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Psychological aspects of HUMAN HIGH SENSITIVITY:

CONCEPTS - IDENTIFICATION - SUPPORT

ACADEMIC HANDBOOK

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Academic handbook

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TABLE OF CONTENTS

CHAPTER 1

ENVIRONMENTAL SENSITIVITY: CONCEPTUALIZATION AND EXPLANATION OF HIGH SENSITIVITY MODELS

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Abstract

Humans and other living beings are sensitive to the environment. Some of them differ in the way they are influenced by environmental conditions. Therefore, environmental sensitivity, which is defined as the ability to perceive and process external

stimuli, has been broadly studied. Such a concept includes different theories which all concur that only a minority of the population possesses a significantly higher environmental sensitivity, and that highly sensitive individuals differ in their response to both positive and negative features of the environment. That sensitivity alludes to internal and external stimuli, such as internal events and sensory, physical and social environments. The factors linked to a strengthened environmental sensitivity can be genetic, behavioral/temperamental and physiological. Every theoretical contribution is unique, but they share some key elements as well. The Sensory Processing Sensitivity theory conceives that sensitivity to be a personality trait manifested in depth of processing, ease of overstimulation, emotional reactivity and awareness of subtleties. The Differential Susceptibility model, which includes the Diathesis-Stress and Vantage Sensitivity theories, suggests that some individuals are more predisposed to be both negatively and positively influenced by the environment, depending on whether its conditions are adverse or thriving. The biological Sensitivity to Context approach proposes that sensitivity is shaped by early environmental conditions, and it is increased by stress response systems. Throughout this chapter, the conceptualization of environmental sensitivity and every theoretical contribution which is included in the Environmental Sensitivity meta-framework will be discussed, as well as the aspects on which they agree and differ.

Key words: environmental sensitivity, sensory processing sensitivity, differential susceptibility, diathesis-stress, vantage sensitivity, biological sensitivity to context.

After reading this chapter, you will learn:

- the definition and conceptualization of environmental sensitivity
- the most prominent theories on environmental sensitivity
- the reasons of creating different frameworks of environmental sensitivity
- how to distinguish the positive and negative environmental influences on highly sensitive people
- the importance of the theoretical perspective of the environmental sensitivity

Introduction

It is well-known that humans are sensitive to the environment, as well as other species in the animal kingdom (Acevedo, 2020; Greven & Homberg, 2020; Pluess, 2015). Nevertheless, people differ in the way they are influenced by environmental stimuli (Lionetti et al., 2018; Lionetti et al., 2019), given that some humans show much more responsivity and sensitivity to the environment compared to others (Greven et al., 2019). That is the reason why environmental sensitivity has been widely studied over the past few years (Aron et al., 2005; Greven et al., 2019).

The concept of *environmental sensitivity* has been defined as the ability of individuals to perceive and process external stimuli (Bröhl et al., 2020), and several approaches have focused on its characterization, both from areas related to research and clinical practice (Pluess, 2015). Generally speaking, the concept of "environment" in the expression "environmental sensitivity", refers to a vast amount of both prominent external and internal stimuli. Specifically, it alludes to internal events (e.g., feelings, thoughts, sensations related to the body such as pain, thirst, or hunger), sensory environments (e.g., olfactory, visual, tactile, auditory), physical environments (e.g., caffeine intake, food), and social environments (e.g., crowds, other people's mood, childhood experiences) (Greven et al., 2019; Greven & Homberg, 2020). Even if environmental sensitivity has been broadly studied, high sensitivity to environmental influences is a minority construct. In other words, only a small percentage of the population can be identified as being highly sensitive to the environment and its influences and stimuli (Acevedo, 2020; Lionetti et al., 2018). In fact, this is one of the characteristics of environmental sensitivity, and one of the main aspects on which every theoretical contribution agrees.

The term environmental sensitivity includes several theories which all explain individual differences in the ability to perceive, process and analyze stimuli from the environment (Greven et al., 2019). These theories are as follows: Sensory Processing Sensitivity theory (SPS; Aron & Aron, 1997); Differential Susceptibility theory (Belsky, 1997), which merges Diathesis-Stress theory (Belsky & Pluess, 2009; Gottesman & Shields, 1967; Hankin & Abela, 2005) and Vantage Sensitivity theory (Pluess & Belsky, 2013); and Biological Sensitivity to Context theory (Ellis & Boyce, 2011). These concepts will be discussed in the following paragraphs of this chapter. It is worth noting that in psychology, the subject of differentiated sensitivity was also taken up by other concepts explaining temperament (including a Regulative Theory of Temperament of J. Strelau). For the sake of consistency of the environmental sensitivity model framework, only selected approaches will be discussed.

Since there are several theoretical approaches in terms of what is the cause of such heightened sensitivity to the environment, the different theories are presented in full detail. Moreover, it must be taken into account that theoretical contributions addressing differences in sensitivity to the environment will be mentioned in chronological order, so as to be able to fathom how the same concept has evolved over the years, depending on the theoretical approach utilized. Apart from explaining such theories, it will be addressed the fact that sensitivity to the environment has two sides and what are the reasons behind. On the one hand, individuals might be more negatively influenced by adverse environments. On the other hand, they could as well be more positively influenced by thriving ones. In other words, this gives support to the idea that there are two sides of the same coin. While there is a dark side of environmental sensitivity, which can negatively affect individuals, there is also a bright side, characterized by enabling individuals to benefit from environmental conditions (Iimura, 2021).

Apart from that, over the chapter it will be briefly mentioned how the environmental sensitivity models are related to other constructs or theories, such as temperamental and personality theoretical approaches (see also paragraph 2.4. High sensitivity and other personality and temperament traits). What is more, it will also be addressed the fact that different aspects regarding brain regions activations or their volumes can have an impact on sensitivity to the environment. Additionally, it will be provided empirical evidence which supports the fact that sensory processing sensitivity, differential susceptibility, diathesis-stress, and vantage sensitivity are in fact markers of sensitivity to the environment.

1.1 Environmental Sensitivity frameworks

As it has been explained, since the 1990s emerged several theoretical frameworks, whose focus were individual differences in sensitivity to the environment. The most renowned in recent years were the Sensory Processing Sensitivity, the Differential Susceptibility, and the Biological Sensitivity to Context theories (Boyce & Ellis, 2005; Greven et al., 2019; Lionetti et al., 2018; Lionetti et al., 2019b). Even though every theoretical approach regarding sensitivity to the environment provides unique contributions, all of them agree on two fundamental aspects: minority of the population possesses a significantly higher sensitivity to environmental influences, and highly sensitive individuals differ in their response not only to negative environmental conditions, but also to positive features of the environment (Greven & Homberg, 2020; Greven et al., 2019; Pluess, 2015, Tillman et al., 2021). Terms related to positive and negative environmental conditions will appear throughout the handbook. Positive conditions are understood here as conditions supportive to human development (such as constructive styles of upbringing, parental attitudes and styles, adequate parental care), conditions rich in protective factors, and generally conducive to health. Negative conditions are understood (depending on the cited studies) as those rich in risk factors, potentially affecting the emergence of problems in the area of mental health (such as violence, parental failure).

In an attempt to integrate every single theoretical contribution in the field of sensitivity to the environment, the Environmental Sensitivity meta-framework emerged (Pluess, 2015). This last concept has been defined as the ability of individuals to perceive and process external stimuli (Bröhl et al., 2020), and it could be useful concerning research and practical applications (Pluess, 2015).

Since many empirical studies have focused on psychological, physiological or genetic sensitivity factors, it seems that environmental sensitivity might be driven by several mechanisms (Greven & Homberg, 2020; Pluess, 2015). Nevertheless, there is a strong likelihood that these sensitivity factors reflect biological mechanisms which jointly influence neurobiological susceptibility as the underlying main mechanism of environmental sensitivity. This means that specific characteristics of the central nervous system are reflected by a heightened environmental sensitivity,

resulting in an easier and deeper registration of environmental information (Pluess, 2015; Tillman et al., 2021).

It goes without saying that individual differences in environmental sensitivity are shaped by both environmental influences and genetic factors (Assary et al., 2020; Pluess, 2015). Notwithstanding, the extent to which genetics can influence such differences depends on those conditions in the environment experienced by individuals, particularly in early stages of development. For instance, increased environmental sensitivity could be predicted by the quality of the prenatal environment, but only in those children who carry sensitivity genes (Pluess, 2015). In fact, a study whose sample comprised monozygotic, opposite sex dizygotic and same-sex dizygotic twins has brought to light that 47% of the variation in sensitivity is caused by the influence of genetics (Assary et al., 2020). Another investigation found that 15% of the variance of environmental sensitivity is explained by the dopaminergic system (Chen et al., 2011). These findings indeed provide evidence to claim that both genetics factors and environmental sensitivity are related.

Apart from genetics, there are certain aspects of the brain structure and functioning which have been found to be related to sensitivity to the environment. One investigation (Pluess et al., 2020), whose sample consisted of same-sex twins, dizygotic and monozygotic, focused on the volume of different brain regions and whether that volume is somehow related to the impact that environmental influences can have on individuals. The findings of the study indicated that, in boys with a larger left amygdala, there was a significant correlation between higher environmental quality (environment rich in factors that protect and promote human health) lower total problems (Pluess et al., 2020). In fact, that association was not statistically significant in boys whose amygdala volume was smaller. Additionally, those boys who had a large left amygdala, when growing up in thriving, caring and encouraging environments, had more prosocial behaviors and experienced less adversity (Pluess et al., 2020).

As for the brain functioning, some studies have analyzed individuals' brains while undergoing functional magnetic resonance imaging (fMRI). One of these investigations found that higher scores in environmental sensitivity were in fact associated with greater activations in certain areas of the brain. Those areas play an essential role in attention and alertness towards relevant stimuli in terms of social interaction (e.g., the cingulate area), emotional meaning making (e.g., middle temporal gyrus), and action planning and control of movements (e.g., premotor area) (Acevedo et al., 2014). Apart from that, highly sensitive individuals showed stronger activation of the dorsolateral prefrontal cortex, which plays a crucial role in decision-making, complex tasks and higher order cognitive processing (Acevedo et al., 2014). Another fMRI study found that for those individuals who viewed positive images (conducive to positive emotions) the trait of sensory processing sensitivity was associated with a stronger reward response in the nucleus accumbens and the ventral tegmental area, both characterized by having high levels of dopamine (Acevedo et al., 2017). As for the results of individuals who had to view negative

pictures (conducive to negative emotions), it was found a strong activation in the amygdala, given that it plays a crucial role in the detection of aversive stimuli. There was also an activation of the secondary somatosensory cortex, which is involved in attention, sensorimotor integration, self-perception, memory and learning (Acevedo et al., 2017).

Another investigation addressing brain regions and their association with the trait of sensory processing sensitivity is the fMRI study of Jagiellowicz et al. (2011). Specifically, participants were scanned while they were doing a task which involved acknowledgment of subtle or significant changes in pictures of landscapes. Its results reflected that highly sensitive individuals take much more time to respond to subtle changes in images, apart from showing stronger activations in brain areas which are involved in visual attention (Jagiellowicz et al., 2011).

Certainly, there are several possible markers of environmental sensitivity which have already been identified, such as genetic, psychological and physiological factors (Lionetti et al., 2018; May et al., 2020). Nevertheless, these factors do not completely nor directly represent markers of sensitivity. That is the reason why environmental sensitivity remains the most accurate attempt to measure levels of neurosensitivity in humans (May et al., 2020). Even it has originally postulated the hypothesis that environmental sensitivity could be presented as a general factor, investigations has proven that a three-factor structure has been much more adequate and suitable for the data so far (Pluess et al., 2018). These three factors are as follows: Ease of Excitation (EOE), which is related to the fact that highly sensitive individuals might be easily overwhelmed by both internal and external stimuli (e.g., negative responses to being hungry or thirsty, or to having to experience many things at once); Low Sensory Threshold (LST), which refers and unpleasant sensory arousal to external influences (e.g., reactions to loud noises and bright lights); and Aesthetic Sensitivity (AES), which refers to aesthetic awareness (e.g., being moved by music and arts very deeply). Apart from being a tool which can be utilized with adults, later on the scale was adapted to children, which made it possible for the Highly Sensitive Child Scale to be developed (Pluess et al., 2018).

Additionally, the Environmental Sensitivity meta-framework does make a differentiation between sensitivity types as well (Greven & Homberg, 2020; Pluess, 2015). It has been hypothesized that the combination of specific sensitivity genes and diverse environmental conditions could promote the development of different types of sensitivity (Pluess, 2015). Therefore, it could be said that if the environment tends to be generally neutral, this will facilitate the development of a general sensitivity to both negative and positive environments, which is associated with the Differential Susceptibility theory (Ellis et al., 2011; Greven & Homberg, 2020; Pluess, 2015). If the environment tends to be supportive, this may result in the development of a sensitivity towards thriving and positive environments, which is connected with the Vantage Sensitivity theoretical approach (Pluess, 2015). Lastly, if the environment is predominantly adverse, this could promote the development of a heightened sensitivity towards threatening and negative environmental conditions, which is related

to the Diathesis-Stress theory (Belsky & Pluess, 2009; Greven & Homberg, 2020; Pluess, 2015). Moreover, it has been suggested that adversity in early stages of development can increase sensitivity towards adversity in those individuals carrying sensitivity genes. For instance, adolescents in early institutional care who carried the 5-HTTLPR short allele were more likely to face emotional problems when experiencing recent stressful life events (Pluess, 2015).

The following sections will show different frameworks of environmental sensitivity, which have been developed in the past few years from experts in order to clarify the theoretical aspects of this concept. Thus, five main theories were created to respond the need to fill in the theoretical gaps of environmental sensitivity beyond its merely physical feature.

1.1.1 Sensory Processing Sensitivity theory

This theoretical approach states that the concept of Sensory Processing Sensitivity (SPS) is both a psychological and biological trait which is associated with a strengthened sensitivity to the environmental influence, enhanced awareness, empathy, self-reflection and depth of processing (Acevedo, 2020; Greven & Homberg, 2020; Pluess, 2015). Regarding its origin, it ought to be noted that SPS began to be studied 20 years ago, which had been studying and a vast number of investigations had been carrying out (Aron et al., 2005; 2010; 2012). Additionally, it should be pointed out that the SPS theory was influenced by personality and temperament theories. Specifically, they were the result of qualitative research conducted with children and adults who identified themselves as shy, introverted or easily overwhelmed by environmental stimuli (Greven & Homberg, 2020; Greven et al., 2019). Therefore, it is not unexpected to state that the term of SPS is a concept utilized in science in order to describe the highly sensitive personality (Greven & Homberg, 2020).

From this theoretical perspective, the SPS concept is considered to be an inherited temperament trait which reflects individuals' differences in the way of integrating and analyzing environmental stimuli (Aron et al., 2005; Greven et al., 2019; Lionetti et al., 2019a). In other words, it has been proposed that the SPS term is a measurable personality dimension (de Villiers et al., 2018). According to researchers, SPS is a stable personality trait which emerges in childhood and is shaped by the environment while growing up (Pluess, 2015). Given that it is a minority trait and only a small percentage of the population actually possesses it, which appears to be found in approximately 20% of the population and in more than one hundred species, it could be confirmed the existence of different levels of sensitivity (Aron et al., 2005; Greven & Homberg, 2020; Jagiellowicz et al., 2016, Pluess, 2015). That is, some individuals could be low sensitive and some others could be highly sensitive, but without forgetting about those whose levels of sensitivity are medium (Acevedo, 2020; Lionetti et al., 2018).

As a representation of the idea that sensory processing sensitivity is a continuum ranging from low to high sensitivity to external influences, and also taking into

consideration that there is a medium level of such sensitivity, the dandelion-tulip-orchid metaphor is utilized to describe those patterns (Greven et al., 2019; Lionetti et al., 2018). In the beginning, it was only used the dandelion-orchid metaphor, given that it was only conceived the existence of two levels of environmental sensitivity: low and high (Boyce & Ellis, 2005). According to that allegory, dandelions represent those individuals whose levels of sensitivity to the environment are low, whereas the concept of orchids is utilized to describe those who show higher levels of the exact same sensitivity (Boyce & Ellis, 2005). Nevertheless, when it was discovered the existence of a group of population whose levels of sensitivity to the environment were neither low nor high, but medium, the expression of tulip entered the equation (Lionetti et al., 2018).

In relation to the different sensitivity groups, the first studies carried out on SPS discovered only two groups: low and high levels of SPS (Aron et al., 2005; Greven et al., 2019). That is why SPS tended to be conceived as a category trait, rather than a continuum (Aron et al., 2005; Greven et al., 2019). In spite of this, a recent investigation threw light on this issue, since three groups of sensitivity were found when recruiting individuals ranging from 8 to 19 years old (Pluess et al., 2018). In fact, the percentages of such groups were as follows: low (25-35%), medium (41-47%), and high (20-35%) sensitive groups (Pluess et al., 2018). Because of that, it has been suggested that the trait of SPS is not a category concept, but a continuous trait, which will explain that individuals fall into three different sensitivity classes (Greven et al., 2019; Pluess et al., 2018) (read more in Chapter 2).

Regarding those individuals who are highly sensitive, from the SPS perspective they are quite sensitive to subtleties since they have a greater awareness of the environment and a low sensory threshold when it comes to perceiving information (Aron et al., 2005; Chavez et al., 2021; Greven & Homberg, 2020; Iimura & Kibe, 2020). Due to such a low sensory threshold, they are easily overstimulated by stimuli and have an increased emotional and physiological reactivity to the environmental influences (Aron et al., 2005; Greven & Homberg, 2020; Iimura & Kibe, 2020). What is more, they process information in depth and more thoroughly (Aron et al., 2005; Greven & Homberg, 2020; Iimura & Kibe, 2020). In novel situations they are easily overstimulated, apart from needing more time to observe and being less likely to act owing to that novelty (Aron et al., 2005; Chavez et al., 2021; Greven & Homberg, 2020; Lionetti et al., 2019a).

Furthermore, some genetic studies have found an association between SPS and the short allele of the serotonin transporter polymorphism (5-HTTLPR, Aron et al., 2005), or with the dopamine receptor D4 gene (DRDR; Greven et al., 2019). Nevertheless, that is not the only association which has come to light, because it has also been found that the dopamine system contributes in fact to the highly sensitive personality trait (Chen et al., 2011). One of the reasons for this is the fact that the dopaminergic system is related to attentional, motivational and reward processes (Pluess & Belsky, 2013). Apart from genetics, differences in SPS are also associated with a more sensitive central nervous system (Pluess, 2015).

Similar to the Differential Susceptibility and the Biological Sensitivity to Context theories, this theoretical contribution makes reference to those inter-individual differences in sensitivity, independent of being in a positive or negative environment (Bröhl et al., 2020; Chavez et al., 2021). One difference between the two aforementioned theories and the SPS theory is their origin. While the former was developed from childhood developmental approaches, the latter emerged from research and perspectives in adults and focused on individual differences in cognitive processes and emotional reactivity (Greven & Homberg, 2020). What makes the SPS model unique is the fact that it is the first theory to conceive sensitivity to the environment as a personality trait, which is reflected in emotional reactivity, depth of processing, sensitivity to subtleties, ease of overstimulation and empathy (Greven & Homberg, 2020).

Focusing on the core elements of the SPS theory, there exists an acronym which is rather useful to remember them, which is "DOES" (Greven et al., 2019). The first letter stands for the depth of processing, which can be observed in highly sensitive individuals. Principally, it makes reference to the tendency to employ more complex and deeper processing strategies in order to plan an effective course of actions (Aron et al., 2012; Homberg et al., 2016). Owing to the deployment of such complex strategies, it is obvious why SPS has been linked to "pause to check", since highly sensitive individuals do need more time to process stimuli exhaustively, mainly in novel situations (Aron er al., 2005; Homberg et al., 2016).

The second letter of the acronym, the O, is for overstimulation. Without a shred of doubt, highly sensitive individuals are easily overstimulated, which can lead them to generally withdraw from social contexts, to experience shyness or even to have a poorer decision-making process (Homberg et al., 2016; Greven et al., 2019). This characteristic would explain why individuals high on SPS, in comparison to those whose levels of SPS were lower, work faster and more accurately on difficult perceptual tasks, but feel more stressed when doing such tasks (Homberg et al., 2016).

The third letter of the acronym, the E, stands for emotional reactivity, as well as physiological stress reactivity and arousability (Aron et al., 2012; Pluess, 2015). According to SPS theory, the trait is characterized by having stronger emotional responses (both positive and negative), and empathy to others' affective cues (Acevedo et al., 2018). In fact, a fMRI investigation studied participants' response to viewing photos of partners and strangers with negative and positive facial expressions (Acevedo et al., 2014). Its results indicated that SPS had an association with more activation in brain regions associated with empathy, such as the inferior frontal gyrus and the insula (Acevedo et al., 2014). Other research studies have determined activations unique to SPS that have been shown in neural structures related to reward processing, physiological homeostasis and pain-control, self-other processing, awareness and reflective-thinking, and self-control (Acevedo et al., 2018). Moreover, SPS have shown clear activations in amygdala, hippocampus, and hypothalamus, which are associated with emotional, self-control and executive function (Acevedo et al., 2018). This would suggest that highly sensitive individuals integrate sensory information to a greater degree in response to others' affective states (Homberg et al., 2016).

The fourth and last letter of the aforementioned acronym, the S, is for subtleties. This means that highly sensitive individuals show greater awareness of environmental subtleties, such as lightning or smells, due to possessing a heightened sensitivity to subtle stimuli (Greven et al., 2019; Homberg et al., 2016).

As a matter of fact, there are several studies in which it was analyzed the relationship between SPS theory and other personality and temperamental theories. The main personality theories which have been compared to the SPS model in different studies are Eysenck's personality theory (Aron & Aron, 1997), Gray's Reinforcement Sensitivity theory (Amiri & Navab, 2019; Pluess et al., 2018), Rothbart's temperamental model (Evans & Rothbart, 2006; Sobocko & Zelenski, 2015), and McCrae and Costa five-factor model of personality (Assary et al., 2020; Bröhl et al., 2020).

Focusing on Eysenck's personality theory, one article carried out seven studies to examine the relationship between that theory and the SPS model (Aron & Aron, 1997). Its results indicate that there was a positive correlation between introversion and environmental sensitivity ($r = 0.29$; $p < 0.01$) (Aron & Aron, 1997).

Regarding Gray's Reinforcement Sensitivity theory, different studies have found positive and moderate correlations between SPS and Behavioral Inhibition System (Pluess et al., 2018; Sobocko & Zelenski, 2015). Nevertheless, some other investigations have discovered positive but weaker associations between SPS and Behavioral Activation System (Şengül-İnal et al., 2018; Smolewska et al., 2006).

As for Rothbart's temperamental model, some studies found strong and positive correlations between negative affectivity, sensory discomfort, ease of excitation (EOE) and low sensory threshold (LST) (Evans & Rothbart, 2008; Sobocko & Zelenski, 2015). It must be pointed out that EOE and LST are two of the three factors into which the HSPS is divided. However, another study found low associations between such variables (Pluess et al., 2018).

Concerning McCrae and Costa's five-factor model of personality, some consistent and moderate to strong correlations between the sensitivity trait and neuroticism were found, which might reflect a strengthened sensitivity to negative environmental conditions (Lionetti et al., 2019a). Moreover, negative correlations were found as well between SPS and extraversion (Lionetti et al., 2018; Smolewska et al., 2006). In the case of openness, studies have found a positive association with SPS, and even a strong one with the third factor of the HSPS, which is known as aesthetic sensitivity (AES; Lionetti et al., 2018; Şengül-İnal et al., 2018). As for conscientiousness and agreeableness, significant correlations were found only with AES (Lionetti et al., 2018; Sobocko & Zelenski, 2015).

One of the questions which have arisen owing to the relationship between the aforementioned theories is whether the construct of SPS could already be captured by other temperamental traits. Despite having found a moderate relationship between personality traits and SPS, some meta-analyses have gathered enough information to support the fact that the construct of SPS is indeed a largely distinct trait (Lionetti et al., 2018). On the whole, and even if these theories are different from each other and possess unique defining aspects, all of them have in common the

fact that they reflect how individuals differ in response to the environment (Greven & Homberg, 2020).

1.1.2 Differential Susceptibility theory

The Differential Susceptibility approach, which is influenced by evolutionary theories and developmental psychology, suggests that highly susceptible individuals are more predisposed to be negatively affected by adverse conditions in the environment (Chavez et al., 2021; Greven et al., 2019). However, this theory also posits that those individuals are more likely to take advantage and benefit from positive and thriving environmental conditions (Pluess, 2015; Slagt et al., 2017). Moreover, from this theoretical approach it has been proposed that some individuals might be more sensitive in a physiological and neurological way (de Villiers et al., 2018). This, in fact, causes them to process, perceive, and react to environmental stimuli more strongly (de Villiers et al., 2018).

As for the reasons why some individuals may be more influenced, both positively and negatively depending on the environment, it has been argued it is due to a strategy of evolution (Greven et al., 2019; Iimura & Kibe, 2020). What this means is that in order for nature to maintain fitness and diversity of species, there are differences in sensitivity. Such differences (low and high sensitivity) represent two developmental strategies, which are low and high plasticity (Belsky and Pluess, 2009; Greven et al., 2019; Lionetti et al., 2019b). Instead of speaking in terms of "vulnerability", it is about being "developmentally plastic" or "malleable" (Pluess & Belsky, 2013).

Even though the Diathesis-Stress and Differential Susceptibility theories appear to be similar, there is a substantial difference between the two of them. While the former posits that some individuals tend to be more easily affected by environmental adversities, the latter states that apart from being more likely to be affected negatively, they could also benefit more from thriving conditions in the environment (Greven et al., 2019; Pluess & Belsky, 2013). Notwithstanding, it must be highlighted that the Diathesis-Stress theory is integrated in the Differential Susceptibility framework, alongside the Vantage Sensitivity theory (Greven et al., 2019).

Regarding empirical evidence which supports the Differential Susceptibility theory, and consequently, the hypothesis that highly sensitive individuals might be both positively and negatively affected by environmental conditions, there are few studies. To cite one example, one investigation focused on the effect of environmental sensitivity on negative affectivity and adverse parental environment (Belsky & Pluess, 2009). Specifically, it was found that while highly sensitive individuals scored higher on negative affectivity when having reported a tricky and complicated childhood, they obtained lower scores on negative affect when they did not have such a troubled infancy (Aron et al., 2005). This suggests that while highly sensitive individuals might be negatively influenced by adverse conditions, they might as well benefit disproportionately from thriving and positive environments, which

supports the Differential Susceptibility theoretical approach (Aron et al., 2005). Another investigation aimed at kindergarten children compared negative emotionality and environmental sensitivity as susceptibility markers (Slagt et al., 2017). Notwithstanding, it was found that children's negative emotionality was not related to changes in child behavior and changes in parenting. In fact, it was also discovered that environmental sensitivity interacted with both positive and negative parenting in predicting externalizing behavior, but that was not the case for prosocial behavior. This meant that externalizing behavior decreased when negative parenting decreased in highly sensitive children, but those types of behaviors did also increase when negative parenting increased, which supports the Differential Susceptibility model (Slagt et al., 2017).

Given that the Differential Susceptibility approach can be conceived as a combination of two opposite theories, both of them are presented in order to understand their origins and how they have evolved until becoming the two sides of the same coin. This is what is known as the dark and bright sides of sensitivity to the environment.

1.1.3 Diathesis-Stress theory

The Diathesis-Stress theory, also called the transactional or dual-risk model, posits that some individuals possess certain characteristics which make them more susceptible to risks or threats in the environment (Belsky & Pluess, 2009). This implies that those individuals are at higher risk of being negatively affected by environmental adversities, and therefore, they are more likely to develop diseases when facing environmental stressors (Belsky & Pluess, 2009; Greven & Homberg, 2020; Iimura, 2021). As a matter of fact, it is called the dual-risk model as well because of the interaction between vulnerability factors and stressors coming from the environment (Belsky & Pluess, 2009; Greven & Homberg, 2020). Among the vulnerability factors, there are behavioral, genetic, or physiological ones (Belsky & Pluess, 2009; Greven & Homberg, 2016; Uher & McGuffin, 2008). Another conceptualization of this model could be the dark side of sensitivity to environmental influences (Iimura, 2021).

Furthermore, the Diathesis-Stress model postulates that psychological problems are caused indeed by the interaction between two factors. On the one hand, there exists an individual's inherent tendency to vulnerability. On the other hand, there is some type of external stimuli which causes stress. In other words, if an individual who is more likely predisposed to experiences some kind of stressor, they could face some problems as a consequence of that combination (Belsky & Pluess, 2009; de Villiers et al., 2018).

As for the vulnerability factors which have been linked to a heightened sensitivity to the environment, they can be genetic (e.g., short allele of the serotonin transporter gene polymorphism), behavioral/temperamental (e.g., negative emotionality or difficult temperament), and physiological (e.g., high physiological

reactivity) (Belsky & Pluess, 2009; Greven & Homberg, 2020; Greven et al., 2019; Lionetti et al., 2018).

There are few studies which support the hypothesis of the Diathesis-Stress theory related to high sensitivity, that is, the suggestion that some highly sensitive individuals, when experiencing some stressful situations and possessing certain types of inherent vulnerability factors, might suffer more the negative consequences of environmental adversities (Aron & Aron, 1997; Belsky & Pluess, 2009; Booth et al., 2015; Liss et al., 2005). For instance, a study found an interaction between environmental sensitivity and parenting. Specifically, it was found that highly sensitive individuals who reported having an unhappy childhood obtained higher scores on social introversion and negative emotionality, whereas there was no difference between highly and non-highly sensitive individuals on those traits when they reported having a happy childhood (Aron & Aron, 1997; Belsky & Pluess, 2009). Furthermore, in another investigation, individuals whose scores indicated high levels of environmental sensitivity reported the highest depression scores, but only when parental care was low (Liss et al., 2005). However, when parental quality was high, environmental sensitivity scores were not correlated with depression scores (Liss et al., 2005). Another study focused on the effect of environmental sensitivity on life satisfaction and childhood experiences (Booth et al., 2015). Its results indicate that highly sensitive people reported lower life satisfaction when having experienced a negative childhood. Nevertheless, there was no such difference observed in life satisfaction between highly and non-highly sensitive participants when it comes to reporting positive childhood experiences (Booth et al., 2015).

1.1.4 Vantage Sensitivity theory

As a result of the conceptualization of both the Diathesis-Stress and Differential Susceptibility theories, the focus started to be placed on the evaluation of the positive effects of interventions, rather than persisting in paying more attention to inter-individual differences in responsivity to negative conditions in the environment (Greven & Homberg, 2020). One concept which has emerged over the past year is what is known as the "bright side" of susceptibility to the environment and it is in accordance with what Vantage Sensitivity theory symbolizes (de Villiers et al., 2018; Iimura, 2021; Pluess & Belsky, 2013). Basically, Vantage Sensitivity is a concept which represents the tendency of highly sensitive individuals to take advantage of certain positive conditions in the environment, and benefit in a disproportionate way from support and enrichment, and from thriving experiences, such as intervention programs (Iimura, 2021; Lionetti et al., 2019b; Pluess & Belsky, 2013). Other expressions utilized in order to describe this theoretical approach are the bright side of sensitivity to the environment (Iimura, 2021).

Concerning the underlying factors which explain individual differences in Vantage Sensitivity, there are genetic (e.g., serotonin transporter-linked polymorphic region), physiological (e.g., cortisol reactivity) and psychological characteristics

(e.g., negative emotionality in early stages of development) (de Villiers et al., 2018; Pluess, 2015; Pluess & Boniwell, 2015). Therefore, it has been proposed that those individuals who have such characteristics, when experiencing an extreme but positive situation, will have their levels of physical and cognitive functioning increased, whereas those who lack such factors will maintain their level of optimal organism functioning (Pluess & Belsky, 2013).

Recent data which supports the hypothesis that some individuals do in fact benefit more from positive experiences comes from different school-based interventions (Iimura, 2021). To cite one example, Pluess & Boniwell (2015) analyzed whether there were differences between the two sensitivity groups before and after taking part in a school-based intervention aimed at preventing depression. Its results suggested that those girls scoring high on Sensory Processing Sensitivity did in fact benefit from the intervention, since their depression scores lowered. Nevertheless, when comparing with the non-highly sensitive girls, the school-based intervention was not successful (Pluess & Boniwell, 2015). Another study utilized a school-based anti-bullying intervention aimed at children (Nocentini et al., 2018). Specifically, its results reflected that highly sensitive boys, compared to those who did not score high on that personality trait, benefited significantly more than non-highly sensitive boys, in terms of reduced internalizing problems and victimization. Therefore, these findings provide evidence to support the Vantage Sensitivity model.

Each of these theories mentioned (Diathesis-Stress, Sensory Processing Sensitivity, Differential Susceptibility, Biological Sensitivity to context, and Vantage Sensitivity) attempt to explain the construct of environmental sensitivity. They also tried to determine the impact of the environment through a meta-framework, including the theories created before. However, what do you think about the characteristics they share? What do you think about the different proposals?

1.2 Biological Sensitivity to Context theory

As for this theoretical approach, the focus is on physiological differences in reactivity to the environment and its stimuli, or even stress (e.g., immune reactivity, arterial pressure, cortisol production) (Boyce & Ellis, 2005). As a matter of fact, this theory suggests that early exposure to extreme conditions in the environment, both positive and negative, increases an individual's neurobiological susceptibility (Boyce & Ellis, 2005; Gunnar, 1994). This means that environmental influences can have an impact on shaping differences in sensitivity to the environment over time (Aron & Aron, 1997; Greven et al., 2019; Pluess, 2015). That is, those individuals who are exposed to thriving or adverse environmental conditions might develop a higher physiological reactivity and, therefore, a heightened sensitivity to the environment (Kohn, 1991; Lionetti et al., 2019b; Pluess, 2015).

Consequently, neurobiological susceptibility to extreme positive or negative environments reflects a strengthened reactivity in stress response systems (Aron & Aron, 1997; Boyce & Ellis, 2005; Ellis & Boyce, 2011; Greven et al., 2019). What is more, it has been found that both environmental and genetic factors do play a vital role in the adjustment of biological stress response systems during stages of early development. In fact, the neurobiological systems are characterized by a notorious early plasticity (Boyce & Ellis, 2005). All of this entails that not only do stress response systems increase susceptibility to adverse environments, but they also increment susceptibility to supportive conditions (Boyce & Ellis, 2005; Greven et al., 2019).

Based on the statement that individual differences in stress reactivity represent variations in susceptibility to both negative and positive features of the environment, it is proposed by this theoretical approach a U-shaped and curvilinear relationship between encouragement versus stress in early stages of development and the creation of Biological Sensitivity to Context (Boyce & Ellis, 2005; Greven & Homberg, 2020). Basically, this would reflect how individuals who experience very stressful situations in their early infancy might develop strengthened reactivity profiles. Whereas those children who experience the opposite, that is, thriving and encouraging situations in their early childhood, could in fact develop heightened reactivity profiles as well (Boyce & Ellis, 2005). Regarding those individuals who are raised in supportive environments, it could be said that their levels of biological sensitivity to context are lower, and they would also be represented in the U-shaped curvilinear relationship postulated by this model as can be seen in Figure 1 (Boyce & Ellis, 2005; Greven & Homberg, 2020).

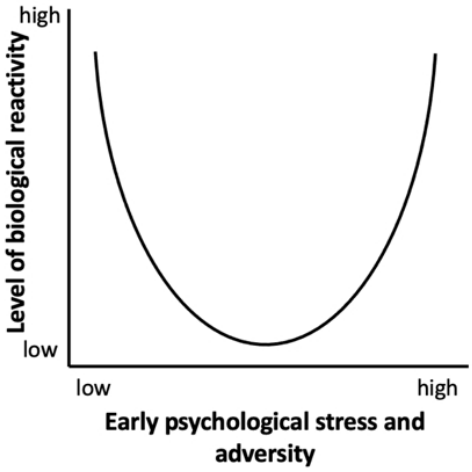

Figure 1.1. Biological sensitivity to context (Boyce & Ellis, 2005).
U-shaped curvilinear relationship between level of biological reactivity and psychological stress.

Unlike the Differential Susceptibility or Sensory Processing Sensitivity theories, the Biological Sensitivity to Context emphasizes how crucial it is the role that early environmental influences play in shaping differences in sensitivity to the environment (Greven et al., 2019; Pluess, 2015). Therefore, the importance placed on genetics by the Differential Susceptibility theory is not the central aspect by which the Biological Sensitivity to Context theory is characterized (Greven et al., 2019). Without a shred of doubt, they play a role in the model, given that individuals who are genetically predisposed to becoming environmentally sensitive are more likely to do so, but only when exposed to very stressful or supportive environments during childhood (Boyce & Ellis, 2005; Greven & Homberg, 2020).

1.2.1 Illustrative representation of the environmental sensitivity meta-framework

Given that sensitivity to the environment can be studied and examined from different theoretical perspectives, the different models of environmental sensitivity are presented. As can be seen in Figure 2, the key aspects of each theory are synthesized in order to better understand what each model represents.

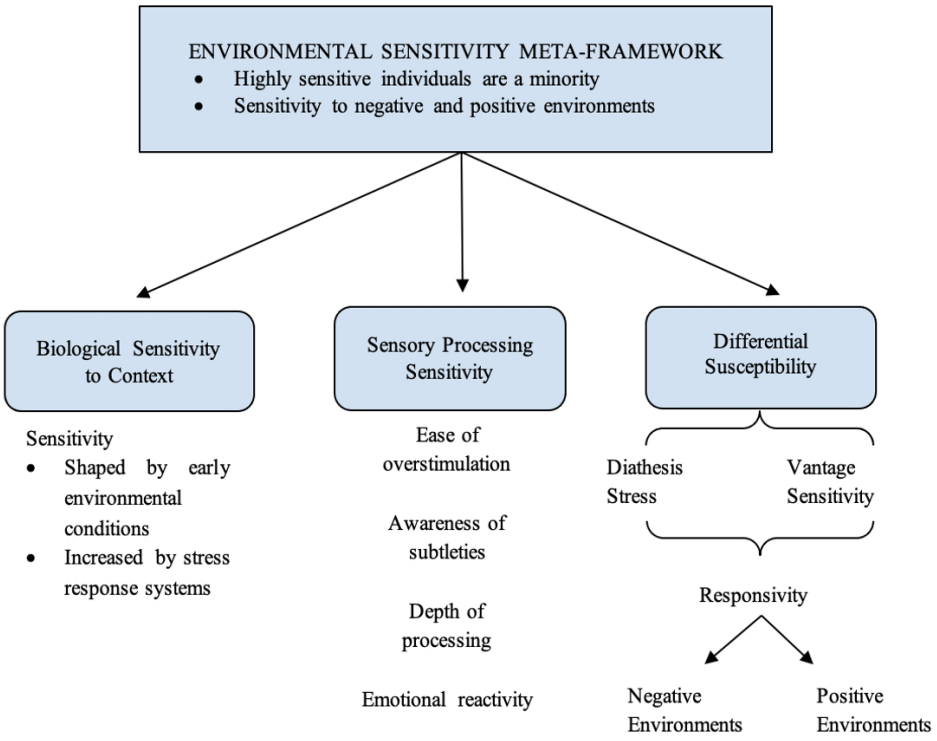

Figure 1.2. Models of Environmental Sensitivity (Greven et al., 2019).

From the Environmental Sensitivity meta-framework, the Neurosensitivity hypothesis was postulated (Greven & Homberg, 2020; Pluess, 2015). It is suggested by this hypothesis that both early environments and sensitivity genes, as well as their interaction, can shape the sensitivity of the central nervous system (Greven & Homberg, 2020; Pluess, 2015). In other words, the sensitivity of the central nervous system is determined by the effect and interaction of environmental and genetic factors. Perhaps, this would the results observed in the study by Acevedo et al. (2021). In which they examined brain connectivity by functional magnetic resonance imaging in 15 healthy adults (9 women and 6 men) by observing them in a resting state after completing a social affective empathy task. The results showed that highly sensitive (vs. low sensitive) individuals had enhanced patterns of neural connectivity within the ventral attention, dorsal attention and limbic networks following the affective/social task. These brain regions play a role in memory consolidation, physiological homeostasis and deliberative cognitive processing. In fact, these findings support the fact that depth of processing is a key element of environmental sensitivity. Indeed, these findings support the fact that depth of processing is a key element of environmental sensitivity. Given that some individuals possess a higher degree of sensitivity in the way they process sensory information, that might entail a greater likelihood for the development of psychopathology. In fact, although sensitivity and sensory processing are similar but not the same terms, a recent systematic review analyzed fourteen studies in order to prove whether there was an association between sensory processing and quality of life (Costa-López et al., 2021). Despite these results indeed indicate a negative, moderate and significant association between these variables (Costa-López et al., 2021), this trait has been also labeled as a 'bright side', promoting a positive health functioning in response to positive environments (Sweitzer et al., 2012). Highly sensitive individuals may therefore take the form of security of attachment from sensitive parenting, academic achievement resulting from high-quality childcare, prosocial behaviors due to supportive social networks, and life satisfaction stemming from positive life events (Pluess & Belsky, 2012).

Remember

- Environmental Sensitivity has been defined as the ability to perceive and process external stimuli.
- Individual differences in Environmental Sensitivity are shaped by both genetic factors and environmental influences.
- Only a small percentage of the population is highly sensitive.
- The most renowned theories on individual differences in sensitivity to the environment are: Sensory Processing Sensitivity, Differential Susceptibility and Biological Sensitivity to Context.
- Environmental Sensitivity was postulated as an attempt to integrate every theoretical contribution in the field of individual differences in sensitivity to the environment.
- Highly sensitive individuals might be positively influenced by thriving environments, and negatively affected by adverse ones.

Summary

All of the aforementioned theories explained (Diathesis-Stress, Sensory Processing Sensitivity, Differential Susceptibility, Biological Sensitivity to context, and Vantage Sensitivity) are characterized by being unique, but at the same time they share some key aspects. In fact, they all try to explain the reasons why some individuals develop and show greater sensitivity and responsiveness to the environment. Perhaps, every model proposed could partially be true and what could differ is the type of environment in which individuals are immersed, which would therefore shape the type of sensitivity to the environment that will be developed. This would be related to the sensitivity types described in the meta-framework of environmental sensitivity, as described in this chapter. Nevertheless, those sensitivity types are to be examined in an empirical way.

As a matter of fact, future research ought to make use of longitudinal and experimental studies, given that correlational investigations do have their limitations. Not only should participants be imagined in perceived negative conditions in the environment, but they should also be exposed to positive environments in order to examine the veracity of the different theoretical approaches. The main reason is that controlling both positive and negative environmental variables will provide the scientific community with reliable empirical data. Apart from that, this would also be beneficial, since the trait of sensory processing sensitivity would achieve more empirical evidence to support its uniqueness. Additionally, this would help distinguish the sensory processing sensitivity trait from other temperamental and personality constructs.

Furthermore, it is of the utmost importance to understand how the central hypothesized characteristics in the Sensory Processing Sensitivity model are related to each other. This means that it is necessary to know the relationship between ease of stimulation, depth of processing, sensitivity to subtleties in the environment, and emotional reactivity and empathy. Additionally, it remains unclear the role that the biological systems play in responsivity. That is, it is still unknown if the same biological systems which support sensitivity to adverse conditions in the environment are also the ones which are related to sensitivity to positive environmental conditions.

By knowing better and profoundly the sensory processing sensitivity construct, it could also be possible and achievable to prevent some problems that highly sensitive individuals might face throughout their life cycle, as a consequence of being much more sensitive to the environment. By the same token and taking into consideration that experiences in early stages of life have a profound impact on individuals' sensitivity, some interventions could be promoted from the educational point of view. In this way, individuals high in sensory processing sensitivity could disproportionately benefit from such interventions, which will decrease the likelihood of developing diseases or illnesses in the long term.

All in all, every theoretical approach on the field of environmental sensitivity provides specific information to explain why some individuals differ in the

responsivity they show and possess towards the environment. In fact, there is empirical evidence which supports the different sensitivity models, as it has been explained in the different sections of this chapter. Therefore, the emerging picture seems to be complex and there is a strong need to continue studying the construct of environmental sensitivity, given that it has a vast number of implications for those who show much more sensitivity to the environment. One of those is the possible relationship that exists between sensory processing sensitivity and quality of life, as it has already been addressed in this chapter. That is the reason why highly sensitive individuals must be provided with the suitable and appropriate tools and skills, so that they can cope with stressful situations on a daily basis and in every context of their life. As a matter of fact, this could be beneficial for their quality of life, well-being and daily functioning, given that they could face problems and despite being predisposed to be negatively influenced by adverse conditions, they could solve them adequately and in a healthy way.

Revision questions

Read the following statements related to the chapter and guess if they are True or False. Then, justify your response if needed.

1. The concept of environmental sensitivity implies the perception and processing, not only of the intern stimuli, but also of the sensory, physical and social extern stimuli.
2. Most of the general population can be categorized as highly sensitive to environmental stimuli.
3. The Sensory Processing Sensitivity Theory suggests that the environmental sensitivity could be understood as a personality trait.
4. From the Sensory Processing Sensitivity Theory, highly sensitive people tend to avoid environmental stimuli. They therefore may present less awareness of the environment and process the information in a general manner. They could point out less emotional and physiological response to environmental influences.
5. It is known that the noradrenergic system is associated with the sensitivity trait, and its relationship with the attentional, motivational and rewarding processes.
6. The acronym DOES refers to the depth of processing, ease of overstimulation, empathy, emotional reactivity, and sensitivity to subtleties.
7. The Differential Susceptibility theory hypothesizes the relationship between Diathesis-Stress theory and high sensitivity.
8. The Differential Susceptibility Theory highlights the tendency of the highly sensitive individuals to take advantage of the positive features of the environment, and to benefit

from the support and intervention programs, in which they work out other psychological variables.

9. The Biological Sensitivity to Context Theory suggests that individuals, who are genetically predisposed to be highly sensitive, present more likelihood to present high sensitivity in stressful of supportive contexts during their childhood.
10. The Neurosensitivity approach points out that both genetic and environmental factors determine the sensitivity of the central nervous system. Due to this, some individuals may present a high level of sensitivity when processing information, considering this trait as a protector factor to copy psychopathologies.

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