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Environmental Sensitivity and Parenting: A Systematic Review of Mediating Mechanisms in Child Development

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Abstract

Children learn how to make sense of the world around them from their caregivers. Yet not all children respond to their environment in the same way. Environmental sensitivity frameworks suggest that some children can be more responsive than others to what happens around them, particularly within parenting contexts. Research shows that highly sensitive children are more influenced by parenting quality, but we still do not know much about the processes that explain why this happens. This systematic review examined empirical studies exploring environmental sensitivity, parenting, and child developmental outcomes, with a focus on mediating mechanisms. The review was guided by three main questions: how parenting is operationalized, which mediating mechanisms have been tested, and what patterns emerge across parenting, mechanisms, and outcomes.

Sixteen studies were included in the review following the PRISMA guidelines, published between 2016 and 2025, with participants age range from infancy through adolescence. The majority of studies employed longitudinal designs and primarily relied on questionnaire-based assessments. Environmental sensitivity was mainly assessed within the Sensory Processing Sensitivity framework, typically using the Highly Sensitive Child scale, with some studies employing temperament or biological indicators. Parenting was most often operationalized as behavioral caregiving quality (styles, warmth, observed behavior), assessed through parent-report questionnaires or observational coding. A few studies examined it within family stress or transactional models. Developmental outcomes mainly included internalizing and externalizing symptoms, as well as social competence and prosocial behavior, measured through parent or self-report measures.

Across studies, moderation analyses consistently indicated that environmental sensitivity functioned as a conditional factor, with highly sensitive children showing amplified responses to variations in caregiving quality. However, only 6 out of 16 studies formally tested mediation. When mechanisms were tested, they mostly involved cognitive-emotional processes, such as rumination and stress appraisal, or broader family stress dynamics. Indirect effects were more consistently observed for internalizing than for externalizing outcomes, suggesting that cognitive-emotional processing may represent a particularly relevant pathway linking parenting and emotional adjustment in highly sensitive children. Overall, findings indicate that environmental sensitivity shapes for whom parenting matters most, whereas explanatory mechanisms remain comparatively underdeveloped. These results suggest that interventions may be particularly beneficial for highly sensitive children when targeting cognitive-emotional and family stress processes. Future research should prioritize longitudinal designs integrating sensitivity with clearly specified cognitive-emotional and relational mechanisms to clarify how parenting influences developmental outcomes.

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Lastly, I hope we all see our depth as a strength and keep going, even when things feel difficult.

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1. Introduction

From the beginning of life, parenting plays an important role in shaping children's development. Through everyday interactions with caregivers, children become familiar with their environment. They learn how to make sense of the world around them. These early experiences form the foundation for their emotional and behavioral functioning, in particular through the quality of early relationships with caregivers (Ainsworth et al., 1978). However, while parenting is clearly important, its effects are not experienced the same way by all children.

Many children can experience and respond to environments differently. Some children appear particularly sensitive to how they are treated, showing stronger emotional and behavioral responses to both negative and positive caregiving experiences. These individual differences in sensitivity have been noticed and conceptualized by researchers over the years under the construct of environmental sensitivity. Environmental sensitivity refers to the capacity to perceive, process, and respond to environmental stimuli, such as social, emotional, or sensory, at a more intense level than others (Pluess, 2015). Over time, it has become an important topic because it has been increasingly used to explain heterogeneity in children's responses to caregiving environments.

Prior research on child development focused more on vulnerability-based models, emphasizing that certain children are more likely to develop problems when exposed to adverse environments (Monroe & Simons, 1991). In addition, vulnerability was viewed as a disadvantage, increasing the risk of maladaptive outcomes, such as emotional and behavioral issues, when they are exposed to stress or difficult caregiving contexts (Ingram & Luxton, 2005). Although these models made significant contributions to understanding developmental risk, they

centered on negative outcomes and did not consider the part where that heightened sensitivity could have benefits in supportive environments.

Over the years, research has started to challenge this view. Environmental sensitivity models propose that heightened sensitivity may increase how strongly individuals respond to environmental influences, including both adverse and supportive experiences. From this standpoint, the same children who are most affected by negative caregiving environments may also be those who benefit the most from warmth, responsiveness, and support (Belsky & Pluess, 2009). This shift has reframed environmental sensitivity as a form of developmental plasticity, instead of just vulnerability.

While environmental sensitivity frameworks help explain why children differ in their responsiveness to parenting, they also raise a further question: how do caregiving experiences come to shape development in more sensitive children? Much of the existing research has focused on identifying for whom parenting matters most, far less attention has been given to the processes through which parenting influences emotional and behavioral outcomes in sensitive children (Pluess & Belsky, 2013). Understanding whether and how mediating mechanisms have been empirically examined is essential for moving beyond description toward explanation, and for translating environmental sensitivity research into effective intervention and prevention strategies.

1.1 Theoretical Framework

The environmental sensitivity theory proposes that children vary in the degree to which they respond to their environments, which include both positive and negative experiences (Pluess, 2015). These individual differences are central to understanding why similar parenting environments may lead to diverse developmental outcomes across children. Over time,

researchers have described environmental sensitivity through several theoretical frameworks, such as Sensory Processing Sensitivity (SPS) (Aron & Aron, 1997) and the Highly Sensitive Child (HSC) model (Pluess et al., 2018). SPS can be understood as a trait reflecting heightened awareness of environmental input, deeper processing of experiences, and stronger emotional reactions. The HSC model uses these principles to examine how such traits shape children's responsiveness to parenting and broader environmental contexts.

Within this perspective, parenting is considered a central environmental influence. Parenting quality (Ainsworth, 1978), styles (Baumrind, 1967), stress (Abidin, 1992), or other difficulties can all be expected to impact children's development. Studies suggest that children who are more environmentally sensitive can be more responsive to how they are parented, meaning they can be especially negatively affected by stress or harsh parenting, but may also benefit more from support and warmth (Slagt et al., 2016). This pattern suggests that sensitivity is not only about whether parenting matters, but also about how children respond to parenting experiences.

Although environmental sensitivity theory explains why children differ in their responses to parenting, it provides less clarity on the processes through which caregiving experiences shape developmental outcomes. Broader developmental theories have proposed mechanisms that include heightened emotional and stress reactivity (Boyce & Ellis, 2005), emotional regulation (Morris et al., 2007; Eisenberg et al., 2010), deeper cognitive processing and appraisal of caregiving experiences (Aron & Aron, 1997), and ongoing parent-child interactions involving co-regulation and bidirectional influence (Davies & Cummings, 1994). In summary, these accounts suggest that parenting influences development in environmentally sensitive children not

simply by increasing or decreasing exposure to risk, but by shaping the emotional, cognitive, and biological processes through which environmental experiences are perceived and responded to.

1.2 Aim

The aim of the present systematic review was to examine empirical findings on environmental sensitivity in the context of parenting and child development. In more detail, this review aims to synthesize evidence on how parenting has been operationalized, which mediating mechanisms have been empirically examined to explain developmental outcomes within parenting contexts, and explore the patterns in the associations between types of parenting, mediating mechanisms, and child developmental outcomes within environmental sensitivity research. By integrating findings from environmental sensitivity research, the review aims to clarify current empirical practices and identify gaps in process-oriented investigation within this literature.

1.3 Research Questions

1. How is parenting operationalized across studies examining environmental sensitivity in children?
2. Which mediating mechanisms have been empirically examined within environmental sensitivity research to explain developmental outcomes involving parenting contexts?
3. What patterns emerge in the associations between types of parenting, mediating mechanisms, and child developmental outcomes within environmental sensitivity research?

2. Literature Review

2.1 Parenting and Child Development

Parenting represents the main environment in which children begin to understand and engage with the world around them. For many years, development research has focused on the role of parenting in shaping children's emotional and behavioral functioning. Ainsworth (1978) demonstrated that the quality of early parenting relationships plays a major part in the development of children. Through observational studies, she showed that caregiver sensitivity and responsiveness to children's signals are essential components of quality parenting. When caregiving is consistent and attuned, children are more likely to feel secure, which supports emotional regulation, social engagement, and exploration. On the contrary, caregiving that is inconsistent or emotionally unavailable may weaken this security and increase the risk of emotional and behavioral difficulties. These findings highlight the role of caregiving quality in shaping early developmental directions.

Parenting also varies in the level of stress parents experience in their daily caregiving role. Parenting stress describes the extent to which parents feel overwhelmed by the demands of raising a child, particularly when child characteristics, contextual pressures, or limited personal resources place ongoing demands on caregivers (Abidin, 1992). When parenting stress is high, parents may find it harder to remain emotionally available, patient, and consistent, often becoming more reactive in their interactions with their children (Deater-Deckard, 1998). These shifts in everyday parenting practices are associated with higher levels of emotional and behavioral difficulties in children (Neece et al., 2012). Consequently, children's behavioral

problems can further increase parental stress, creating reciprocal patterns that may intensify over time (Patterson, 1983).

Parenting can be described in terms of broader interaction patterns, often referred to as parenting styles. Based on warmth and structure there are four styles: authoritative, authoritarian, permissive, and neglectful (Baumrind, 1967). Differences in parental warmth and structure have been linked to variations in children's emotional regulation and behavioral adjustment (Baumrind, 1967; Maccoby & Martin, 1983; Pinquart, 2017). However, maintaining supportive and consistent parenting can be particularly challenging under conditions of high stress, which may weaken the benefits typically associated with more positive parenting styles (Deater-Deckard, 1998; Anthony et al., 2005). Together, these findings highlight that parenting influences child development not only through observable behaviors, but also through parents' psychological experiences and the broader family context in which caregiving takes place.

Although there are strong links between parenting quality, stress, style and child development, children exposed to similar caregiving environments do not develop in the same ways. Some children show noticeable emotional or behavioral difficulties in response to adverse parenting, whereas others show more adaptability (Belsky & Pluess, 2009). Similarly, supportive and responsive caregiving may promote substantial developmental gains in some children, while resulting in more limited benefits for others (Belsky, 1984). Research on temperament, emotional reactivity, and self-regulation provides early evidence for such variability, demonstrating that child characteristics can moderate the effects of parenting on developmental outcomes (Rothbart & Bates, 2006; Thomas & Chess, 1977). Combined, these studies indicate that the impact of parenting does not depend only on caregiving quality, style or stress, but also on individual differences in children.

Historically, parenting research has focused on how parenting behaviors are related to child outcomes on average across populations. This work has helped identify general patterns of caregiving and development. However, looking only at overall trends can hide important differences between children. For some children, parenting may have a much stronger influence, while for those who are more resilient or less reactive, it can have a weaker effect (Belsky & Pluess, 2009; Pluess, 2015). Because of this, approaches that focus only on overall patterns offer limited insight into why some children are more strongly affected by parenting experiences than others. This limitation has led researchers to shift toward approaches that consider for whom parenting matters most, laying the groundwork for environmental sensitivity frameworks, while raising further questions about how parenting experiences are translated into developmental outcomes. The following sections outline key models that were developed over the years to explain this variability.

2.2 Vulnerability-Based Models

There are some theoretical frameworks that have been proposed to describe individual differences in sensitivity to environmental influences. One of the earliest approaches is the diathesis-stress model, which proposes that some people have pre-existing vulnerabilities such as genetic predispositions, neurobiological sensitivity, or temperament traits that contribute to the chance of developing psychopathology when faced with environmental stressors (Monroe & Simons, 1991). Within this framework, challenging experiences including family conflict, harsh parenting, or chronic stress are thought to activate these vulnerabilities and increase the risk of emotional and behavioral problems (Ingram & Luxton, 2005). Overall, the diathesis-stress model conceptualizes individual differences in sensitivity mainly in terms of risk. Individuals with heightened vulnerability are expected to show poorer outcomes than others in adverse

environments, while little attention is given to explaining what happens to them in a positive context. For this reason, this model has been criticized for its strong focus on negative outcomes, giving little consideration to the potential benefits that positive environmental conditions, such as sensitive and responsive parenting, may hold for individuals influenced by their environments (Belsky & Pluess, 2009).

Other related vulnerability-based models have also investigated how broader contextual stressors affect child development through family processes. In particular, family stress models (Conger et al., 1992) provide a framework for understanding how broader contextual difficulties influence child development through changes in family functioning and parenting. According to these models, stressors such as economic hardship, family instability, and chronic strain may enhance the psychological distress of parents, which in return undermines parenting quality and leads to harsher, less consistent, or less emotionally responsive caregiving (Conger et al., 1992; McLoyd, 1998; Conger & Donnellan, 2007). From this perspective, children's emotional and behavioral difficulties are viewed as indirect consequences of stress related changes in the caregiving environment rather than as direct effects of adversity alone.

One of the strengths of family stress models is that they point out mediating processes. By identifying parental distress and parenting behaviors as key mechanisms linking contextual stress to child outcomes, these models provide a clear, process-orientated explanation of how environmental risk becomes developmentally consequential. This has been valuable for both research and intervention, as it highlights modifiable family-level targets such as parental mental health and caregiving practices (Conger et al., 2010).

However, when considered in relation to environmental sensitivity, family stress models also show important limitations. In particular, these models tend to conceptualize child characteristics mainly as vulnerability factors that increase exposure to stress, rather than as indicators of differential responsiveness. Accordingly, family stress models largely predict one-sided effects of adversity and offer limited insight into why some children may benefit more than others from supportive or positive caregiving environments (Rutter, 2007). In addition, although family stress models place strong emphasis on mediation, the mechanisms they examine are often limited to parental distress and caregiving behaviors. Less attention is given to child-level emotional, cognitive, or physiological processes that may also shape how children respond to parenting. Consequently, while family stress models provide a strong foundation for understanding how risk is transmitted within families, they are less well suited to explaining individual differences in responsiveness to both adverse and supportive parenting contexts. These limitations helped the growth of alternative frameworks that reframe sensitivity not as vulnerability, but as heightened openness to environmental influence.

2.3 Biological and Developmental Perspectives

Another model is the Biological Sensitivity to Context model (Boyce & Ellis, 2005), which highlights the role of physiological reactivity as a key mechanism behind individual differences in environmental sensitivity. This framework argues that children's responsiveness can be different depending on their biological stress systems, including the hypothalamic pituitary adrenal axis (HPA) and the autonomic nervous system, which regulate physiological responses to stress and environmental demands. Variation in these systems shapes how strongly children react to environmental demands and supportive contexts. Beyond stress physiology,

some researchers have explored dopamine-related genetic variants like DRD4 as biological markers of sensitivity to the environment (for example, Cho et al., 2016).

Importantly, heightened biological reactivity means not simply a marker of vulnerability but also increased sensitivity to the environment's influences more broadly. Empirical studies support this view, showing that children with high stress reactivity have been linked to poorer outcomes under adversity but to better adaptation under supportive caregiving (Obradovic, 2010). Research on the development of the HPA axis further indicates that environmental experiences, particularly parenting, play a key role in calibrating stress reactivity over time (Gunnar & Quevedo, 2007). Together, these findings suggest that physiological reactivity functions as a central mechanism through which environmental experiences, especially parenting, become biologically embedded in development and linked to later developmental outcomes. This perspective marked a shift toward understanding sensitivity as openness to environmental influence, a core idea further developed in sensitivity-based models of developmental plasticity.

2.4 Differential Susceptibility Theory

More recent models of environmental sensitivity describe variations among individuals as due to increased adaptability rather than vulnerability alone. Differential Susceptibility Theory proposed by Belsky and Pluess (2009) suggests that some individuals are not just more vulnerable to adverse environments but generally more responsive to environmental influences more broadly. From this perspective, highly sensitive individuals tend to show poorer outcomes when exposed to harsh conditions, but they can also experience more positive outcomes when raised in warm and nurturing environments.

Above all, this theory views sensitivity as a type of developmental plasticity rather than a disadvantage. It is important to note that it does not define sensitivity in terms of a single trait or mechanism. Instead, heightened susceptibility may be identified by a range of characteristics, including temperamental reactivity, biological stress sensitivity, or genetic factors (Belsky & Pluess, 2009). These characteristics are not harmful, and their developmental consequences depend more strongly on environmental conditions, particularly caregiving experiences. Accordingly, children who are most negatively affected by harsh or inconsistent parenting may also benefit the most from sensitive and responsive caregiving. This represents a significant change in how individual differences are understood, as it challenges traditional assumptions that risk factors function in the presence of difficulties. In contrast, Differential Susceptibility predicts bidirectional effects, meaning the same children who fare worst in unsupportive environments may also show the greatest gains in positive contexts.

2.5 Vantage Sensitivity

In addition to broader environmental sensitivity frameworks, we have Vantage Sensitivity (Pluess & Belsky, 2013) that offers a more focused perspective on individual differences in how children respond to positive environmental experiences. Rather than concentrating on vulnerability to adversity, this model points out that some individuals are likely predisposed to benefit from supportive environments, such as warm and responsive parenting. From this perspective, sensitivity is expressed as a tendency toward greater development advantages in favorable contexts, without necessarily implying on increased susceptibility to negative conditions. Accordingly, children high in vantage sensitivity are expected to show more improvements in emotional, cognitive, or behavioral functioning when exposed to positive

caregiving practices, interventions, or supportive social conditions, compared to less sensitive peers.

This framework complements other environmental sensitivity models by drawing attention to the asymmetric effect of positive environments and shifting the focus toward benefits of development. Moreover, it points out the value of identifying children who are most likely to benefit from supportive caregiving environments, thus further emphasizing the role of sensitivity-related processes in shaping development.

Although several theoretical models have described differential responsiveness, the present review primarily focuses on studies operationalizing environmental sensitivity through Sensory Processing Sensitivity (SPS) and the Highly Sensitive Child (HSC) framework.

2.6 Sensory Processing Sensitivity

Another important framework within the environmental sensitivity literature is Sensory Processing Sensitivity (SPS), which describes individual differences in how deeply people process and respond to sensory and emotional information (Aron & Aron, 1997; Aron et al., 2012). Individuals high in SPS often notice subtle details in their surroundings, respond more strongly to emotional cues, and have deeper processing of experiences. During childhood, these characteristics may be especially evident in close relational contexts, such as interactions with caregivers. Importantly, this framework is conceptualized as a normal variation in environmental responsiveness, rather than a deficit or dysfunction. Children high in sensitivity may experience overstimulation more easily in chaotic or harsh environments, but they may also show enhanced empathy, learning, and emotional understanding when raised in calm, supportive, and responsive

caregiving contexts. From this perspective, the developmental consequences associated with SPS depend largely on the quality of the caregiving environment.

The idea of heightened sensitivity was first operationalized in adults through the Highly Sensitive Person (HSP) scale, developed by Aron and Aron (1997). This work described sensitivity as a stable individual difference characterized by deeper processing of sensory and emotional information. Building on this approach, Pluess and colleagues (2018) extended the concept to childhood by developing the Highly Sensitive Child (HSC) scale. The HSC captures similar features of sensitivity in children and provides a way to assess how strongly children respond to their environments, particularly to everyday experiences within caregiving contexts. The scale is intended to measure normal variation in children's responsiveness to both supportive and challenging environments.

As such, SPS aligns with broader environmental sensitivity frameworks by emphasizing that the developmental consequences of heightened sensitivity depend on environmental quality, particularly the nature of caregiving experiences. Within Pluess' Environmental Sensitivity meta-framework (Pluess, 2015), SPS is conceptualized as one of several observable manifestations of a broader, underlying sensitivity trait. From this perspective, SPS captures the psychological and behavioral expression of environmental sensitivity, complementing biologically oriented models such as Biological Sensitivity to Context (Boyce & Ellis, 2005) and genetically informed susceptibility frameworks. Rather than representing vulnerability alone, SPS identifies for whom both negative and positive caregiving influences are more likely to be amplified.

2.7 Integrative Framework: Environmental Sensitivity Meta-Framework

The theoretical models discussed above agree on the idea that individuals vary in how strongly they respond to environmental influences, particularly within caregiving contexts. To put these perspectives together, Pluess (2015) proposed the Environmental Sensitivity meta-framework, which describes sensitivity as a general trait that shapes responsiveness to both positive and negative environmental conditions. In childhood, environmental sensitivity has most commonly been measured using the Highly Sensitive Child (HSC) scale (Pluess et al., 2018), which was developed based on the Sensory Processing Sensitivity (SPS) framework.

Within this framework, environmental sensitivity can be thought of as a general characteristic that shows up in different ways. It may be expressed through biological processes, such as how strongly a child's stress system reacts to the environment (Boyce & Ellis, 2005), through psychological and behavioral characteristics like emotional reactivity and deep processing of experiences (Aron & Aron, 1997), or through differences in how children respond to the quality of their environments as described in Differential Susceptibility (Belsky & Pluess, 2009) and Vantage Sensitivity models (Pluess & Belsky, 2013). These frameworks provided conceptual foundations for the development of the Environmental Sensitivity meta-framework, which integrates these perspectives.

Importantly, the Environmental Sensitivity meta-framework views sensitivity as neither a strength nor a weakness in itself. Being highly sensitive does not automatically place a child at risk or give them an advantage. Instead, outcomes depend largely on the quality of the child's environment, especially the care they receive. From this perspective, highly sensitive children may be more strongly affected by harsh or inconsistent parenting, but they may also benefit more

than others from warm, responsive, and emotionally attuned caregiving. By integrating biological, psychological, and contextual perspectives, the meta-framework provides a coherent account of why parenting does not affect all children in the same way.

While the diathesis-stress models (Monroe & Simons, 1991) emphasize vulnerability to adversity, Differential Susceptibility Theory (Belsky & Pluess, 2009) and Biological Sensitivity to Context (Boyce & Ellis, 2005) highlight sensitivity to both negative and positive environments, and Vantage Sensitivity (Pluess & Belsky, 2013) and SPS (Aron & Aron, 1997) fit naturally within the broader environmental sensitivity framework by emphasizing how deeply children process environmental input, rather than simply how much adversity they experience. However, empirical studies included in this review most frequently operationalized sensitivity through SPS and HSC measures.

Collectively, these frameworks converge on the idea that parenting is a particularly powerful context for environmentally sensitive children, as variations in caregiving may be amplified through heightened perceptual, emotional, and physiological responsiveness. Across environmental sensitivity frameworks, sensitivity is understood as a trait reflecting heightened openness to environmental influence, rather than as a mechanism of development itself. As such, sensitivity indicates for whom parenting is likely to matter most, while mediating processes explain how caregiving experiences are translated into developmental outcomes.

2.8 Mediating Mechanisms

Environmental sensitivity frameworks have provided explanations for why children differ in their responsiveness to parenting. However, this also raises an important question: through which processes do caregiving experiences become developmentally consequential for more

sensitive children? Research has primarily focused on identifying for whom environmental influences matter most, and less attention has been devoted to empirically testing the mechanisms through which parenting experiences are translated into emotional and behavioral outcomes (Pluess, 2015). As a result, proposed mediating mechanisms have been described largely at a conceptual level, drawing on both environmental sensitivity frameworks, broader developmental and relational theories. These mechanisms span multiple levels of functioning, including emotional, cognitive, physiological, and relational processes.

One of the foundational mechanisms includes heightened emotional and stress reactivity, as described in the Biological Sensitivity to Context model (Boyce & Ellis, 2005), which may amplify children's responsiveness to variations in parenting quality (Belsky & Pluess, 2009). However, sensitivity-based studies have rarely directly tested reactivity as a potential mediating process that links parenting to child developmental outcomes. Instead, much of the existing research has focused more on moderation-based designs, examining whether emotionally or biologically reactive children are more strongly affected by parenting quality, rather than investigating how reactivity explains these effects (Pluess, 2015). Consequently, there remains limited empirical evidence clarifying whether and how reactivity functions as a pathway through which parenting experiences shape development in environmentally sensitive children.

Another potential mechanism is emotion regulation, which refers to how children manage and respond to their emotions (Cole et al., 2004). Developmental research has consistently shown that parenting plays an important role in shaping children's emotion regulation skills (Morris et al., 2007). Children who experience emotions more intensely may rely more heavily on caregivers for support in regulating those emotions. In parenting contexts, this heightened processing may intensify the effects of both supportive and adverse caregiving, consistent with

differential susceptibility (Belsky & Pluess, 2009). In contrast, when regulatory support is inconsistent or harsh, children may be at greater risk for internalizing and externalizing difficulties (Eisenberg et al., 2010). Although emotion regulation is widely recognized as a pathway linking parenting to child adjustment (Silk et al., 2003), environmental sensitivity research has rarely tested it directly as a mediating mechanism. Instead, emotion regulation is more often treated as an outcome or discussed conceptually, highlighting a gap between theoretical assumptions and empirical testing within this field (Pluess, 2015).

Beyond emotional processes, cognitive mechanisms may also explain how parenting influences development in highly sensitive children. Environmental sensitivity is often characterized by processing information more deeply and paying closer attention to social and emotional cues in their environment (Aron & Aron, 1997). Therefore, sensitive children may reflect more extensively on caregiving experiences. Supportive parenting can promote more positive self-views and relationship expectations in sensitive children, whereas critical or inconsistent caregiving may increase the likelihood of negative interpretations and internalization of experiences (Grusec & Goodnow, 1994). These cognitive interpretations may therefore serve as mechanisms through which parenting shapes developmental outcomes. However, within environmental sensitivity research, cognitive processes such as rumination and appraisal have only recently begun to be tested directly as mediating pathways, despite their strong theoretical relevance.

Finally, mediating mechanisms may function at the relational and transactional level. Developmental and relational theories emphasize ongoing parent-child interactions, including co-regulation and bidirectional influence, as key processes shaping developmental trajectories over time (Davies & Cummings, 1994). Heightened child reactivity can shape parental

responses, which in turn reinforce children's emotional and behavioral patterns over time, creating ongoing interaction cycles (Sameroff, 2009). Although these relational and transactional mechanisms are central to developmental theory, they have hardly been examined explicitly as mediating processes within environmental sensitivity research. Disruptions in these processes are most commonly reflected in children's internalizing and externalizing symptoms, which represent key indicators of developmental adjustment (Eisenberg et al., 2010; Morris et al., 2007).

Together, findings point to multiple, interrelated mechanisms through which parenting experiences may shape developmental outcomes among highly sensitive children. These can include emotional processes such as heightened emotional and physiological reactivity, emotional regulation, cognitive processes such as deeper processing and appraisal of caregiving experiences, and relational processes and transactional parent-child interactions. These processes are likely to function in combination rather than in isolation. Despite their central role in theory, empirical environmental sensitivity research has predominantly focused on identifying differential responsiveness through moderation analyses, leaving the systematic testing of mediating pathways comparatively underdeveloped.

3. Methodology

3.1 Design

This study used a systematic review design to synthesize empirical findings on environmental sensitivity in the context of parenting and child development. The review followed the PRISMA 2020 guidelines (Page et al., 2022) to have transparency, rigor, and replicability in study identification, screening, and selection procedures. Together, the author

Nita Konjusha, and Lyra Rustemi, students at the University of Pavia, executed the search strings, screening and evaluation of articles such as reviewing the titles, abstracts, and full texts. As a result of heterogeneity in operationalizations of sensitivity and parenting, and methodology approaches in studies, a structured qualitative synthesis was applied.

3.2 Search Strategy

A comprehensive literature search was done across electronic databases commonly used such as PsycNet, PubMed, Scopus. Searches were performed using combinations of keywords related to environmental sensitivity and parenting, including environmental sensitivity frameworks, such as Sensory Processing Sensitivity (Aron & Aron, 1997) and Highly Sensitive Child model (Pluess et al., 2018). There are multiple markers of environmental sensitivity, such as genetic, physiological, and temperament levels, but this study focused on ES, SPS, and HSC, as the phenotypical aspects that capture sensitivity directly. Parenting was searched in parenting related factors such as parenting stress (Abidin, 1992), parental stress (Crnic & Greenberg, 1990), and parenting style (Baumrind, 1967). While parenting can also be defined in different ways, such as attachment and emotional availability, but for this study's conceptual clarity and a manageable scope, parenting was generally focused on the three factors mentioned before. Child behavior was mainly focused on internalizing (anxiety, low mood, social withdrawal), and externalizing symptoms (aggression, hyperactivity, defiance). Outcome terms focused primarily on internalizing and externalizing problems, as these represent the most commonly examined domains of child maladjustment within environmental sensitivity research. For the search string, Boolean operators (AND, OR) were used to combine words. In addition to database searches, a manual search was conducted by searching on website to identify additional relevant studies based on theoretical relevance to environmental sensitivity, mediation and parenting. Studies

found through manual search had the same inclusion and exclusion criteria as other records. To find suitable studies, the following Boolean search strings were used:

For PsycNet: *Any Field: "highly sensitive child" OR Any Field: "environmental sensitivity" OR Any Field: "sensory processing sensitivity" AND Abstract: "parenting stress" OR Abstract: "parental stress" OR Abstract: "parenting style" AND Any Field: internalizing behavioral problems AND Any Field: externalizing behavioral problems OR Any Field: internalising behavioural problems OR Any Field: externalising behavioural problems*

For Scopus: *(ALL ("highly sensitive child") OR ALL ("environmental sensitivity") OR ALL ("sensory processing sensitivity")) AND (ALL ("parenting style") OR ALL ("parenting stress") OR ALL ("parental stress")) AND (ALL ("internalising behaviour problems") OR ALL ("internalizing behavior problems") OR ALL ("externalising behaviour problems") OR ALL ("externalizing behavior problems"))*

For PubMed: *(((((highly sensitive child[Title/Abstract]) OR (environmental sensitivity[Title/Abstract])) OR (sensory processing sensitivity[Title/Abstract])) AND (parenting stress[Title/Abstract])) OR (parental stress[Title/Abstract])) OR (parenting style[Title/Abstract])) AND (internalizing behavioral problems[Title/Abstract])) OR (internalising behavioural problems[Title/Abstract])) OR (externalizing behavioral problems[Title/Abstract])) OR (externalising behavioural problems[Title/Abstract]))*

This search was restricted for studies to be full text and in English language, regardless of the year of publication. The search produced 200 records from PubMed, 29 records from Scopus, and 96 records from PsycNet. There were 320 records left after 5 duplicates were removed. After a title and abstract screening, 68 studies were chosen for full text evaluation, and 14 of those were included in the final synthesis. An additional 17 records were identified through website searching and only 2 of them were included in the final synthesis. The PRISMA flow diagram (Figure 1) provides a summary of the selection process.

3.3 Inclusion and Exclusion Criteria

Studies were included in the screening if they met the following inclusion and exclusion criteria. First, inclusion criteria included the target population, consisting of children or adolescents (0-18) and parents. Secondly, studies that used a recognized theoretical or measurement framework of environmental sensitivity, including Highly Sensitive Child Scale (Pluess et al., 2018), Sensory Processing Sensitivity (Aron & Aron, 1997), or theoretically aligned sensitivity markers. Temperament-based and biological indicators were included only when explicitly conceptualized within environmental sensitivity or susceptibility frameworks. Third, it included a parenting-related environmental variable (e.g., parenting style, caregiving behavior, parental distress, family stress, relational processes). In addition, studies were added if they assessed child developmental outcomes (e.g., internalizing, externalizing, social or behavioral adjustment). Finally, all the studies were empirical studies, published in English and available full text. Articles were excluded if they did not include a sensitivity-related construct or theoretical framework, or a parenting variable. Other studies were excluded if they focused on a different population other than children and did not include behavioral measures. Lastly, non-empirical articles were not included in the screening.

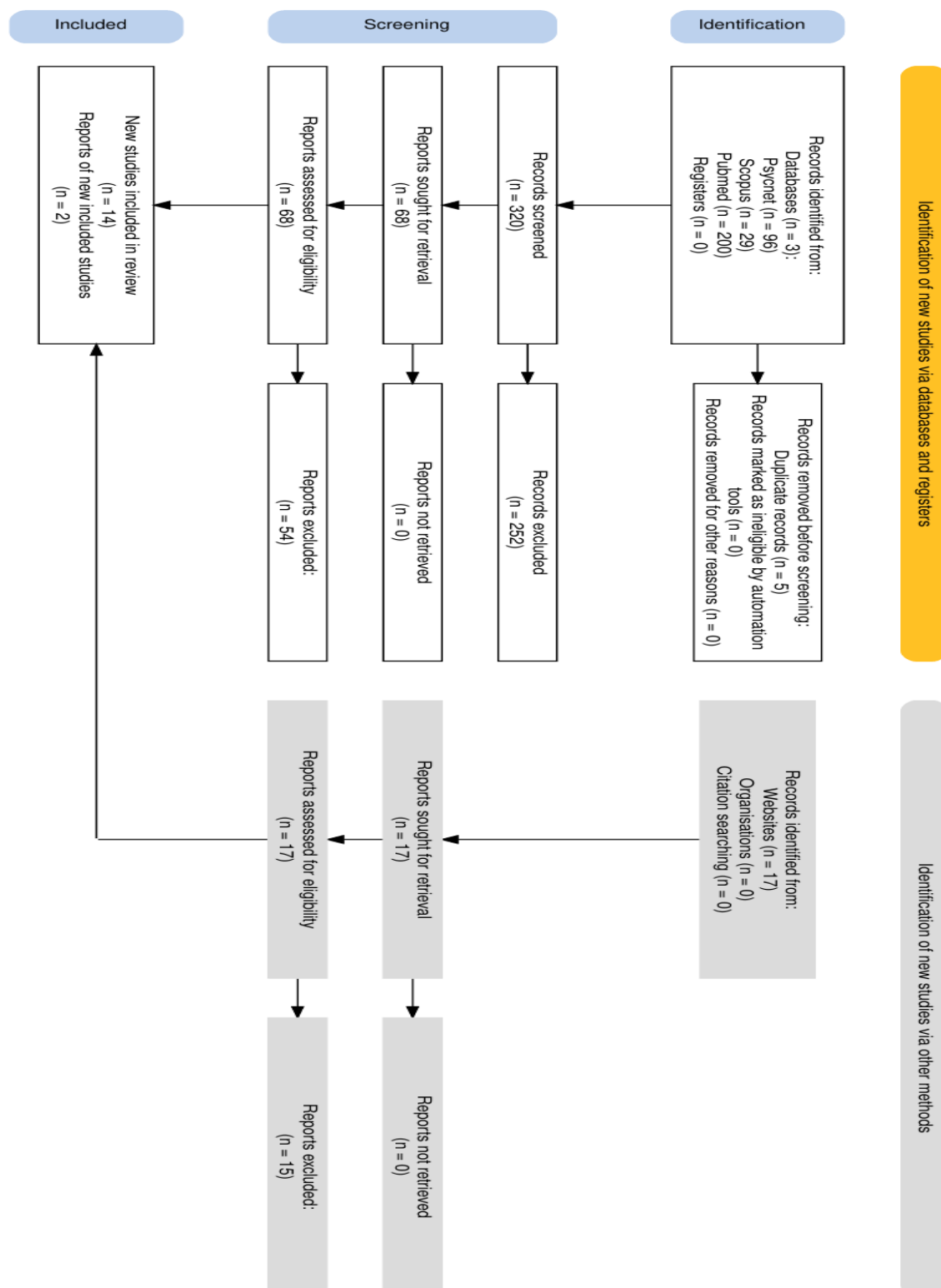


Figure 1. PRISMA 2020 flow diagram illustrating the identification, screening, eligibility, and inclusion of studies.

3.4 Data Extraction

Data were extracted from each selected study by using a structured coding sheet developed for this review. The coding sheet was designed to systematically capture important data. Information that was obtained involved study characteristics (authors, year of publication, country, sample size, age range) and study design (cross-sectional, longitudinal, or experimental). In addition, detailed information was coded for operationalization of environmental sensitivity (SPS, HSC, observer-rated measures, temperament-based or biological markers), the conceptualization and measurement of parenting (parenting styles, observed caregiving behaviors, parental distress, family stress) and the assessment of developmental outcomes (internalizing, externalizing, social competence). Mediation was recorded by including whether mediation or moderated mediation was formally tested, the type of mediator examined (cognitive processes, stress appraisal, family stress, parental distress, transactional processes), and whether indirect effects were statistically supported. Where relevant, the general analytic framework (longitudinal mediation, moderated mediation, structural equation modeling) was noted for descriptive purposes. Extracted data were then synthesized narratively, with particular attention to patterns in how parenting was operationalized, which mediating mechanisms were tested, and how these mechanisms were linked to developmental outcomes within environmental sensitivity frameworks.

4. Results

This chapter presents all the findings of the systematic review conducted in accordance with PRISMA guidelines. There were 16 empirical studies in total included, published in English from the year 2016 to 2025, with participants age range from infancy through adolescence. The

results are organized into study characteristics, measures of environmental sensitivity, parenting, and the examination of the mediating mechanism. Lastly, followed by the synthesis of patterns across parenting, mechanisms, and outcomes within environmental sensitivity research.

4.1 Study Characteristics

In the final synthesis, 16 empirical studies were used to find out about environmental sensitivity in relation to parenting and child outcomes, with some including adolescent developmental outcomes. Studies were different in sample size, design, developmental period, and in the operationalization of sensitivity and parenting. Some sample sizes were small laboratory samples (for example, $N = 100$; Li et al., 2023; Davies et al., 2021) to large population cohorts (for example, $N > 70,000$; Şengül-İnal et al., 2025). The studies spanned early childhood through adolescence and were conducted across various cultural contexts, such as Europe, North America, or larger population cohorts.

4.1.1 Sample size and study design

Most of the studies included in this review were different in sample size and methodological design, reflecting the wide range of empirical approaches used in environmental sensitivity research. The experimental and observational studies typically had samples of approximately 100 to 200 participants. For example, Li et al. (2023) run two studies with samples of 120 and 151 children, combining cross-sectional correlational analyses with an experiment of evaluative feedback. Also, van Prooijen et al. (2018) conducted a cross-sectional study with 107 children aged around two years old and their parents.

On the other hand, several studies were conducted on large longitudinal datasets. Şengül-İnal et al. (2024) used data from the Norwegian Mother, Father, and Child Cohort Study, including 79,889 children. Tung et al. (2019) used data from a nationally representative longitudinal cohort of 9,421 participants, following trajectories of externalizing behavior from 13 years old and later in development. Reiss et al. (2022) used findings from the Early Growth and Development Study, an adoption study following 561 families longitudinally from infancy through adolescence.

In addition, the study design of many included studies used longitudinal designs (for example, Slagt et al., 2018; Davies et al., 2021; Lionetti et al., 2022; Cho et al., 2016), allowing for the examination of developmental change and the link between parenting, sensitivity, and child outcomes. However, there were also a few cross-sectional designs, particularly in studies examining sensitivity with contextual stressors such as family stress and the COVID-19 pandemic (Burgard et al., 2022; Jusienė et al., 2025). Only a small number of studies had an experimental design, for example, Li et al. (2023) used evaluative feedback to assess children's behavioral and emotional responses as a function of sensory processing sensitivity.

4.1.2 Cultural diversity

The final studies had diverse cultural and national contexts, but Western, high-income countries dominated. Several studies were conducted in Western Europe, including the Netherlands (Slagt et al., 2018; Burgard et al., 2022; van Prooijen et al., 2018; Hentges et al., 2023; Van Dijk et al., 2022), Norway (Şengül-İnal et al., 2025), and Lithuania (Jusienė et al., 2025). On the other hand, other studies were conducted in the United States (Davies et al., 2021; Cho et al., 2016; Reiss et al., 2023; Kim and Kochanska, 2025; Sher-Censor et al., 2016; Tung et

al., 2019; Lionetti et al., 2019; 2022). In addition, there were a smaller number of studies that extended sensitivity research beyond Western contexts. For example, Li et al. (2023) examined sensory processing sensitivity and parenting in Chinese preschoolers. Overall, the literature had an international reach, providing evidence that sensitivity is present in different cultural contexts.

4.1.3 Developmental periods

Studies had a wide range of developmental periods, from infancy to adolescence, but most examined were early childhood and preschool age. There were several studies that focused on children 2 to 6 years old, including Jusienė et al. (2025), Kim and Kochanska (2025), Van Prooijen et al. (2018), and Lionetti et al. (2019). Similarly, Şengül-İnal et al. (2025) focused on toddlers (18-36 months) and examined them into early childhood, while Hentges et al. (2023) examined preschoolers during the transition to early schooling. Children in preschool and in school (around 3 to 7 years old) were examined in studies such as Li et al. (2023), Slagt et al. (2018), Davies et al. (2021), and Sher-Censor et al. (2016).

Fewer studies focused on adolescence, Burgard et al. (2022), Van Dijk et al. (2022), and Tung et al. (2019), followed children into adolescence. Reiss et al. (2023), drawing on the Early Growth and Development Study, followed children from infancy through adolescence, allowing for examination of long-term transactional processes. Notably, Lionetti et al. (2022) bridged developmental periods from early childhood and adolescence by assessing parenting and sensitivity at age 3 and internalizing outcomes at ages 9 and 12. In sum, the average age at baseline ranged between 2 and 6 years in early childhood samples, with fewer studies examining adolescents (9-18 years).

4.1.4 Measures of Environmental Sensitivity

Environmental sensitivity was measured in multiple ways across the included studies. It was most commonly assessed using questionnaire-based measures of Sensory Processing Sensitivity (Aron & Aron, 1997) and the Highly Sensitive Child (HSC) scale (Pluess et al., 2018), as well as observer-based Highly Sensitive Child Rating System (HSC-RS; Lionetti et al., 2019). Internal consistency of SPS (Li et al., 2023) and HSC (Van Dijk et al., 2022; Slagt et al., 2018; Burgard et al., 2022) was consistently acceptable to good (Cronbach's α ranging from .73 to .81), and the HSC-RS (Lionetti et al., 2019; 2022) also demonstrated satisfactory psychometric properties. Overall, the literature relied primarily on established and validated tools to assess environmental sensitivity.

Several studies operationalized sensitivity within temperament-based markers. For example, Davies et al. (2021) and Hentges et al. (2023) classified children according to dove versus hawk temperament profiles, reflecting evolutionary-informed patterns of behavioral inhibition and boldness. Other markers examined negative emotionality (Şengül-İnal et al., 2025), emotional reactivity (Jusiené et al., 2025), anger and fear proneness (Kim and Kochanska, 2025), self-regulation difficulties (Sher-Censor et al., 2016), and effortful control (van Prooijen et al., 2018). These temperament-based constructs captured differences in emotional reactivity and regulatory functioning and were used in some studies as indicators of susceptibility to environmental influences.

Finally, a few studies used biological indicators of sensitivity. For example, Cho et al. (2016) operationalized sensitivity through the presence of the dopamine D4 receptor long allele (DRD4), while Tung et al. (2019) examined dopaminergic genetic variants alongside childhood

maltreatment history. Taken together, environmental sensitivity was assessed primarily through SPS/HSC-based measures, with some studies using temperament or genetic indicators as alternative markers of differential responsiveness.

4.1.5 Operationalization of Parenting

Across all the included studies, parenting was operationalized at multiple levels, ranging from specific caregiving behaviors and parenting styles to broader family processes. These variables were assessed mostly using parent-report questionnaires (for example, Li et al., 2023; Lionetti et al., 2019) or observational coding systems (Davies et al., 2021; Kim & Kochanska, 2025).

In several studies, parenting was examined in terms of parenting styles or reported caregiving behaviors. For example, two studies of Lionetti et al. (2019; 2022) assessed authoritative, authoritarian, and permissive parenting styles using the Parenting Styles and Dimensions Questionnaire (PSDQ). Similarly, Burgard et al. (2022) assessed parenting style using Parenting Styles Inventory-II. Li et al. (2023) measured parental warmth and rejection using the Parent Acceptance-Rejection Questionnaire. In addition, Slagt et al. (2018) examined positive and negative parenting dimensions through parent-report measures. Across these studies, parenting was primarily framed in terms of style-based or behavioral dimensions.

Other studies used observational assessments of caregiving interactions. Davies et al. (2021) and Hentges et al. (2022) coded maternal and paternal behaviors during structured parent-child interaction tasks using standardized observational systems. These observations captured both supportive (for example, warmth, sensitivity) and negative (for example, hostility, intrusive control) dimensions of parenting. In Davies et al. (2021), parenting quality was examined within

a broader model of family adversity that also included interparental conflict and parenting difficulties, meaning that caregiving was analyzed in the context of wider family stress. Similarly, Kim and Kochanska (2025) used observational measures of Mutually Responsive Orientation, reflecting shared positive affect and cooperation, and parental power assertion as an indicator of controlling discipline.

In addition, some studies examined parenting within broader family processes. Şengül-İnal et al. (2025) modeled family stress as a latent construct that included maternal psychological distress, relationship dissatisfaction, and parental locus of control. Likewise, Jusienė et al. (2025) examined parental distress and media-related coping strategies as parenting-related processes influencing child behavior. Van Dijk et al. (2022) assessed parental triangulation in divorced families, capturing children's exposure to interparental conflict. Cho et al. (2016) examined responsive-supportive parenting as a composite of warmth, monitoring, and consistent discipline, explicitly modeling reciprocal and transactional processes between parenting and child self-regulation over time.

Overall, parenting was operationalized using heterogeneous conceptual frameworks and measurement strategies. Some studies focused on discrete caregiving behaviors or style-based dimensions (warmth, rejection, authoritative versus authoritarian styles), whereas others relied on observational coding of interactional processes such as sensitivity, hostility, mutually responsive orientation, or power assertion. Some of the studies, used parenting within broader family stress or relational models, assessing constructs such as parental psychological distress, interparental conflict, triangulation, or socioeconomic strain. Although these approaches differed in scope and level of analysis, they shared a common emphasis on parenting as a key environmental influence on child development. Across studies, parenting was captured through

established self-report instruments and structured observational systems with demonstrated psychometric validity.

A detailed overview of study characteristics is presented in Table 1. A more comprehensive coding summary is provided in Appendix A.

Table 1. Characteristics of Studies Examining Environmental Sensitivity, Parenting, and Child Outcomes (N = 16)

<i>Authors (Year)</i>	<i>Sample (N; Age)</i>	<i>Design</i>	<i>Sensitivity Measure</i>	<i>Parenting Variable</i>	<i>Mediator Tested</i>	<i>Outcomes</i>
<i>Li et al. (2023)</i>	N = 120; 151; 3-6 yrs	Cross-sectional & Experimental	SPS (HSC)	Warmth; Rejection	Emotional arousal (ns)	Prosocial behavior
<i>Van Dijk et al. (2022)</i>	N = 135; 8-17 yrs	Longitudinal	HSC	Parental triangulation	Loyalty conflict; Self- esteem	Internalizing & Externalizing
<i>Davies et al. (2021)</i>	N = 70; 243 families; early childhood	Cross-sectional & Longitudinal	Dove temperament	Parenting quality; Family adversity	None tested	Internalizing
<i>Lionetti et al. (2019)</i>	N = 292; early childhood	Longitudinal	HSC-RS	Parenting styles	None tested	Internalizing; Externalizing ; Social competence
<i>Slagt et al. (2018)</i>	N = 264; 3–7 yrs	Longitudinal	SPS	Positive & Negative parenting	None tested	Externalizing ; Prosocial
<i>Sher- Censor et al. (2016)</i>	N = 187 dyads; preschool	Longitudinal	Temperament- based self- regulation	Maternal representations	None tested	Externalizing ; Adjustment
<i>Cho et al. (2016)</i>	N = 309; late childhood– adolescence	Longitudinal	DRD4 genotype	Responsive- supportive parenting	Transactional pathway	Self- regulation

<i>Kim & Kochanska (2025)</i>	N = 200 families; 16 months–4.5 yrs	Longitudinal	Temperament (fear/anger)	MRO; Power assertion	None tested	Externalizing
<i>Şengül-İnal et al. (2025)</i>	N = 79,889; 1.5–5 yrs	Longitudinal	Temperament-based negative emotionality	Family stress	Family stress (moderated mediation)	Internalizing & Externalizing
<i>Hentges et al. (2023)</i>	N = 243; preschool–Grade 1	Longitudinal	Hawk/Dove temperament	Warmth; Control	None tested	Internalizing; Externalizing
<i>Reiss et al. (2023)</i>	N = 561 families; 9 months–15 yrs	Longitudinal	Temperament-based emotionality	Harsh parenting; Warmth	Transactional processes (theorized)	Internalizing; Externalizing
<i>Van Prooijen et al. (2018)</i>	N = 107 families; 2 yrs	Cross-sectional	Temperament-based effortful control	Emotional availability	None tested	Internalizing; Externalizing
<i>Tung et al. (2019)</i>	N = 9,421; adolescence	Longitudinal	Environmental sensitivity marker	Parental closeness/harshness	None tested	Externalizing
<i>Jusienė et al. (2025)</i>	N = 754; 2–5 yrs	Cross-sectional	Temperament-based emotional reactivity	Parental distress	Parental distress; media-related coping	Externalizing
<i>Lionetti et al. (2022)</i>	N = 196; 3–12 yrs	Longitudinal	HSC-RS	Parenting styles	Rumination (moderated mediation)	Internalizing
<i>Burgard et al. (2022)</i>	N = 395; 9–18 yrs	Cross-sectional	HSC	Parenting styles	Perceived stress	Internalizing

Note. SPS = Sensory Processing Sensitivity; HSC = Highly Sensitive Child; HSC-RS = Highly Sensitive Child-Rating System. Sensitivity markers include questionnaire-based, observational, temperament-based, and biological indicators consistent with environmental sensitivity frameworks. “Mediator tested” indicates formal mediation or moderated mediation analyses.

4.2 Mediating Mechanisms Examined

In this review, only 6 of the studies explicitly examined mediating mechanisms, linking parenting-related environments to child developmental outcomes within an environmental sensitivity framework. Several studies formally tested mediation, whereas most studies had moderation-based designs. Those that did test mediation, approaches varied considerably in the developmental period, methodological design, and the measures of both sensitivity and intervening processes. Some of the mechanisms included cognitive processes, emotional arousal, stress appraisal, and broader family stress processes. In addition, several studies proposed or supported transactional pathways conceptually, without formally testing indirect effects.

4.2.1 Cognitive Mechanisms

The most explicit evidence for a cognitive mediating mechanism within environmental sensitivity research was provided by Lionetti et al. (2022). This longitudinal study followed 196 children from age 3 into late childhood and early adolescence (ages 9 and 12) as part of the Stony Brook Temperament Study. Environmental sensitivity was assessed observationally at age 3 using the Highly Sensitive Child Rating System (HSC-RS), derived from multiple standardized laboratory temperament tasks. Parenting styles (permissive, authoritarian, and authoritative) were assessed at age 3 using the Parenting Styles and Dimensions Questionnaire (PSDQ). The mediating variable, rumination, was measured at age 9 using Child Response Styles Questionnaire (CRSQ), capturing repetitive and passive focus on negative thoughts and feelings. Depressive symptoms were assessed at ages 9 and 12 using the Children's Depression Inventory. Using Bayesian moderated mediation analyses, the authors tested whether rumination mediated

the association between early parenting and later internalizing symptoms as a function of environmental sensitivity.

Results indicated that permissive parenting predicted higher levels of rumination only among highly sensitive children. Rumination, in turn, was positively associated with depressive symptoms at both ages 9 and 12, showing a significant conditional indirect effect. No comparable mediation effects were observed for authoritarian or authoritative parenting styles. Indirect effects were non-significant for those styles. These findings provide longitudinal evidence that cognitive processing styles, specifically rumination, function as mechanisms through which parenting experiences shape internalizing outcomes for environmentally sensitive children.

4.2.2 Emotional Arousal

A related but shorter-term affective mechanism was explored by Li et al. (2023) in their experimental Study 2 involving 151 preschool-aged children. Sensory processing sensitivity was assessed using the parent-reported Highly Sensitive Child (HSC) scale. Children participated in a structured task in which they received experimentally manipulated positive or negative evaluative feedback. Prosocial behavior was assessed through behavioral observations, and emotional arousal was operationalized as changes in children's affective state following feedback, measured using pre- and post-task child-reported affect ratings.

In addition to testing sensitivity $\times$ feedback interaction effects, Li et al. (2023) examined whether emotional arousal functioned as an intervening mechanism in a mediated moderation framework. Results indicated that highly sensitive children exhibited stronger affective responses to both positive and negative feedback conditions. However, the indirect pathway from feedback

to prosocial behavior via emotional arousal was not statistically significant. Thus, although emotional arousal was theoretically proposed as a potential mechanism explaining heightened responsiveness among sensitive children, empirical support for mediation was not obtained. Nevertheless, this study is noteworthy because it represents one of the few experimental attempts within environmental sensitivity research to directly test an affective process underlying differential responsiveness.

4.2.3 Stress Appraisal

A related cognitive-emotional mechanism was examined by Burgard et al. (2022) in a cross-sectional study of 395 Dutch adolescents aged 9 to 18 years during the first COVID-19 lockdown. Sensory processing sensitivity was assessed using a shortened self-report version of the Highly Sensitive Child Scale, while internalizing problems were measured using the Patient Health Questionnaire-4. The proposed mediator was adolescents perceived impact of the COVID-19 pandemic, operationalized as a subjective appraisal of stress across multiple life domains (for example, school disruption, social isolation, family stress). Parenting style was assessed via adolescent self-report using the Parenting Style Inventory-II.

Sensory processing sensitivity was indirectly associated with internalizing symptoms through greater perceived pandemic-related stress. The indirect effect from perceived stress was statistically significant, indicating partial mediation. Parenting styles did not moderate this indirect pathway, although authoritative parenting was independently associated with lower perceived stress and fewer internalizing symptoms. These findings suggest that subjective stress appraisal functions as a mediating mechanism linking environmental sensitivity to emotional adjustment, particularly under stress conditions.

4.2.4 Family Stress and Parental Distress

At a family level, Şengül-İnal et al. (2025) provided one of the clearest examples of a moderated mediation model involving family stress processes. Using longitudinal data from approximately 79,889 children in the Norwegian Mother, Father, and Child Cohort Study (MoBa), the authors examined pathways from early family income to child internalizing and externalizing problems at age five. Child negative emotionality, assessed at 18 and 36 months using selected items from the Emotionality, Activity, and Shyness Temperament Questionnaire, was conceptualized as a temperamental sensitivity marker.

The mediator, family stress, was modeled as a latent construct measured at age three, comprising maternal psychological distress, relationship dissatisfaction, and parental locus of control. Child outcomes were assessed at age five using the Child Behavior Checklist. Structural equation modeling showed that family stress significantly mediated the association between low family income and both internalizing and externalizing problems. Importantly, multigroup analyses showed that these indirect effects were substantially stronger among children high in negative emotionality, supporting a “double jeopardy” pattern. Indirect effects were stronger among children high in negative emotionality, indicating that sensitivity intensified the pathway from socioeconomic adversity through family stress to behavioral outcomes.

A related family-level mediation model was tested by Jusienė et al. (2025) in a study of 754 preschool-aged children (2-5 years). Emotional reactivity, assessed using the Emotional Reactivity scale of the CBCL, served as a temperament-based sensitivity indicator. Externalizing problems were measured using the CBCL Externalizing Problems scale. The authors tested a transactional mediation model in which child emotional reactivity predicted parental distress,

which in turn predicted greater reliance on media-related coping strategies (using screens to regulate child distress), leading to increased child screen time and higher levels of externalizing behavior. Structural equation modeling supported indirect effects through parental distress and screen time, although media-related coping did not directly predict externalizing outcomes. Although not framed explicitly within differential susceptibility theory, this study illustrates how temperament-based reactivity may operate within transactional family processes through indirect pathways.

In addition, Van Dijk et al. (2022) tested a longitudinal mediation model in a sample of 135 children from 77 recently divorced families. In which parental triangulation predicted children's internalizing and externalizing problems indirectly through loyalty conflicts and self-esteem. Significant indirect effects were observed, indicating that triangulation influenced child adjustment through children's relational-cognitive processing of interparental conflict. Environmental sensitivity was assessed using the Highly Sensitive Child scale, but it did not significantly moderate the mediation pathways. Even though sensitivity did not moderate the mediation, the study provides important evidence about when parenting mechanisms operate independently of sensitivity.

4.2.5 Conceptual and Transactional Process Pathways

Several studies did not formally test mediation using indirect effects but provided evidence for process-oriented pathways linking parenting and development. Cho et al. (2016) examined 309 African American families longitudinally from late childhood to mid-adolescence, operationalizing sensitivity biologically through the presence of the DRD4 long allele. Parenting quality (responsive-supportive parenting) and child self-regulation were assessed using parent

and teacher reports. Structural equation modeling revealed bidirectional associations between parenting and child self-regulation, with both pathways moderated by child and parent genotype. Although self-regulation was not modeled as a mediator in a traditional sense, it functioned as a developmental process linking parenting across time, illustrating how sensitivity-related biological factors shape ongoing parent-child interaction cycles.

Similarly, Reiss et al. (2023) synthesized findings from the Early Growth and Development Study, emphasizing evocative gene-environment correlations and reciprocal parent-child interactions as mechanisms through which child characteristics and parenting mutually influence development. While these mechanisms were inferred through longitudinal sequencing and genetically informed designs rather than formal mediation tests, they provide strong conceptual support for transactional pathways in environmental sensitivity research.

4.3 Patterns Across Parenting, Mediating Mechanisms, and Developmental Outcomes

In the studies included for this systematic review, several consistent patterns were shown in how parenting characteristics, mediating mechanisms, and child developmental outcomes are linked within environmental sensitivity research. Even though study designs, developmental periods, and operationalizations varied, the findings unite on a number of recurring patterns through which caregiving environments become developmentally consequential.

4.3.1 Parenting Patterns

When patterns across studies were examined, three dominant parenting domains emerged, such as parenting style and caregiving quality, parental distress and family stress processes, and relational and transactional dynamics. These domains differed not only in

measurement strategy but also in how parenting was theoretically positioned within environmental sensitivity models.

First, the majority of studies conceptualized parenting as a behavioral caregiving quality, operationalized through parenting style and observed or reported parenting practices. These included authoritative, authoritarian, and permissive parenting styles (Lionetti et al., 2019; Lionetti et al., 2022; Burgard et al., 2022), parental warmth and rejection (Li et al., 2023), positive and negative parenting practices (Slagt et al., 2018), and observed sensitivity or hostility in parent-child interactions (Davies et al., 2021; Hentges et al., 2023; Kim & Kochanska, 2025). Within this domain, parenting was examined as a proximal caregiving exposure, typically positioned along dimensions of warmth and responsiveness versus harshness and control. Across these studies, warm and structured parenting was linked to more adaptive emotional and behavioral outcomes, particularly among highly sensitive children.

Second, several studies conceptualized parenting not as discrete behaviors but as embedded within broader family stress systems. In this domain, parenting was conceptualized within broader contextual stress systems, where parental psychological distress and family strain functioned as mediating processes. For example, Şengül-İnal et al. (2025) modeled family stress as a latent construct comprising maternal distress, relationship dissatisfaction, and perceived lack of control, demonstrating indirect pathways from socioeconomic adversity to child outcomes. Similarly, Jusienė et al. (2025) tested a sequential mediation model in which child emotional reactivity predicted parental distress, which in turn shaped coping practices and contributed to externalizing behavior. Across these studies, caregiving was situated within emotional and contextual strain, highlighting how parental psychological functioning and family-level stress processes translate environmental risk to child outcomes.

Third, some studies conceptualized parenting within broader relational or transactional systems, emphasizing bidirectional and time-dependent processes rather than linear effects. These included parental triangulation in divorced families (Van Dijk et al., 2022), responsive-supportive parenting within genetically informed longitudinal models (Cho et al., 2016), and cumulative family adversity interacting with temperament profiles over time (Davies et al., 2021). In these frameworks, parenting was not treated as a static environmental exposure but as part of an ongoing dynamic system in which child characteristics shape caregiving responses, which in turn influence child development. These models emphasized that parenting and child characteristics influence one another over time, highlighting dynamic feedback loops rather than one-directional effects.

Notably, the way parenting was operationalized often shaped the type of mediating mechanism examined. Studies focusing on parenting styles or caregiving quality were more likely to test intrapersonal cognitive mechanisms, such as rumination or stress appraisal (Lionetti et al., 2022; Burgard et al., 2022). In contrast, studies conceptualizing parenting within broader family stress frameworks more frequently examined emotional or contextual mediators, including family stress and parental distress (Şengül-İnal et al., 2025; Jusienė et al., 2025). This pattern suggests that the conceptualization of parenting influenced which mechanisms were examined and how developmental pathways were modeled.

4.3.2 Patterns in Mediating Mechanisms

Even though a few studies explicitly tested mediation, those that did converged on a limited number of recurring mechanisms. These mechanisms clustered at two primary levels of

analysis: intrapersonal cognitive-emotional processes and broader family-level stress processes, with additional support for transactional pathways.

At the intrapersonal level, cognitive and appraisal-based processes were most consistently linked to internalizing outcomes. Across studies, mechanisms such as rumination and stress appraisal operated as pathways linking sensitivity-related processes and environmental stress contexts to internalizing outcomes (Lionetti et al., 2022; Burgard et al., 2022). In these models, higher sensitivity was associated with greater cognitive-emotional engagement with stressful or inconsistent experiences. Experimental evidence also explored short-term affective processes, although emotional arousal did not consistently function as a mediator of prosocial outcomes (Li et al., 2023).

At the family level, parental distress and family stress emerged as central contextual mechanisms. Longitudinal models indicated that family stress mediated associations between socioeconomic adversity and child behavior problems, particularly among children characterized by higher emotional reactivity (Şengül-İnal et al., 2025). Sequential pathways further showed that child sensitivity could evoke parental distress, which then contributed to maladaptive coping dynamics and externalizing outcomes (Jusienė et al., 2025). These findings place parenting within broader emotional and systemic strain rather than as isolated behavioral acts.

In addition, several studies highlighted transactional processes in which parenting and child characteristics influenced one another over time. Although these models did not test mediation in a traditional indirect-effect framework, they underscored bidirectional developmental pathways linking sensitivity and caregiving across developmental periods (Cho et al., 2016; Reiss et al., 2023). Overall, mediation findings remain limited, and when tested

mechanisms most often involved cognitive-emotional and family-level stress processes, with emerging evidence for transactional dynamics. Notably, indirect effects were more consistently observed for internalizing than for externalizing outcomes, whereas externalizing problems were more often examined within moderation-based or broader family stress frameworks.

Across the reviewed studies, formal mediation analyses were conducted less frequently than moderation-based tests. Several investigations identified significant indirect pathways, including associations between parental triangulation and child adjustment through loyalty conflicts and self-esteem (Van Dijk et al., 2022), links between sensory processing sensitivity and internalizing symptoms via stress appraisal during the COVID-19 pandemic (Burgard et al., 2022), and pathways from emotional reactivity to externalizing behavior through parental distress and media-related coping processes (Jusienė et al., 2025). Two studies further extended these models by testing moderated mediation, demonstrating that indirect effects varied depending on children's levels of environmental sensitivity or negative emotionality (Lionetti et al., 2022; Şengül-İnal et al., 2025). In contrast, experimental attempts to identify short-term affective mediators did not yield statistically significant indirect effects (Li et al., 2023). Overall, the literature reflects a predominance of moderation-focused designs, with comparatively fewer studies directly examining explanatory mechanisms. To further synthesize the distribution of mediating mechanisms, Table 2 summarizes studies reporting findings of mediation and moderated mediation.

Table 2. *Summary of Mediation and Moderated Mediation Findings in Environmental Sensitivity Research (2016-2025)*

Type of Mediator	Mediation	Moderated Mediation
Cognitive and Appraisal Mechanisms	Burgard et al. (2022) - Sensory processing sensitivity → perceived COVID-19 stress → internalizing symptoms	Lionetti et al. (2022) - Permissive parenting → rumination → depressive symptoms (conditional indirect effect)
Affective Mechanisms	Li et al. (2023, Study 2) - Evaluative feedback (positive vs. negative) → emotional arousal → prosocial behavior (no significant indirect effect)	—
Family Stress Mechanisms	Van Dijk et al. (2022) – Parental triangulation → loyalty conflicts → internalizing and externalizing problems; Parental triangulation → self-esteem → internalizing problems	Şengül-İnal et al. (2025) - Low family income → family stress → internalizing and externalizing problems (indirect effects stronger for high negative emotionality)
Parental Distress & Coping Mechanisms	Jusienė et al. (2025) - Child emotional reactivity → parental distress → media-related coping → externalizing behavior (sequential mediation)	—

Note. Only studies that formally tested mediation or moderated mediation models are included. Moderation-only findings are excluded.

4.3.3 Patterns in Developmental Outcomes

The developmental outcomes examined across studies primarily included internalizing behaviors and externalizing behaviors, with distinct patterns emerging across outcome domains.

In the limited number of mediation studies, internalizing outcomes were most consistently associated with intrapersonal cognitive-emotional mechanisms. Across these studies, processes such as rumination and stress appraisal emerged as pathways linking caregiving experiences and sensitivity to later emotional distress (Lionetti et al., 2022; Burgard et al., 2022). These findings suggest that environmentally sensitive children may be particularly prone to intensified cognitive processing of negative experiences, increasing vulnerability to internalizing difficulties. Beyond mediation studies, several moderation-based investigations also linked sensitivity to internalizing outcomes. For example, Davies et al. (2021) and Hentges et al. (2023) found that children characterized by *dove* temperament showed amplified internalizing responses under adverse caregiving but reduced symptoms under supportive parenting. Together, evidence indicates that internalizing outcomes are most closely tied to intrapersonal mechanisms involving emotional reactivity and cognitive appraisal.

Externalizing outcomes were more often associated with family stress and parenting-related distress mechanisms, as well as transactional processes. Family stress mediated associations between socioeconomic adversity and externalizing problems in early childhood (Şengül-İnal et al., 2025), while parental distress and maladaptive coping strategies contributed to preschoolers' externalizing behavior in transactional models (Jusiené et al., 2025). Moderation-based findings also supported sensitivity-related amplification of externalizing outcomes. Slagt et al. (2018) found that sensory processing sensitivity moderated associations between both positive and negative parenting and changes in externalizing behavior over time. Davies et al. (2021) reported that *dove* temperament moderated the association between family adversity and trajectories of social withdrawal and internalizing problems, though effects for externalizing were less consistent across studies. Tung et al. (2019) found that maltreated youth

showed altered sensitivity to parental closeness in predicting trajectories of violence and delinquency. Overall, externalizing outcomes were more frequently embedded within family stress dynamics and reciprocal parent-child processes than within intrapersonal cognitive mechanisms.

Social and prosocial outcomes were examined primarily through moderation-based designs. For example, Li et al. (2023) found that children high in sensory processing sensitivity showed greater susceptibility to negative parenting and experimentally manipulated feedback in predicting prosocial behavior. Although Study 2 tested whether emotional arousal mediated this heightened responsiveness, the indirect effect was not statistically significant. Similarly, Lionetti et al. (2019) found that observer-rated environmental sensitivity moderated the association between authoritative parenting and social competence, with highly sensitive children showing higher social competence under supportive parenting, consistent with a vantage sensitivity pattern. Overall, while moderation effects demonstrated positive developmental outcomes, mediation processes were rarely supported empirically.

4.3.4 Integrated Patterns Across Parenting, Mechanisms, and Outcomes

When findings across studies are considered together, there are patterns that emerge in how parenting, mediating processes, and developmental outcomes are linked within environmental sensitivity research.

Across moderation-based studies, environmental sensitivity consistently functioned as a conditional factor rather than as a direct explanatory mechanism. Sensitivity was identified for whom parenting had stronger developmental effects. Highly sensitive children showed amplified responses across different caregiving conditions, consistent with patterns predicted by

environmental sensitivity frameworks. Also, amplification effects appeared strongest in early childhood samples, whereas findings in adolescence were more context-dependent. However, formal mediation analyses were comparatively rare.

When mediating mechanisms were formally tested, they clustered into two primary domains: intrapersonal cognitive-emotional processes and broader family-level stress processes. Cognitive mechanisms, such as rumination and stress appraisal, were mainly implicated in internalizing pathways, suggesting that heightened cognitive processing may translate caregiving experiences into anxiety and depressive symptoms among sensitive children. In contrast, family stress and parental distress operated at the contextual level and were associated with both internalizing and externalizing outcomes, highlighting the role of systemic emotional strain in shaping developmental trajectories. Importantly, the type of mediating mechanism appeared to differ depending on how proximal the caregiving context was. More immediate parenting behaviors were typically associated with intrapersonal cognitive processes, whereas broader contextual stressors were linked to family-level stress dynamics.

Lastly, different outcome domains were associated with distinct mediating mechanisms. Internalizing outcomes were most consistently linked to intrapersonal cognitive-emotional mechanisms in mediation studies, whereas externalizing outcomes more often emerged within family stress and transactional models. Social and prosocial outcomes were primarily examined in moderation-based models, whereas mediation analyses focusing on these outcomes were rare and had limited empirical support. Taken together, findings suggest that environmental sensitivity strongly describes differential responsiveness to caregiving contexts, whereas empirical research has only begun to clarify the cognitive, emotional, and contextual processes through which these effects unfold.

5. Discussion

In the 16 empirical studies published between 2016 and 2025, the present systematic review examined how environmental sensitivity has been studied in relation to parenting and child developmental outcomes, with a specific focus on mediating mechanisms. There were several consistent patterns that occurred across studies, regarding how parenting was conceptualized and how it was linked to mediating mechanisms and developmental outcomes. This section includes the interpretation of findings, theoretical implications, considers applied relevance for intervention, highlights strengths and limitations, and provides recommendations for future research.

5.1 Interpretation of Findings

One of the most consistent patterns across included studies was that parenting was primarily conceptualized in terms of behavioral caregiving quality. Most studies relied on established style frameworks or behavioral dimensions. Within this approach, parenting was positioned as a relatively immediate and direct influence on child development, described along a spectrum from supportive to harsh practices. This perspective fits well with differential responsiveness models because it allows for clear testing of sensitivity $\times$ parenting interactions. However, it also narrows the conceptualization of caregiving. When we only look at specific parenting behaviors, we may miss how children actually experience those interactions and how the overall emotional climate shapes their development over time.

A smaller group of studies adopted parenting from a broader perspective, viewing it within family stress systems and relational dynamics. In these models, caregiving was not treated as a set of observable acts, but as part of an emotional and contextual climate shaped by parental

distress, relational strain, or socioeconomic challenges. Some studies also adopted transactional frameworks, emphasizing that parenting and child characteristics influence one another over time through continuous feedback processes. These perspectives show that parenting is not just about individual behaviors, but about ongoing two-way interactions within the whole family system.

These conceptual differences were also visible in the way parenting was measured across studies. When parenting was framed as specific behaviors or styles, studies typically used parent-report questionnaires or observational coding. On the other hand, when parenting was examined within wider family stress or transactional frameworks, researchers more often relied on longitudinal data and more complex analytic approaches. In this way, the conceptualization of parenting was closely linked to both measurement strategy and the types of mediating processes examined.

Despite these differences in conceptualization and measurement, moderation findings were remarkably consistent. Children high in environmental sensitivity, most often identified using the Highly Sensitive Child framework, showed stronger associations between parenting quality and developmental outcomes. Under inconsistent caregiving, they showed elevated internalizing and externalizing symptoms, but under warm conditions they demonstrated better adjustment. This pattern supports the idea that environmental sensitivity is not simply a vulnerability, but a trait that increases children's responsiveness to their environment, making them more affected by both negative and positive caregiving.

Moderation models mainly tell us for whom parenting matters, but not how its effects actually occur. Although environmental sensitivity theories highlight cognitive, emotional, biological, and relational mechanisms, very few studies have directly tested these processes. In

this review, only six out of sixteen studies examined mediation. This suggests that the field is more focused in showing that some children are more responsive than others, but it is still less developed in explaining the mechanisms through which parenting influences sensitive children's development. Even though stress reactivity and emotion regulation are widely discussed in the literature, they were not examined as formal mediators in the included studies. This gap may partly reflect the methodological constraints, as testing indirect pathways typically requires larger samples, longitudinal designs, and more complex analytic strategies than moderation analyses.

When mediation was tested, mechanisms clustered at both the individual cognitive-emotional level and the broader family stress level. Most of the proposed mechanisms operated at the individual level. In particular, cognitive processes such as rumination and stress appraisal seemed to explain how caregiving environments were linked to internalizing problems. These findings suggest that highly sensitive children may think more deeply about negative experiences, which could increase their risk for anxiety and depressive symptoms when caregiving is tense. This interpretation aligns particularly with Sensory Processing Sensitivity theory (Aron & Aron, 1997; Aron et al., 2012), which identifies deeper cognitive processing of environmental stimuli as a central characteristic of highly sensitive individuals. Overall, among the limited mediation studies, mediation effects were most consistent for internalizing outcomes, indicating that cognitive-emotional processes may play a particularly important role in explaining emotional difficulties among highly sensitive children.

At the family level, parental distress and broader family stress processes acted as contextual pathways linking adversity to child outcomes. These indirect effects were often stronger for children characterized by temperament-based sensitivity, suggesting that sensitivity

may amplify the impact of stress within the family system. Overall, these findings move environmental sensitivity research beyond a narrow focus on parent-child behaviors and show that caregiving takes place within larger relational and socioeconomic contexts that influence development over time.

In contrast, experimental evidence for short-term emotional mediation was limited. Although highly sensitive children showed stronger emotional reactions to evaluative feedback, these emotional responses did not consistently explain changes in their behavior. This indicates that heightened reactivity on its own is not enough to account for developmental outcomes. Emotional responsiveness may signal differential sensitivity, but it does not by itself explain how caregiving experiences translate into longer-term adjustment. Taken together, these findings indicate that mediation research within environmental sensitivity remains limited and concentrated primarily on cognitive-emotional and family stress processes, with little examination of biological or relational mechanisms.

Clear patterns were found across outcome domains. Indirect effects were more constantly observed for internalizing than for externalizing outcomes. Internalizing problems were most linked to individual-level cognitive and emotional mechanisms, particularly rumination and stress appraisal. In contrast, externalizing outcomes were more often explained within family stress and transactional models, involving parental distress and ongoing parent-child interactions. Social and prosocial outcomes were mainly studied using moderation designs, with little evidence for mediation. Overall, these findings suggest that environmental sensitivity may function differently depending on the type of outcome. Emotional symptoms seem to be more related to how sensitive children interpret and reflect on their experiences, while behavioral problems may be shaped more by wider family stress and interaction patterns. This points to the

importance of considering outcome-specific pathways when examining mediation in environmental sensitivity research.

Taken together, this review highlights both the strengths and the limitations of current environmental sensitivity research. Environmental sensitivity research has made considerable progress in showing that children have differences in how strongly they respond to parenting. However, the field is still less developed in explaining the mechanisms behind these effects. Existing mediation studies remain limited in number and scope, focusing primarily on cognitive-emotional and family stress pathways, while biological and relational mechanisms are still underexplored. Moving forward, research should combine sensitivity markers with clearly defined cognitive-emotional and family-level processes in longitudinal designs. This would shift the focus from identifying who is most responsive to understanding how developmental change unfolds. Such integration is crucial for improving explanatory precision in environmental sensitivity research.

5.2 Theoretical Implications

A central theoretical implication of this review is that environmental sensitivity should be understood as a trait that reflects how strongly children respond to their environment, rather than as a developmental mechanism in itself. Across studies, sensitivity consistently strengthened the association between parenting and child outcomes. This supports the core idea of Differential Susceptibility Theory (Belsky & Pluess, 2009), which proposes that some children are more responsive to environmental influences. In some cases, findings also resembled vantage sensitivity (Pluess & Belsky, 2013), where sensitive children benefited more from supportive environments, and in other cases, they were closer to diathesis-stress models (Monroe & Simons,

1991), particularly when sensitivity intensified vulnerability under adversity. Together, these patterns are consistent with the broader Environmental Sensitivity framework (Pluess, 2015), which integrates differential susceptibility, vantage sensitivity, and diathesis-stress as alternative expressions of individual differences in environmental responsiveness.

However, while sensitivity reliably identified who was more responsive, it did not fully explain how parenting influenced development. The actual processes linking caregiving to outcomes were cognitive, emotional, relational, and contextual. This distinction is theoretically important. Environmental sensitivity is not the mechanism of change, rather, it moderates the strength of mechanisms that translate environmental input into developmental outcomes. In other words, sensitivity amplifies environmental input, but it is the child's cognitive processing, emotional regulation, and family dynamics that ultimately translate caregiving experiences into adjustment outcomes. This perspective also aligns with transactional and developmental systems models (Sameroff, 2009), which emphasize that development unfolds through ongoing interactions between children and their environments. From this view, sensitivity can be understood as a plasticity factor that influences the magnitude of environmental effects, while specific psychological and relational processes determine the direction and form those effects take over time.

Overall, these findings suggest that the field should move beyond simply documenting trait $\times$ environment interactions and instead focus more on identifying the processes through which environmental input produces change. Conceptualizing environmental sensitivity as a marker of plasticity rather than a causal mechanism may enhance theoretical clarity and shift the field toward process-oriented models capable of explaining not only who is most affected by environmental input, but how developmental change happens.

5.3 Applied Relevance

Based on what emerged from this review, the practical value of environmental sensitivity is not only in identifying which children respond more strongly to interventions, but also in understanding which developmental processes should be targeted. Across studies, cognitive processes such as rumination and stress appraisal, as well as family-level stress factors like parental distress, repeatedly appeared as key pathways linking parenting to adjustment in highly sensitive children. These processes give us concrete directions for intervention design.

Randomized controlled trials already show that environmental sensitivity influences how well children respond to interventions. For example, in a school-based depression prevention program, reductions in depressive symptoms were observed only among girls high in Sensory Processing Sensitivity (Pluess & Boniwell, 2015). In the Kiva anti-bullying trial, highly sensitive boys showed the strongest reductions in victimization and internalizing symptoms (Nocentini et al., 2018). Similarly, in the Identity Project intervention, adolescents higher in sensitivity demonstrated greater gains in identity exploration (Ceccon et al., 2023). Together, these findings suggest that highly sensitive youth may benefit more from supportive interventions.

At the same time, these studies primarily demonstrate differential effectiveness, but they do not clearly specify the underlying psychological processes responsible for these amplified gains. The mechanisms identified in this review suggest possible explanations. For instance, depression prevention programs may be especially effective for highly sensitive youth if they directly address repetitive negative thinking and stress appraisal, which seem particularly relevant for this group. Although rumination was not directly measured in the Pluess and Boniwell (2015) study, it is likely that cognitive-behavioral components reduced maladaptive

thinking patterns, which may partly explain greater improvements among highly sensitive participants. Future research should explicitly test whether mechanisms like rumination mediate treatment effects.

Beyond individual cognitive processes, the review also highlighted parental distress and broader family stress as important pathways. This indicates that parenting-focused interventions may be especially beneficial for highly sensitive children. Programs that enhance parental sensitivity and responsiveness, such as the Video-feedback Intervention to Promote Positive Parenting (VIPP; Bakermans-Kranenburg et al., 2003), may be particularly relevant. By helping parents better understand and respond to their child's signals, and by reducing harsh or inconsistent reactions, such interventions may prevent heightened sensitivity from translating into emotional or behavioral difficulties. Supporting parental emotion regulation and reducing caregiver stress may further strengthen positive outcomes for children who are especially responsive to caregiving quality.

Overall, integrating markers of environmental sensitivity (such as SPS or the Highly Sensitive Child scale) with clearly defined developmental processes could lead to more precise and mechanism-informed intervention models. In this view, environmental sensitivity is not simply about identifying who benefits most. It can also guide decisions about which processes should be targeted to promote adaptive development among children who are especially responsive to their environments.

5.4 Limitations

Several limitations should be considered when interpreting these findings. First, only a small number of studies formally tested mediating mechanisms. This reflects the current state of

the literature rather than a limitation of the review itself, but it does restrict how strongly we can draw conclusions about developmental processes. It also makes it difficult to compare mechanisms across different ages and outcome domains. Second, there was considerable variation across studies in terms of design, measurement, and analytic strategies. Although this reflects the diversity of the field, it reduces comparability across studies and makes it challenging to synthesize findings quantitatively.

Third, the search strategy was intentionally specific in order to align with the research questions. While this helped maintain conceptual clarity, it may have limited the inclusion of studies examining broader relational, ecological, or biological processes. Although some studies were identified through screening and reference checks, certain dimensions of environmental sensitivity research may still be underrepresented in the present review. Fourth, most of the included studies were conducted in Western, high-income contexts. Cultural differences in parenting practices and interpretations of sensitivity may influence how environmental sensitivity operates, which limits the generalizability of these findings.

Finally, this review did not include a formal meta-analysis. Conclusions are therefore based on qualitative synthesis rather than pooled effect sizes. However, given the variability in how key constructs were defined and measured, a quantitative meta-analysis may not yet be methodologically appropriate. Despite these limitations, this review provides a structured and theory-informed overview of how parenting and mediating mechanisms are currently examined within environmental sensitivity research. By identifying both consistent patterns and key gaps, it offers a foundation for more integrative and process-focused future research.

5.5 Implications for Future Research

The findings of this review point to a few key directions for future research. First, studies should move beyond testing moderation alone and begin examining moderated mediation models. Rather than only asking whether sensitivity strengthens parenting effects, future research should also investigate how these effects occur. Although there is solid evidence that some children are more responsive to parenting, we still know relatively little about the processes that explain these differences. Future longitudinal studies with multiple time points are especially important to clarify whether cognitive, emotional, and relational mechanisms truly account for sensitivity-related outcomes over time.

Second, the mediating mechanisms examined so far remain relatively narrow. In the studies included in this review, mediation analyses focused mainly on cognitive processes such as rumination and stress appraisal, as well as family-level stress dynamics. While these findings provide an important starting point, they likely capture only part of the developmental picture. Environmental sensitivity theory points to additional processes that have received far less empirical attention, including emotion regulation capacities, physiological stress reactivity, and patterns of parent-child co-regulation over time. Expanding the range of mechanisms examined in future studies would allow for a more comprehensive understanding of how heightened environmental responsiveness is translated into specific developmental outcomes. Integrating psychological and biological processes within longitudinal, multi-level designs may be particularly valuable for clarifying how these pathways unfold across development.

6. Conclusion

Overall, environmental sensitivity research has clearly shown that children differ in how strongly they respond to caregiving environments. From most of the studies included in this review, sensitivity, commonly operationalized as Sensory Processing Sensitivity measured through the Highly Sensitive Child framework, consistently strengthened the link between parenting and developmental outcomes. These findings support the idea that environmental sensitivity reflects developmental plasticity, rather than simply vulnerability.

At the same time, this review revealed an important imbalance in the literature. While there is strong and consistent evidence for moderation effects, just a few studies have examined the mechanisms that explain how parenting influences development in sensitive children. The limited mediation evidence points to possible explanatory pathways, particularly cognitive-emotional processes such as rumination and stress appraisal, as well as broader family stress dynamics. Indirect effects were most consistently observed for internalizing outcomes, suggesting that cognitive processing may be especially relevant for emotional difficulties in highly sensitive children. However, these mechanisms remain underexamined and are not consistently tested across developmental stages or outcome domains.

In conclusion, the findings indicate that environmental sensitivity does not function as a developmental mechanism in itself. Rather, it amplifies environmental input, while cognitive, emotional, and relational processes determine how that input is translated into adjustment outcomes. Advancing the field therefore requires moving beyond identifying who is most responsive to clarifying how developmental change unfolds. By examining both the operationalization of parenting and the mediating processes that have been empirically tested,

this review contributes to greater conceptual clarity and helps identify potential process targets for intervention. Future longitudinal and multi-level studies are needed to better connect environmental sensitivity with the specific processes through which parenting shapes child development.

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Appendix A

Table 1. Characteristics of Studies Examining Environmental Sensitivity, Parenting, and Child Outcomes (N = 16)

Authors (Year)	Sample (N; Age)	Design	Sensitivity Marker	Parenting Variable	Mediator Tested	Outcome(s)	Analytic Approach	Level of Analysis
Li et al. (2023)	Study 1: N=120; Study 2: N=151 (3–6 yrs)	Cross- sectional & Experimental	Sensory Processing Sensitivity (SPS; HSC scale)	Parental warmth; rejection	Emotional arousal (no indirect effect)	Prosocial behavior	Moderated mediation	Individual child
Van Dijk et al. (2022)	N=135 children (8–17 yrs); divorced families	Longitudinal	Highly Sensitive Child (HSC; child- report)	Parental triangulation	Loyalty conflicts; self-esteem (mediation)	Internalizing; externalizing	Longitudinal mediation	Child within family context
Davies et al. (2021)	Study 1: N=70; Study 2: N=243 (early childhood)	Cross- sectional & Longitudinal	Dove temperament (low stimulation & behavioral flexibility)	Parenting quality; family adversity	Not tested	Internalizing problems	Moderation models	Individual + family context
Lionetti et al. (2019)	N=292 (early childhood)	Longitudinal	Observed Environmental Sensitivity (HSC-RS)	Parenting styles	Not tested	Internalizing; externalizing; social competence	Moderation	Individual child

Authors (Year)	Sample (N; Age)	Design	Sensitivity Marker	Parenting Variable	Mediator Tested	Outcome(s)	Analytic Approach	Level of Analysis
Slagt et al. (2018)	N=264 (3–7 yrs)	Longitudinal	Sensory Processing Sensitivity (SPS via HSC)	Positive & negative parenting	Not tested	Externalizing ; prosocial	Moderation	Child within family
Sher-Censor et al. (2016)	N=187 dyads (preschool)	Longitudinal	Self-regulation (temperament-based sensitivity marker)	Maternal representations	Not tested	Externalizing ; adjustment	Moderation	Child + caregiving context
Cho et al. (2016)	N=309 (childhood–adolescence)	Longitudinal	DRD4 genotype (biological sensitivity)	Responsive-supportive parenting	Transactional pathway (self-regulation)	Child self-regulation	SEM; transactional model	Child & parent; genetic moderation
Kim & Kochanska (2025)	N=200 families (16 months–4.5 yrs)	Longitudinal	Temperament-based sensitivity (negative emotionality: anger/fear)	MRO; power assertion	Not tested	Rule violations	Moderation	Mother–child dyads
Şengül-İnal et al. (2025)	N=79,889 (1.5–5 yrs)	Longitudinal	Negative emotionality (temperament-based sensitivity marker)	Family stress; parental distress	Family stress (moderated mediation)	Internalizing; externalizing	SEM; moderated mediation	Multilevel (SES → family → child)

Authors (Year)	Sample (N; Age)	Design	Sensitivity Marker	Parenting Variable	Mediator Tested	Outcome(s)	Analytic Approach	Level of Analysis
Hentges et al. (2023)	N=243 (preschool– 1–Grade 1)	Longitudinal	Hawk/Dove temperament	Observed parenting	Not tested	Internalizing; conduct problems	Moderation	Individual child
Reiss et al. (2023)	N=561 adopted children (9 months– 15 yrs)	Longitudinal	Temperament/e motionality (proxy sensitivity)	Harsh parenting; warmth; family climate	Theorized transactional processes	Internalizing; externalizing	Genetically informed longitudinal model	Multilevel (genetic + parenting)
Van Prooijen et al. (2018)	N=107 (2 yrs)	Cross- sectional	Effortful control (temperament marker)	Emotional availability; discipline	Not tested	Externalizing ; internalizing	Moderation	Individual child
Tung et al. (2019)	N=9,421 adolescen ts (13–32 yrs follow- up)	Longitudinal	Altered environmental responsiveness following adversity (susceptibility marker)	Parental closeness; harshness	Not tested	Violence; delinquency; substance use	Growth trajectory models	Multilevel (adversity + relationships)
Jusienė et al. (2025)	N=754 (2–5 yrs)	Cross- sectional	Emotional reactivity (CBCL; temperament marker)	Parental distress; media coping	Sequential mediation	Externalizing	SEM (serial mediation)	Child + parent level

Authors (Year)	Sample (N; Age)	Design	Sensitivity Marker	Parenting Variable	Mediator Tested	Outcome(s)	Analytic Approach	Level of Analysis
Lionetti et al. (2022)	N=196 (3–12 yrs)	Longitudinal	Observed Environmental Sensitivity (HSC-RS)	Parenting styles	Rumination (moderated mediation)	Depressive symptoms	Bayesian moderated mediation	Child level
Burgard et al. (2022)	N=395 adolescen ts (9–18 yrs)	Cross- sectional	Sensory Processing Sensitivity (SPS via HSC)	Parenting style	Perceived COVID-19 stress (mediation)	Internalizing	Mediation analysis	Individual adolescent

Note. Sensitivity markers include questionnaire-based measures (e.g., Sensory Processing Sensitivity; Highly Sensitive Child Scale), observational ratings (HSC-RS), temperament-based indicators (e.g., negative emotionality, effortful control), and biological markers (e.g., DRD4 genotype). Only studies that met inclusion criteria for environmental sensitivity frameworks were included.