using two different self-report health measures. Broadly speaking, this SPS-health relationship is in keeping with four prior studies (Ahadi & Basharpoor, 2010; Benham, 2006; Iamura & Takasugi, 2022; Takahashi et al., 2020) but differs from Grimen & Diseth (2016), who found no correlation between SPS and physical health complaints.

In keeping with our results, the relationship of EOE and LST with physical symptoms has been demonstrated in two prior studies (Ahadi & Basharpoor, 2010; Takahashi et al., 2020), but failed to reach statistical significance in another (Grimen & Diseth, 2016). Although weaker, we also found a statistically significant correlation between AES and health, an association that failed to reach significance in both Ahadi and Basharpoor's study and Grimen and Diseth's study (Takahashi et al., did not assess AES). Considered together, these findings suggest that both EOE and LST are better predictors of self-rated health than is AES, and that these significant relationships are demonstrated in diverse samples (from the U.S., Iran, and Japan). There are a number of possible explanations as to why Grimen & Diseth's non-significant findings diverge from this, including their relatively small sample size, the use of a three-item health measure, and differences in the item loadings on their three-factor SPS solution. However, recognizing the file-drawer problem in psychological science (Franco et al., 2014), their nonsignificant findings remain an important part of the overall puzzle.

Because debate over the unidimensional/multidimensional nature of SPS has yet to be fully resolved, and because it provided a more complete picture in relation to previous findings, we also examined the relationship between the total HSPS score and physical symptoms. In keeping with the findings of Benham (2006) and, more recently, by Iamura and Takasugi (who focused exclusively on self-reported gastrointestinal symptoms), we found a statistically significant association. However, as with the previously referenced individual factors, Grimen & Diseth (2016) failed to show a significant correlation. Our correlation between total HSPS score and physical symptoms measured by the CHIPS ($r = .453$) closely matches that reported by Benham ($r = .445$) and was larger than the correlations with individual factor scores. It may therefore be advisable to include total HSPS scores in studies of SPS, even when the primary focus is on SPS factors.

A central aim of our study was to examine whether perceived psychological stress might serve as a mediator of the relationship between SPS and physical health. We demonstrated that this was indeed the case for the overall HSPS score and the EOE and LST factors, with complementary mediation (Zhao et al., 2010) shown for two distinct measures of physical health. Importantly, our analysis controlled for age, gender, and negative affect and we were therefore able to show that these pathways were not simply a result of these potentially confounding factors. The AES factor of SPS is often considered a more positive aspect, being negatively correlated with neuroticism and positively correlated with openness to experience (Smolewska et al., 2006). In our sample, AES showed a statistically significant, but weak, correlation with both health measures, and stress was not found to mediate that relationship. As such, it may be a less prominent concern for those interested in the SPS-health relationship.

Clinical Implications

Given that SPS is proposed as an enduring inherited trait (Aron & Aron, 1997), the identification of modifiable mediators of its relationship with ill health is an important goal. Our findings complement the existing work of Takahashi et al. (2020), who found that various components of dispositional mindfulness (nonreactivity, nonjudging, describing, acting with awareness) mediate the relationship between SPS and physical symptoms. Although both studies suggest that those with greater EOE and LST might be at risk for poorer health, they also tentatively suggest that this is not immutable; that interventions to increase mindfulness and reduce stress could potentially attenuate the effect. Health providers might consider utilizing the HSPS as a screening tool for patients, to identify individuals for whom stress reduction or mindfulness practices might be particularly promising. Based solely on the strength of relationships observed, our results (and those of Takahashi et al.) suggest that LST alone might serve as a sufficient predictor, simplifying administration and scoring in a clinical context. However, differences in the item loadings on this factor between studies limits the validity of this approach at the current time.

Because mindfulness practices have been shown to lower stress (Miller et al., 2022), it might be tempting to suggest this interventional approach over other stress reduction techniques. Those with greater SPS tend to report lower mindfulness, acceptance, and psychological flexibility (Bakker & Moulding, 2012), leaving room for growth, and there is preliminary evidence that mindfulness training can increase mindfulness in "highly sensitive people" (Soons et al., 2010). However, important distinctions have been made between dispositional (trait) mindfulness and the "cultivated mindfulness" that results from training/practice (Rau & Williams, 2016). Therefore, we would recommend that future studies examine the relative effectiveness of various stress-reduction techniques for mitigating the association between SPS and ill health.

Limitations and future directions

Our study had several limitations. First, our sample was relatively homogeneous in nature – composed of primarily Hispanic, female, psychology students. However, this can be balanced by the fact that, within the SPS literature, most studies of factor structure have been based on non-Hispanic samples (but see Chacon et al., 2021 and Montoya-Pérez et al., 2019). In regard to studies of the SPS-health relationship, all but one study (Benham, 2006) was based on predominantly non-Hispanic samples. Future studies may benefit from examining this SPS-stress-health model in more heterogenous groups to support generalizability, particularly given that Hispanics have been shown to report greater somatization than other ethnic groups (Aragona et al., 2005). Second, our use of self-report measures, and a convenience sample also limit the generalizability. Although our health measures are well-validated, future research would benefit from the inclusion of more objective measures. A study by Goldberg et al. (2017) found that adolescents scoring high in SPS were more likely to have Type I diabetes than those scoring lower, providing cautious support to the idea that the SPS-health relationship may extend beyond self-report measures. But additional studies examining health related physiology (e.g., blood pressure, immune function) and health conditions (e.g., gastrointestinal disease, psoriasis) are needed. We also recognize that the cross-sectional nature of the design does not provide a strong basis for determining the causal pathways. Future studies based on longitudinal designs would help to address this limitation.

It is worth noting that the developmental perspective of SPS proposed in Aron and Aron's seminal work (1997) suggested that the consequences of high trait SPS may be affected by early childhood experiences. More recently, those high in SPS have been more colorfully characterized as Orchids, "flourishing" when raised in healthy and supportive environments, but more vulnerable to the effects of inadequate care (Greven et al., 2019). Thus, those higher in SPS might have a predisposition toward worse outcomes in adverse contexts and better outcomes in positive or supportive contexts, so early intervention through

empirically supported prevention strategies might have the added benefit of weakening (or potentially even reversing) the relationship between SPS and poor health. However, because individuals high in SPS who experienced troubled childhoods report higher neuroticism, our controlling for this through negative affect may have partially addressed this confound. Future research would benefit from focused exploration of how adverse childhood experiences might moderate the SPS-stress-health relationship.

Conclusion

The results of this study suggest that individuals with greater SPS tend to report poorer physical health. Our data supported a three-factor model of SPS and demonstrated that the SPSS-health relationship is mediated by perceived stress with two of these factors, EOE and LST. Our study suggests that treatments focused on stress reduction might be an avenue through which the impact of SPS on physical health can be modified.

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Table 1

Results from principal axis factoring with Promax rotation: Factor loadings and coefficient omegas.

Item		Factor		
		EOE	AES	LST
14.	Do you get rattled when you have a lot to do in a short amount of time?	.711		
16.	Are you annoyed when people try to get you to do too many things at once?	.706		
20.	Does being very hungry create a strong reaction in you, disrupting your concentration or mood?	.512		
21.	Do changes in your life shake you up?	.629		
23.	Do you find it unpleasant to have a lot going on at once?	.886		
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?	.497		
27.	When you were a child, did parents or teachers seem to see you as sensitive or shy?	.382		
2.	Do you seem to be aware of subtleties in your environment?		.605	
10.	Are you deeply moved by the arts or music?		.560	
12.	Are you conscientious?		.652	
15.	When people are uncomfortable in a physical environment do you tend to know what needs to be done to make it more comfortable (like changing the lighting or the seating)?		.581	
4.	Do you tend to be more sensitive to pain?			.401
6.	Are you particularly sensitive to the effects of caffeine?			.649
7.	Are you easily overwhelmed by things like bright lights, strong smells, coarse fabrics, or sirens close by?			.707
9.	Are you made uncomfortable by loud noises?			.516
13.	Do you startle easily?			.445
18.	Do you make a point to avoid violent movies and TV shows?			.597

19.	Do you become unpleasantly aroused when a lot is going on around you?			.411
McDonald's Omega		.82	.70	.78

Note: EOE = Ease of Excitation; AES = Aesthetic Sensitivity; LST = Low Sensory Threshold

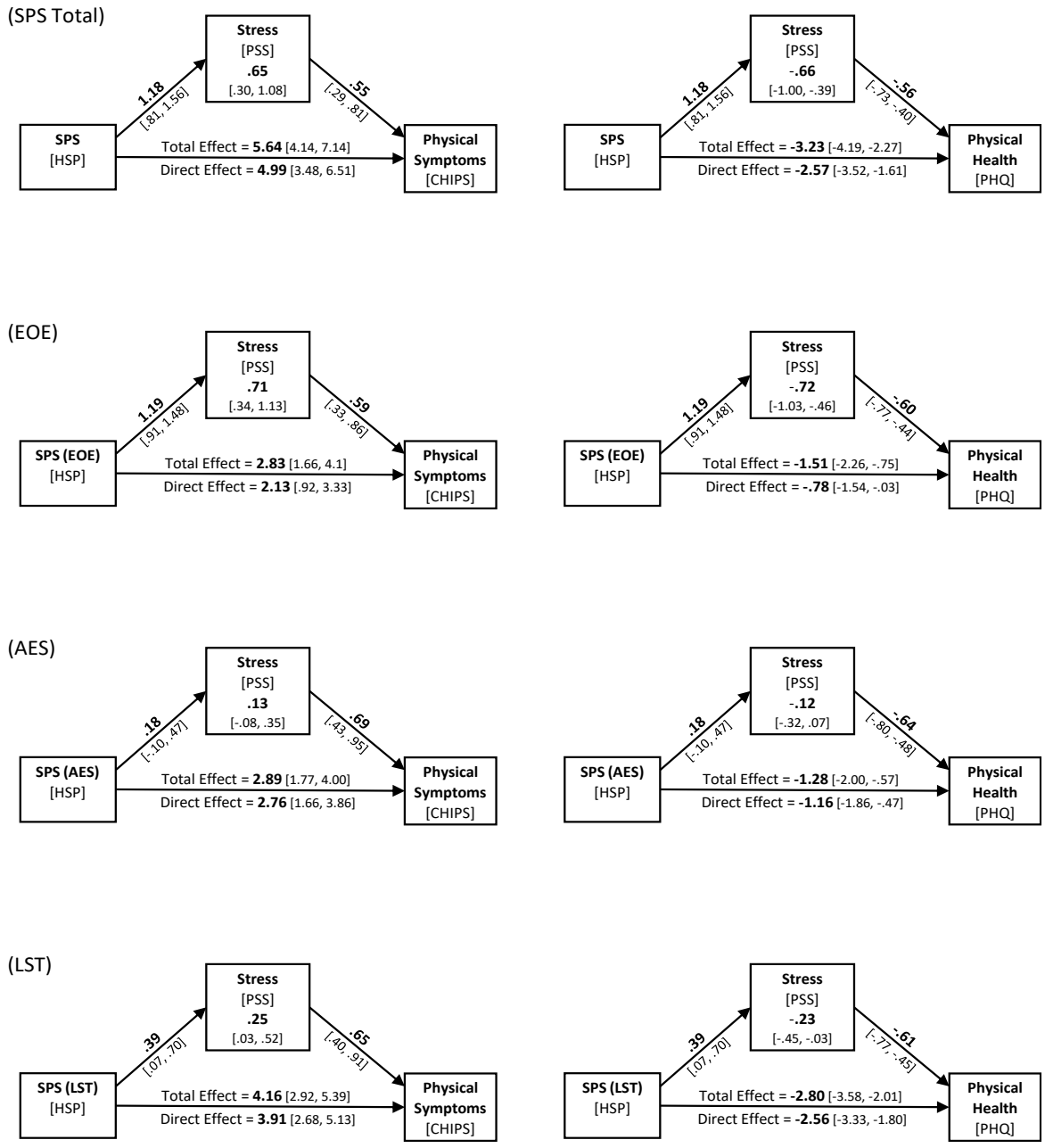
Table 2

Characteristics of Participants and Correlations Between Variables

Variable	*M*	*SD*	1 Age	2 SPS	3 EOE	4 AES	5 LST	6 PSS	7 NA	8 CHIPS
1. Age	20.64	4.19								
2. Sensory Processing Sensitivity (SPS)	3.94	1.03	.008							
3. Ease of Excitation (EOE)	4.33	1.29	-.020	**.868**						
4. Aesthetic Sensitivity (AES)	4.25	1.24	.060	**.719**	**.473**					
5. Low Sensory Threshold (LST)	3.19	1.21	.020	**.824**	**.613**	**.425**				
6. Stress (PSS)	21.04	6.28	.008	**.457**	**.475**	**.208**	**.339**			
7. Negative Affect (I-PANAS-SF)	11.72	4.47	.027	**.534**	**.478**	**.307**	**.459**	**.576**		
8. Physical Symptoms (CHIPS)	33.70	23.77	.021	**.453**	**.370**	**.283**	**.413**	**.422**	**.485**	
9. Physical Health (PHQ)	67.55	14.88	-.018	**-.426**	**-.342**	**-.238**	**-.414**	**-.465**	**-.468**	**-.700**

Note. N = 905 (listwise); bolded correlation coefficients indicate $p < .001$.

Figure 1. Illustration of mediation model paths and statistics for stress as a mediator of the relationship between SPS and physical symptoms and physical health. Values represent coefficients and 95% confidence intervals.



Note: SPS = Sensory Processing Sensitivity; HSP = Highly Sensitive Person scale; PSS = Perceive Stress Scale, CHIPS = Cohen-Hoberman Inventory of Physical Symptoms; PHQ = Physical Health Questionnaire.