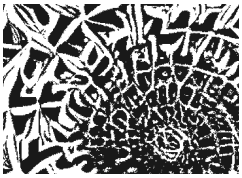

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SENSORY PROCESSING SENSITIVITY IN ADOLESCENCE

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The main aim of this review article is to describe the current state of scientific knowledge on the characteristics of the sensory processing sensitivity (SPS) trait in adolescence. The SPS trait stands for an increased sensitivity of the central nervous system and is associated with a tendency to process stimuli more deeply. People with this trait are highly sensitive people. Previous research has shown that there is a link between this trait and poorer quality of mental health. In addition, adolescence itself is a particularly challenging phase of life for most young people, as numerous changes take place during this developmental phase. For these reasons, highly sensitive adolescents represent a particularly vulnerable group for the development of various types of mental health problems. However, previous research has shown that the development of various problems in adolescents with the SPS trait is largely dependent on environmental factors. This knowledge is essential for professionals (psychologists and psychiatrists) who need to be aware of the main characteristics of highly sensitive adolescents in order to help this group of young people.

Keywords: sensory processing sensitivity, adolescence, mental health, environmental influences

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INTRODUCTION

Adolescence is a life period between childhood and adulthood during which some of the greatest changes in a person's cognitive, socio-emotional and physical development take place (Iimura & Kibe, 2020). This developmental phase covers a period from approximately 10 to 24 years (Sawyer et al., 2018).

Due to the many changes that take place in a person's life during this time, adolescence is not easy for anyone. However, not all adolescents will have mental health problems and not all will develop internalising and externalising problems (Benner, 2011; Iimura & Kibe, 2020; Steinberg & Morris, 2001). In fact, many adolescents cope well when confronted with various stressors in life. In addition, many previous studies have shown that environmental influences such as social support and the quality of adolescents' relationships with their family and friends play an important role in adolescents' mental health (Steinberg & Morris, 2001). Despite this, for some adolescents, various adversities in life have a greater negative impact and some adolescents do not benefit from positive environmental influences such as social support (Iimura & Kibe, 2020). The question arises as to what the difference is between these adolescents. The extent to which these environmental influences affect adolescents' development may depend to some extent on their sensory processing sensitivity trait.

Sensory Processing Sensitivity (SPS) is a trait that implies neurological differences in the cognitive processing of stimuli and is associated with a more sensitive nervous system (Acevedo et al., 2014; Gearhart & Bodie, 2012; Rajić, 2023). This trait is associated with greater sensitivity and responsiveness to environmental stimuli (Acevedo et al., 2014). People with this trait are highly sensitive people, and in the general population there are about 20 to 30% of them (Jagiellowicz et al., 2016; Lionetti et al., 2019; Pluess et al., 2018; Rajić, 2023, 2024). In recent decades, there has been an increasing number of studies on the SPS trait worldwide. However, the general public as well as experts first became aware of the characteristics of highly sensitive people, adolescents and children through the books of Elaine Aron, which are largely based on her therapeutic work with highly sensitive individuals (Aron, 2002; Aron; 2011; Aron, 2013).

Aim of review and literature search

The main aim of this paper is to describe the current state of scientific knowledge about the trait that can help explain differences in the effect of environmental influences on adolescents. To achieve this goal, a literature search was conducted in Google Scholar and PubMed using the search terms "sensory processing sensitivity in adolescence", "highly sensitive adolescents" and "environmental sensitivity in adolescence". In addition, to fully describe the SPS trait, articles on the main characteristics of sensory processing sensitivity and the research on envronmental sensitivity were searched using the search terms "sensory processing sensitivity", "high sensitivity" and "environmental sensitivity". The articles included in this review were not selected by year of publication, as research on the SPS trait is relatively new and has only been conducted since the mid-1990s.

THE MAIN CHARACTERISTICS OF HIGHLY SENSITIVE ADOLESCENTS

The main characteristics of highly sensitive people are deeper information processing, higher emotional reactivity, overstimulation and sensing the subtle, which form the acronym *DOES* (Aron, 2011; Aron et al., 2012; Rajić, 2023, 2024).

Depth of processing, as the name suggests, refers to the deeper information processing of highly sensitive people compared to non-highly sensitive people (the rest of the population that is not highly sensitive). This is the central feature of the SPS trait that influences many other characteristics of highly sensitive individuals (Acevedo et al., 2021; Rajić, 2023). Numerous studies have shown that certain areas of the brain are more active in people with the SPS trait, which are related to deeper information processing (Acevedo et al., 2021; Jagiellowicz et al., 2011). This characteristic can be expressed through sensing the subtleties (one of the main characteristics of highly sensitive individuals), which refers to all the little things that people with the SPS trait perceive that non-highly sensitive people do not (Aron, 2011). Depth of processing can also manifest itself in highly sensitive adolescents through a greater awareness of how other people see them (Aron, 2002). Consequently, adolescents with the SPS trait living in Western cultures are also more aware of the fact that they do not fit into the cultural ideal. It is important to point out that this cultural ideal relates to the cultures of America, Canada, and Western Europe, where most research on the SPS trait has been conducted. In fact, in a study conducted in China, it was found that children who exhibited characteristics associated with the SPS trait were popular in school (Chen et al., 1992). The reason for this lies in Confucian philosophy, which emphasises that inhibited individuals are more mature (Chen et al., 1992; King & Bond, 1985). Consequently, shy children in China are considered "good" and well-behaved. For this reason, behaviours associated with inhibition and sensitivity are more acceptable and popular in China than in the West, where such characteristics are not as highly valued. The results of this study have also shown that sensitive children were less popular in Canada (Chen et al., 1992). Elaine Aron reports that sensitive adolescents from Western cultures try to conform to the majority for these very reasons, i.e., to conform to the "accepted and popular" way of life and behaviour to avoid the disapproval of their parents and the rejection by their peer groups. Therefore, they sometimes try to change themselves to fit in with the majority, and if someone does something they do not want, this can lead to an increase in their dissatisfaction (Aron, 2002).

However, the depth of processing can also have numerous positive consequences, such as aesthetic awareness (Acevedo et al., 2021). Many studies on the personality profile of

highly sensitive people have shown that there is a correlation between this aspect of the SPS trait (operationalised in the Aesthetic Sensitivity factor, which is one of the factors of the scale developed to assess the SPS trait) and the Openness to Experience personality dimension (Grimen & Diseth, 2016; Rajić, 2023; Sobocko & Zelenski, 2015; Smolewska et al., 2006). The reason for this lies in the similar object of measurement of these two constructs, which means that as aesthetic sensitivity increases, openness to experience will increase too (Ahadi & Basharpoor, 2010; Rajić, 2023). However, the results of some studies show a connection between the SPS trait and openness to experience only from late adolescence (Bröhl et al., 2020; Lionetti et al., 2019). The explanation for this can be found in a study which showed that openness to experience develops during adolescence. Namely, the development of the intellect during adolescence consequently affects greater openness to new life experiences (Allik et al., 2004). For this reason, it can be hypothesised that the characteristics associated with aesthetic sensitivity also develop during this stage of life (e.g. Aesthetic Sensitivity item: *Do you notice and enjoy delicate or fine scents, tastes, sounds, works of art?*) (Rajić, 2023). Considering that the factor of aesthetic sensitivity has been associated with positive outcomes such as better mental health in previous studies (Dal, 2015; Grimen & Diseth, 2016; Khosravani et al., 2021; Meyerson et al., 2020; Yano & Oishi, 2018), some authors hypothesise that higher aesthetic sensitivity will only develop under the influence of positive aspects of the environment (Liss et al., 2008). Nevertheless, the question of which factors in adolescence influence the development of more positive aspects of the SPS trait remains open.

Another consequence of depth of processing and another key characteristic of all highly sensitive people is the ease of getting into the state of overarousal. If someone processes information more deeply, it is more likely that this person will also become physically and mentally fatigued more easily (Aron, 2011; Rajić, 2023). Therefore, highly sensitive people need less stimulation than non-highly sensitive people to get into a state of overstimulation. This characteristic was operationalised in the factors Ease of Excitation and Low Sensory Threshold (two factors of the scale developed to assess the SPS trait). The items of the Ease of Excitation factor assess the ease of getting into the state of feeling mentally overwhelmed by stimuli, while the Low Sensory Threshold factor assesses the unpleasant arousal caused by external stimuli (Smolewska et al., 2006). In a large number of studies, it has been shown that aspects of high sensitivity operationalised in these factors were associated with lower quality of mental health. Just a few examples of these studies include the associations of these factors with:

anxiety symptoms (Liss et al., 2008; Hofmann & Bitran, 2007), depressive symptoms (Liss et al., 2008; Yano & Oishi, 2018), burnout syndrome (Meyerson et al., 2020; Redfearn, 2019), obsessive-compulsive disorder (Khosravani et al., 2021), and symptoms of seasonal affective disorder (Hjordt & Stenbæk, 2019). Therefore, the ease of getting into the state of overarousal represents one of the negative sides of the SPS trait, as it can often make life more difficult. However, it is believed that this characteristic is least pronounced in adolescence and early adulthood, as young people desire a higher level of stimulation compared to highly sensitive children and older adults. There are several reasons for this. Some of these in-clude the many biological changes that take place during adolescence, the desire of adolescents to try new things, or simply the lack of life experience due to which they are not yet sufficiently aware of their stimulation threshold (Aron, 2002). It is important to point out that Elaine Aron has written about the ways this characteristic affects the lives of highly sensitive adolescents. Although research has shown that this is one of the fundamental characteristics associated with the SPS trait, and although it has been operationalised in the scales developed to assess the SPS trait (Aron & Aron, 1997; Pluess et al., 2018; Pluess et al., 2023), not many studies have been conducted on the different ways it affects the lives of highly sensitive people at different developmental stages.

Another main characteristic of highly sensitive people is their higher emotional reactivity, which stands for higher positive and negative emotions, and this characteristic is also related to the higher empathy of this group of people (Aron et al., 2012). In one study, for example, it was shown that highly sensitive students (late adolescence) had a stronger negative affect when they received bad feedback about their academic achievement, than non-highly sensitive students (Aron et al., 2005). The results of another study showed that individuals with the SPS trait also reacted more strongly to positive emotional stimuli (Jagiellowicz et al., 2016). Many studies have shown that highly sensitive people have more intense positive and negative emotions than the non-highly sensitive part of the population and that certain environmental factors have a greater influence on their emotions (Acevedo et al., 2014; Aron et al., 2005; Aron et al., 2012; Jagiellowicz et al., 2016). Given that adolescents generally have more intense emotions than adults and children (Diener et al., 1985; Larson et al., 1980), the question arises as to how highly sensitive adolescents regulate their generally more intense emotions, how this may affect their mental health and what role environmental factors play in this. Although this has not yet been extensively researched, the results of one study showed that only highly

sensitive people with difficulties in emotion regulation were more likely to have symptoms of depression and anxiety (Brindle et al., 2015). In a more recent study, it was shown that highly sensitive people have lower emotion regulation skills compared to non-highly sensitive people. The results of this study also showed that mainly young people (late adolescence) belonged to the group of highly sensitive people with low emotion regulation. These results point to the difficulties that highly sensitive individuals can have in regulating their emotions (Liu & Tian, 2024).

ENVIRONMENTAL INFLUENCES ON HIGHLY SENSITIVE ADOLESCENTS

As already mentioned, another important characteristic of people with the SPS trait is their higher environmental sensitivity. Environmental sensitivity as a construct was first defined within the theoretical framework of the same name (Aron & Aron, 1997; Belsky, 1997; Belsky & Pluess, 2009; Ellis & Boyce, 2011). Environmental sensitivity is one of the most basic individual characteristics that can be observed in humans as well as in a large number of animal species (Pluess, 2015; Rajić, 2023). This means that everyone is sensitive to environmental influences. However, studies show that people vary greatly in their sensitivity to environmental influences, with some being more sensitive and some less (Pluess et al., 2018). Numerous studies have shown that the SPS trait is a reliable marker for environmental sensitivity (Greven et al., 2019). For example, highly sensitive people with poorer environmental quality in childhood had lower life satisfaction (Booth et al., 2015), higher depression scores (Liss et al., 2005) and higher neuroticism as adults (Aron & Aron, 1997).

Numerous studies conducted with highly sensitive adolescents have also shown a greater influence of both supportive and aversive aspects of the environment on this group of adolescents. For example, in two studies where the SPARK resilience programme (Boniwell & Ryan, 2009) was implemented, it has been shown that highly sensitive students benefited more from this programme compared to their non-highly sensitive peers (Kibe et al., 2020; Pluess & Boniwell, 2015). This resilience programme, symbolised by the acronym SPARK, which stands for Situation (S), Perception (P), Autopilot (A), Reaction (R), and Knowledge (K), was first developed in the United Kingdom and is based on the principles of cognitive-behavioural therapy and positive psychology. The main aim of this programme is to promote protective factors (e.g. self-esteem, self-regulation, etc.) in young people in order to develop their resilience and prevent depression (Boniwell & Ryan, 2009; Kibe

et al., 2020; Pluess & Boniwell, 2015). The positive effect of the SPARK resilience programme implemented in schools in Great Britain has been demonstrated in research with highly sensitive students of early adolescent age. Highly sensitive girls had significantly lower depression scores after participating in this programme, while this difference was not found for non-highly sensitive girls (Pluess & Boniwell, 2015). In a study conducted on a sample of Japanese high school students, it was also shown that highly sensitive adolescents (aged 15 to 16) benefited more from this programme. They had significantly better well-being, meaning they had higher levels of self-efficacy and significantly lower depression scores after participating in this programme. It is important to point out that these students had significantly lower well-being before starting the programme than non-highly sensitive students. However, they also benefited significantly more from this programme than their peers (Kibe et al., 2020). The results of one study showed that highly sensitive adolescents who were charged with minor offenses were less likely to reoffend if they lived in a supportive environment compared to those who did not live in a supportive environment. The effect of a supportive family environment could not be proven for the group of non-highly sensitive adolescents (Donley et al., 2016; Pluess et al., 2018). One study even showed that daily exercise as a positive aspect of the environment has a moderating role between the SPS trait and depressive symptoms in late adolescence (Yano & Oishi, 2018).

However, not all studies were able to prove a bigger influence of the environment on highly sensitive adolescents, while some studies showed the moderating role of other variables between the interaction of higher sensitivity and a greater environmental influence. One study, for example, showed that highly sensitive girls were more likely to develop internalising problems, and this was independent of environmental influences (Onursal, 2020). The greater likelihood of this group of girls developing internalising problems is not surprising, as a large number of studies have shown that the SPS trait is a risk factor for various internalising problems or for mental health problems in general (Hjordt & Stenbæk, 2019; Panagiotidi et al., 2020; Redfearn, 2019). However, one may wonder why in this case the environment did not have a greater impact on highly sensitive adolescent girls, as a large number of previous studies have shown a greater impact of the environment on highly sensitive people (Aron & Aron, 1997; Booth et al., 2015; Kibe et al., 2020; Liss et al., 2005; Pluess & Boniwell, 2015; Yano & Oishi, 2018). The lack of this explanation can also be found in another study, which showed that not all

highly sensitive adolescents were at higher risk of developing internalising problems during the Covid-19 pandemic (Burgard et al., 2022). The results of a different study offered an explanation as to what factors may have influenced the impact of the COVID-19 pandemic on the mental health of highly sensitive adolescents. In this study, the mediating role of resilience was demonstrated. This means that highly sensitive adolescents do not necessarily experience more stress if they are more resilient (Iimura, 2022). The research findings of Aron and colleagues have also shown that not all highly sensitive adolescents who grow up in an aversive environment exhibit higher shyness, but only those who have developed higher negative affectivity (Aron et al., 2005).

CONCLUSION

This review article provides a comprehensive overview of the current status of research on the SPS trait in adolescence. Although an increasing number of studies on the SPS trait have been conducted in the last decade, based on the analysis of previous research, not enough qualitative studies have been conducted on the main characteristics of high sensitivity.

Although certain aspects of the SPS trait in adolescence have not yet been sufficiently studied, previous research shows that adolescents with the SPS trait are more sensitive to both negative and positive life experiences. However, more recent research shows that the greater influence of negative environmental aspects on highly sensitive people is not linear, i.e., that high sensitivity together with aversive environmental aspects does not necessarily lead to poorer quality of mental health in adolescents if they have better socio-emotional skills. This finding is particularly important for professionals (psychologists and psychiatrists) who can help this vulnerable group of young people cope with stressful life events by supporting them in developing greater resilience, self-efficacy, better emotion regulation, and general socio-emotional skills.

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SENSORY PROCESSING...

Osjetljivost na senzorno procesuiranje u adolescenciji

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Glavni cilj ovog preglednog članka je opis trenutnog stanja znanstvenih spoznaja o karakteristikama crte osjetljivosti na senzorno procesuiranje (OSP) u adolescenciji. OSP crta se odnosi na povećanu osjetljivost središnjeg živčanog sustava i povezana je s tendencijom dublje obrade podražaja. Osobe s ovom crtom vrlo su osjetljive. Prijašnja istraživanja su pokazala da postoji poveznica između ove crte i lošije kvalitete mentalnog zdravlja. Osim toga, adolescencija je sama po sebi posebno izazovna faza života za većinu mladih ljudi, jer se tijekom ove razvojne faze događaju brojne promjene. Iz navedenih razloga visoko osjetljivi adolescenti predstavljaju posebno ranjivu skupinu za razvoj različitih vrsta psihičkih problema. Međutim, dosadašnja su istraživanja pokazala da razvoj različitih problema kod adolescenata sa OSP crtom uvelike ovisi o čimbenicima okoline. Ovo znanje je ključno za stručnjake (psihologe i psihijatre) koji trebaju biti svjesni glavnih karakteristika visoko osjetljivih adolescenata kako bi pružili što kvalitetniju podršku ovoj skupini mladih ljudi.

Ključne riječi: osjetljivost na senzorno procesuiranje, adolescencija, mentalno zdravlje, utjecaji okruženja