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Review article

SENSORY PROCESSING SENSITIVITY: THEORETICAL FRAMEWORK AND EMPIRICAL EVIDENCE

Abstract:

The paper discusses the concept of sensory processing sensitivity (SPS) as a heritable temperamental trait, characterized by deep cognitive processing, high emotional reactivity, sensitivity to subtle stimuli and a tendency towards overstimulation. Sensitivity is considered a phenotypic trait, distinct from neuroticism and introversion. The paper analyzes the relations of SPS with personality traits (through the models of Eysenck and the Big Five), its factor structure and psychometric properties of the instrument that measures it, as well as the connection with positive and negative psychological outcomes. Special emphasis is placed on the role of the environment - as a protective andrisk factor - in moderating between SPS and these outcomes. Research suggests that highly sensitive individuals, although more vulnerable to stress and negative influences, possess significant cognitive, emotional, and social capacities, especially in supportive environments. Future directions point to the need to expand research to include diverse cultural backgroundsand contextual factors, as well as the development of appropriate interventions to promote well-being in this population.

Keywords: *sensory processing sensitivity, highly sensitive person, temperament, personality factors, environmental influence*

Introduction

Sensory processing sensitivity (SPS) is a heritable temperamental trait characterized by increased sensitivity to external and internal stimuli (Aron et al., 2010). SPS includes sensitivity to: caffeine, hunger, pain, subtle stimuli, art, but also sensitivity to stimuli from the environment, which come from: different social groups, family, workplace, school, etc. (Aron, Aron & Jagiellowicz, 2012). The author Elaine Aron, who researches this trait, uses as a synonymthe term highly sensitive person (HSP).

Individuals with high levels of this trait demonstrate deep and thorough cognitive processing of information, greater awareness of subtle changes and details in the environment, greater emotional reactivity, and a greater degree of empathy (Aron & Aron, 1997). Characteristic of such individuals is an increased awareness of interpersonal relationships and a high ability for reflective thinking (Aron, Aron & Jagiellowicz, 2012). The trait manifests itself in a variety of behaviors, such as a tendency to be easily upset and frustrated, but also a sensitivity to aesthetics and a deep admiration for beauty in nature, art, and everydaylife. Sensitive individuals often feel overwhelmed when exposed to a large number of stimuli and information, are easily infected by the feelings of others, and show significant empathic reactions to emotional signals (Avecedo et al., 2014). Due to the deep and complex processing of stimuli and planning for effective action, these individuals often use a "pause and check" strategy (Aron & Aron, 1997). They need to take a short break to think before responding to environmental stimuli.

Sensory processing sensitivity has been discovered and studied in over a hundred animal species, including fruit flies, sunfish, and primates (Wolf, Van Doorn & Weissing, 2008; Wilson et al., 1993). Research suggests that this trait primarily serves an adaptive role.The advantage in the behavior of sensitive individuals is that they can use information that others ignore, in order to better adapt to the environment (Aron, Aron & Jagiellowicz, 2012). The advantages are most noticeable in situations of change or unpredictability in the environment, where sensitive individuals show increased flexibility and ability to learn. However, according to the authors, this behavior requires investing more time and energy in order to achieve the desired goals.

The Theory of Sensory Processing Sensitivity

The Theory of Sensory Processing Sensitivity (Aron & Aron, 1997) is based on an extensive review of research in the literature, which is aimed at investigating related phenomena, such as:introversion, behavioral inhibition, shyness, and similar temperament traits found in some animals (Aron & Aron, 1997). ThisTheory is part of a broader theoretical framework for *Environmental Sensitivity*(Pluess, 2015), which, in addition to this one, includes the theories of Differential Sensitivity (Belsky, 1997; Belsky & Pluess, 2009) and the Biological

Sensitivity to Context (Ellis & Boyce, 2011). The purpose of all threeis to explain individual differences in the ability to perceive and process environmental stimuli. The basic idea is that individuals differ in their sensitivity to both negative and positive environmental influences. However, environment, in the context of the Theory of Sensory Processing Sensitivity, is defined more broadly and includes any external or internal stimulus, including: the physical environment (e.g. food, caffeine), the social environment (e.g. childhood experiences), the sensory environment (auditory, visual, tactile, olfactory), as well as internal events in the organism (e.g.thoughts, feelings, bodily sensations) (Greven et al., 2019). This Theory differs from the other two in that it develops an instrument that measures sensitivity to stimuli as a phenotypic trait, and which is adapted for adult and child populations (Greven et al., 2019).

There are four basic characteristics of sensory processing sensitivity that separate it from other temperament and personality traits: depth of processing, overstimulation, emotional reactivity and empathy, and sensitivity to subtle stimuli (Aron, Aron & Jagiellowicz, 2012).

1. Depth of processing implies that individuals with high levels of SPS are able to receive a huge amount of information at the same time and connect it with each other with a large number of connections. The interconnectedness of information allows these individuals to be more thorough, comprehensive, and creative in their approach to solving problems (Aron, 2020). Due to the deep processing of information, individuals with high levels of SPS usually take a short pause before taking a specific action. This behavior is called "pausing to check" andallows for thorough thought before giving an appropriate response. Therefore, according to the authors, highly sensitive individuals have a deeper and more complex inner world than those with low levels of sensitivity (Aron, 2004 ; Aron & Aron, 1997).

Patterson and Newman (1993) investigated impulsive behaviorof subjects who received feedback on their success in performing a task using rewards or punishments (gaining or losing a certain amount of money). They equated impulsivity with extraversion and found that introverts spent more time reflecting on the feedback before moving on to the next attempt, which proved to be a successful strategy. The researchers concluded that more time for reflection allowed for greater depth and thoroughness in problem solving. Findings from another study (Kjellgreen , Lindahl, & Norlander, 2009a) have shown that high levels of SPS are associated with mystical experiences and altered states of consciousness in situations of sensory isolation.

2. Overstimulation. Because individuals with high levels of SPSnotice even the smallest details and process information deeply, they tire quickly and feel overwhelmed by stimuli in their environment. Therefore, highly sensitive individuals experience stress more easily when exposed to loud, chaotic environments or when faced with tight deadlines or group work (Aron, 2020).

There are HSP who express a need for stimuli and new activities that increase excitement, or who manifest a fear of missing out (Jagiellowicz et at .,

2011). However, they cannot withstand additional stimuli for a long time and try to balance between the need for excitement and the attempt to "return to normal " (Gerstenberg, 2012). According to Aron (2020), excessive stimulation and a feeling of being overwhelmed should not be confused with some problematic conditions such as*sensory discomfort* . The latter is a disorder related to sensory processing.

3. Emotional reactivity and empathy. Individuals with high levels of SPS manifest strong emotional reactions to both positive and negative experiences (Aron, 2020). Such insights come from research that shows that these individuals have greater activity in the centers in the cortex responsible for empathy (Naumann, Bayer & Dziobek, 2022). It has been found that highly sensitive individuals, compared to those with low levels of sensitivity, show stronger reactions when presented with images with a "positive valence".Activity was observed in the parts of the brain responsible for experiencing strong emotions, but also in the "higher" centers responsible for thinking and understanding (Jagiellowicz, 2010). In another study, individuals with high and low levels of SPS were shown pictures of people with happy, sad, and neutral facial expressions. In the first two situations, sensitive individuals showed increased activity in the insular cortex, responsible for various functions related to emotions, but also increased activity in mirror neurons, responsible for empathy (Acevedo et al., 2014).

4. Sensitivity to subtle stimuli means that individuals with high levels of SPS are more likely to notice small, subtle details, within what they hear, taste, touch, and nonverbal signals from other people, which show how they feel and how much they can be trusted (Aron, 2020). Such sensitivity is not the result of high sensitivity of the senses, but of greater activity of the centers in the brain responsible for more complex information processing (Aron, 2020).

The four characteristics of sensory processing sensitivity show similarities to some previously studied temperament and/or personality traits. These include: behavioral inhibition, high stimulus sensitivity, deep information processing, and strong emotional reactivity (Aron, Aron & Jagiellowicz, 2012).

Measurement and factor structure of sensory processing sensitivity

In order to measure the trait sensory processing sensitivity, Elaine Aron and Arthur Aron developed the Highly Sensitive Person Scale (Aron & Aron, 1997). The scale derives from SPS Theory and is based on empirical and exploratory research into what clinicians and the public mean by the term *sensitivity*. The researchers conducted a series of in-depth interviews with 39 adult respondents who identified themselves as "highly sensitive," "introverted," or "easily overwhelmed by external stimuli." The initial version of the scale contained 60 itemsand includes statements that relate to broader information processing. The questionnaire was tested on a sample of 604 respondents, psychology students and 301 respondents from the wider community. The latest

version of the scale consists of 27 items, which cover different indicators of sensitivity to stimuli, such as: "Do you feel uncomfortable with loud noises?", "Do you get upset when you have to do a lot of things in a short time?", "Do other people's moods affect you?","Can you be deeply moved by art or music?". The psychometric properties and validity of the instrument have been confirmed in multiple studies (Greven et al., 2019).

The Highly Sensitive Child Scale(Plus et al., 2018) was constructed to measure the sensory processing sensitivity in children aged eight and up. Scale consisting of 12 items. In younger children, this scale is used with an adapted format that is completed by parents (Slagt et al., 2017).

According to the authors, the Highly Sensitive Person Scale is a unidimensional concept (Aron & Aron, 1997). However, some studies, using factor analysis, have obtained several subfactors of the scale, which measure different aspects of sensitivity to stimuli. Thus, Smolewska and colleagues have identified three components of the SPS: *low sensory threshold (LST)*, *ease of arousal (EAS)* and *aesthetic sensitivity (ES)* (Smolewska, McCabe & Woody, 2006). Other researchers (Evans & Rothbart, 2008) have obtained two subfactors: *sensory discomfort,* which is associated with negative affect, and *oriented sensitivity,* which refers to the perception of subtle stimuli and the depth of processing. There are studies that have obtained four subfactors of this scale (Meyer, Ajchenbrenner & Bowles, 2005).

Sensory Processing Sensitivity and Personality

According to Eysenck's two-factor model, individual personality differences can be described by two factors: extraversion versus introversion and neuroticism versus emotional stability (Eysenck, 1967, *cited in*Greven, 2019). Individuals with higher levels of the extraversion show greater social activity, energy, and a tendency toward external stimulation, while those with lowerdegree tend towards inward orientation, reflection and withdrawal (Eysenck & Eysenck, 1985, *cited in* Greven, 2019). On the other hand, neuroticism represents a continuum between emotional instability and stability, with high scores indicating frequent experiences of anxiety, depression and emotional reactivity, while low scores are associated with emotional balance and calmness.

According to research, highly sensitive individuals often show high levels of the factors introversion and neuroticism. The reason for this connection may be the increased sensitivity of these individuals to external stimuli, deep processing of information, and the large number of connections in the brain, which leads tofeeling overwhelmed and tired. In order to isolate themselves, the individual often avoids noisy and chaotic environments, social events and situations (Aron & Aron, 1997), i.e., displays introverted behavior. Although extraversion is usually associated with sociabilityand energy, some highly sensitive individuals (about 30% of HSPs) manifest extraverted behaviors, but with high sensitivity to social and emotional stimuli (Aron, Aron & Davies, 2005).

Additionally, higher levels of neuroticism in highly sensitive individuals are explained by increasedemotional reactivity to stressful events and negative emotional stimuli (Smolewska, McCabe & Woody, 2006).

The trait sensory processing sensitivityis often considered in the context of the **Big Five Personality** Model**,** which provides a more comprehensive overview of personality traits (Nocentini, Menesini & Plues, 2018). This model (McCrae and Costa , 1994, *cited in* Greven, 2019) includes the factors: extraversion, neuroticism, openness to experience, agreeableness, and conscientiousness. Research shows that SPS is positively associated with neuroticism, openness to experience, and negatively with extraversion (Korubin Kjorluka 2024; Lionetti et al., 2018; Smolewska, McCabe & Woody, 2006, Aron & Aron, 1997). No statistically significant corelation of SPS with the other two factors: conscientiousness and agreement was found (Korubin Kjorluka 2024; Lionetti et al., 2018; Smolewska, McCabe & Woody, 2006).

According to Gray's Reinforcement Sensitivity Theory - RST, individual differences in personality are based on three main neurobiological systems: *Behavioral Activation System – BAS, Behavioral Inhibition System - BIS* and *Fight-Flight-Freeze System - FFFS*.The BAS is responsible for the reactions that occur in response to positive stimuli and rewards, which results in motivation and drive to approach pleasant experiences. On the other hand, the BIS is associated with sensitivity to cues that predict punishment or novelty and is manifested by avoiding potentially negative situations, activating anxiety and caution processes (Gray & McNaughton, 2000, *cited in* Aron, Aron & Jagiellowicz, 2012). The FFFS is responsible for reactions to immediate threat and directs behavior towards confrontation, avoidance, or short-term blocking when experiencing fear. Research shows that the sensory processing sensitivity is closely related to the sensitivity of BIS. Highly sensitive individuals show an increased tendency to choose safe decisions and avoid risks (Smolewska, McCabe & Woody, 2006). On the other hand, the relationship of BAS with SPS is weaker and less consistent. Highly sensitive individuals may show reduced sensitivity to rewards and positive stimuli, which may result in reduced motivation to actively approach new experiences (Aron & Aron, 1997). Such results suggest that BAS has a smaller impact on highly sensitive individuals.

Negative and Positive Psychological Outcomes and Influence of the Environment

Sensory processing sensitivity is a trait that should not be equated with a psychological disorder. However, a large number of studies have found an association between sensitivity and a number of negative outcomes. Thus, high levels of SPS have been found to be corelated with higher levels of stress, anxiety, and depression (Yano, Kase & Oishi, 2019), as well as with difficulties in emotional regulation in stressful situations (Sperati et al., 2024). Furthermore, the results show that individuals with high levels of SPS show low levels of

subjective well-being and life satisfaction (Ershova, 2023). Highly sensitive individuals are characterized by difficulties in relationships, a limited number of personal contacts, dependence on the opinions and assessments of others, and lower self-esteem (Ershova 2023).

However, only a part of these studies include the influence of the environment as a moderator variable between SPS and negative psychological outcomes (Greven, 2019). The environment to which an individual is exposed influences the relationship between sensory processing sensitivity and both positive and negative outcomes (Belsky, 2009). The environment shapes the outcomes of neutral genetic factors, leading to negative and positive manifestations in behavior (Homberg & Lesch, 2011). Highly sensitive individuals are particularly sensitive to the positive and negative influences of the family environment. A negative family environment during developmental stages can exacerbate the negative consequences associated with SPS (Greven, 2019). The results of four consecutive studies show that highly sensitive individuals with negative childhood experiences display greater levels of shyness compared to those with similar experiences but lower sensitivity (Aron at al., 2005). Moreover, individuals raised in unfavorable environments tend to report lower levels of life satisfaction (Booth et al., 2015), along with elevated levels of depression (Liss et al., 2005).

On the other hand, in situations where environmental factors are positive, results show that sensitive individuals experience more positive effects and progress.**Thus**, respondents with higher levels of SPS were found to exhibit greater positive emotions (Lionetti et al., 2018), higher emotional intelligence (O'Neil, 2023), increased creativity and empathy (Laros-van Gorkom et al., 2025), and higher social competencies (Slagt et al., 2018) compared to their less sensitive counterparts.

In a study examining the relationship between sensory processing sensitivity and the 24 character strengths—defined as positive traits expressed through thoughts, feelings, and behavior—the results showed that 15 of the 24 strengths were positively associated with sensitivity: curiosity, love of learning, judgment, social intelligence, perspective, bravery, honesty, kindness, teamwork, fairness, leadership, prudence, appreciation of beauty, gratitude and humor(Korubin Kjorluka, 2025). These results highlight the cognitive and social benefits of SPS. Significant correlations with character strengths such as curiosity, love of learning, judgment, and appreciation of beauty are consistent with theoretical assumptions that highly sensitive individuals are characterized by deeper cognitive processing and increased awareness of their environment. Additionally, the relationship with honesty, kindness, teamwork, leadership, fairness, prudence, gratitude, and humor indicate increased sensitivity to interpersonal relationships, moral values, and behaviors, as well as a desire for social harmony (Korubin Kjorluka, 2025). According to these findings, although SPS is associated with various negative emotional states, it also fosters the capaci-

ties and personal development of the individual, thereby contributing to higher subjective well-being.

Because of their greater susceptibility to environmental influences, psychological interventions have been shown to be more effective in individuals with high levels of sensory processing sensitivity compared to those with lower levels. After an intervention, highly sensitive subjects showed a greater reduction in depression levels, as well as in the effects of peer violence (Pluess, 2015; Nocentini, Menesini & Pluess, 2018). The results of other studies show that when highly sensitive individuals are exposed to images with positive content (images of people they love), their brain centers associated with reward increase (Avecedo et al., 2014).

Future Directions

In recent years, scientific knowledge about sensory processing sensitivity has advanced significantly. There is broad consensus among researchers that SPS is a temperamental trait, genetically influenced and distinct from other traits. Research confirms theoretical assumptions about the basic characteristics of SPS, as well as the neurological basis of this trait (Greven et al., 2024). There is also a growing body of research indicating positive and negative outcomes associated with high sensitivity.

However, this area of research is still developing. Future research should contribute to a better understanding of the basis of SPS, which is common to all highly sensitive individuals. A clear distinction needs to be made between sensitivity, which refers to the perception and processing of stimuli, and reactivity, which is a response to such processing (Greven et al., 2024). Most studies are based on self-report scales, and often use non-representative samples. There is little knowledge about the influence of different contexts – such as family, educational, and work– on positive and negative outcomes of SPS. There is also no data on cultural differences, nor on age and gender differences in the experience and expression of this trait.

The significance of this temperamental trait is increasingly acknowledged in both clinical settings and everyday life. Further research may contribute to the development of psychological interventions aimed at preventing negative outcomes and enhancing the well-being and positive experiences of highly sensitive individuals.

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