



## The relationship between sensory responsiveness profiles, attachment orientations, and anxiety symptoms

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### Abstract

Individual variations in the way people respond to sensory stimuli can sometimes lead to maladaptive representations of the world. Indeed, sensory responsiveness profiles were found to be associated with mood symptoms such as depression and anxiety. The goal of the current study was to investigate whether attachment orientations can account for the relationship between sensory responsiveness profiles and anxiety symptoms. Participants ( $N = 194$ ) completed a battery of questionnaires assessing sensory responsiveness profiles, attachment orientations, and anxiety symptoms. As expected, various associations between sensory responsiveness profiles and anxiety symptoms were accounted for by attachment anxiety and avoidance. We suggest a possible causal path, in which early-developing sensory responsiveness profiles lead to attachment insecurities, which in turn may lead to mood symptoms such as anxiety.

**Key words:** anxiety, attachment, Dunn's model, sensory processing patterns, sensory responsiveness profiles

### INTRODUCTION

At a very basic level, humans are biological machines that create models of reality via input/output systems. However, although people share the same input systems, they are not necessarily 'tuned' similarly to the world. Individuals seem to differ in their abilities to register and modulate sensory information and to organise this sensory input to respond to situational demands (Dunn, 2001). Distinct patterns of noticing and habituating to sensory information have been found in healthy preschoolers (e.g., Dunn & Brown, 1997; Engel-Yeger, 2008) and in healthy adults (e.g., Brown, Tollefson, Dunn, Cromwell, & Filion, 2001). Moreover, research has shown that such individual differences can lead to profoundly different representations of the world, and consequently to different interactions with it (e.g., Dunn, 2001; Engel-Yeger, 2008, Engel-Yeger & Dunn, 2011).

Dunn (2001) proposed a theoretical model in which people's sensory responsiveness profiles are characterised by

their neurological thresholds (sensitivity to sensory input) and behavioural self-regulation strategies. Thus, some individuals may employ a passive behaviour strategy, in which they merely respond to stimuli, whereas other individuals may employ an active behavior strategy, in which the amount and type of input is actively regulated (Dunn, 2001). The two continua of neurological threshold and self-regulation strategy form a two-dimensional space, in which four sensory responsiveness profiles emerge: (1) *sensory avoiding*, which applies to individuals with a *low* neurological threshold and an *active* behaviour strategy, who engage in behaviours that limit exposure to stimuli, (2) *sensory sensitivity*, which applies to individuals with a *low* neurological threshold and a *passive* behaviour strategy, who experience discomfort with sensation, but do not actively eliminate the exposure to the disturbing stimuli; (3) *sensory seeking*, which applies to individuals with a *high* neurological threshold and an *active* behaviour strategy, who experience pleasure from a rich sensory environment and actively seek behaviours that create sensation; and (4) *low registration*, which applies to individuals with a *high* neurological threshold and a *passive* behaviour strategy, who fail to detect stimuli that others notice (Dunn, 2001).

The occupational therapy term *sensory responsiveness* should be distinguished from the broader psychological term *sensory processing sensitivity* (Aron & Aron, 1997). Sensory processing sensitivity refers not only to sensitivity to sensory

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stimulation but also to a deeper depth of processing, involving higher emotional arousal and greater empathic abilities (Aron & Aron, 1997). On the other hand, sensory responsiveness, or *sensory processing* as it is sometimes referred to in the occupational therapy literature, is a more narrowly defined term, concerning only the way the brain processes and deals with incoming sensory information. Although healthy individuals differ in their sensory responsiveness profiles, recent studies have found that about 15% of normative individuals (i.e., individuals without observable signs of a psychopathology) are at the extremes of the sensory responsiveness range (either over-responsive or under-responsive; Lane & Schaaf, 2010). When these patterns become extreme and maladaptive, individuals are said to have Sensory Processing Disorder (SPD) or Sensory Modulation Disorder (SMD; Miller, Anzalone, Lane, Cermak, & Osten, 2007).

### Sensory responsiveness profiles and anxiety symptoms

Maladaptive sensory responsiveness patterns have been linked with various mental health disorders and interpersonal difficulties (e.g., Ben-Avi, Almagor, & Engel-Yeger, 2012; Erez, Gordon, Sever, Sadeh, & Mintz, 2004). Recent studies have concentrated on associations between sensory responsiveness profiles and mood symptoms such as anxiety. Engel-Yeger and Dunn (2011) found that, regardless of self-regulating strategy, healthy individuals with a high sensitivity to incoming stimuli (i.e., sensory avoiding or sensory sensitivity profiles) reported elevated trait and state anxiety. Low registering individuals also reported elevated trait anxiety. A similar relationship between sensory sensitivity and anxiety was found in other studies (e.g., Kinnealey, Koenig, & Smith, 2011).

Although a relationship between various sensory responsiveness profiles and anxiety has been demonstrated, the processes that mediate this relationship remain elusive. One promising direction arises from considering findings that show how early sensory experiences can greatly bias the way infants perceive, experience, and interact with their surrounding environments (DeSantis, Harkins, Tronick, Kaplan, & Beeghly, 2011; Klein, Laish-Mishali, & Jaegermann, 2008). For example, an infant with a sensory sensitive profile may overestimate threatening stimuli or tag nonthreatening stimuli as unpleasant. Motherly attempts of comfort, like a cuddling hug, may be experienced by this infant as more aversive than pleasant, thereby exacerbating rather than alleviating her distress. Conversely, these same comforting attempts may be left unnoticed by an infant with a high sensory threshold. Over time, these repeated experiences may create in these two infants completely different impressions of the world and the interactions it provides.

### Attachment and sensory responsiveness patterns

Attachment theory provides a systematic account of how early interactions give rise to working models of the world. The attachment system is an innate psychobiological system that motivates individuals to seek proximity to supportive others in times of need (Bowlby, 1982). This system's efficient functioning is tied with internal working models that develop in early childhood as a result of interactions with primary caregivers (i.e., attachment figures). These models often carry over into adult relationships (for a review, see Mikulincer & Shaver, 2007). Caregivers who provide reliable comfort in times of need promote positive working models of self and others, and ultimately facilitate secure attachment and adaptive regulatory strategies. Breakdowns in reliable caregiving promote negative working models of self and others, and may ultimately result in insecure attachment, hyperactivating or deactivating regulatory strategies, namely, anxiety and avoidance. Anxiously attached individuals are preoccupied with whether their attachment figures (including adult relationship partners) will be available in times of need. Avoidantly attached individuals, on the other hand, distrust attachment figures' caregiving attempts and strive to maintain behavioral independence and emotional distance. Anxious and avoidant attachment have been linked with poor mental health and interpersonal difficulties in numerous studies (for a review, see Mikulincer & Shaver, 2007).

Previous research has emphasised the contribution of temperamental variables and genetic components to attachment system functioning (e.g., Fox, Kimmerly, & Schafer, 1995), and more specifically, the possible relevance of sensory responsiveness profiles to attachment processes. In a study conducted on an adult sample using Dunn's conceptualisation of sensory responsiveness, sensory sensitivity was positively correlated with attachment anxiety, sensory avoidance was positively correlated with attachment avoidance, low registration was positively correlated with both attachment anxiety and attachment avoidance, and sensation seeking was not correlated with either attachment anxiety or attachment avoidance (Jerome & Liss, 2005). These associations suggest that, to some extent, sensory responsiveness problems contribute to the development of attachment anxiety or avoidance. Moreover, attachment orientations may mediate the relationship between sensory responsiveness profiles and mental and interpersonal difficulties.

### The present research

The goal of the present research was to investigate whether attachment orientations can account for the

previously reported relationship between adult sensory responsiveness profiles and anxiety symptoms. More specifically, we examined a possible causal path in which attachment orientations mediate the effect of sensory responsiveness profiles on anxiety symptoms. This hypothesised path was based on the assumption that adult sensory responsiveness profiles reflect biological mechanisms of processing and reacting to incoming sensory information (Kozioł et al., 2011). These processes are hypothesised to emerge early in life and help shape early attachment-related experiences, which are reflected, to some extent, in attachment orientations later in life. These attachment orientations may influence interpersonal and mental functioning, and specifically, anxiety symptoms.

## METHOD

### Participants

The study consisted of 194 participants, all of which were first-year Psychology students who received course credit for their participation. Male participants ( $N = 45$ ) ages ranged from 20 to 36 (median = 23.5), whereas female participants ( $N = 148$ ) ages ranged from 20 to 30 (median = 22.0). One participant did not provide gender information. The inclusion of gender or age in the statistical analysis did not alter the results.

### Materials and procedure

Participants completed a battery of questionnaires including, the Adolescent/Adult Sensory Profile (AASP; Brown & Dunn, 2002), the Experiences in Close Relationships Scale (ECR; Brennan, Clark, & Shaver, 1998), and the anxiety subscale of the short form of the Depression Anxiety Stress Scales (DASS; Antony, Bieling, Cox, Enns, & Swinson, 1998). Cronbach's alphas for all scales are given in Table 1.

Sensory responsiveness profiles were examined by the Adolescent/Adult Sensory Profile (AASP; Brown & Dunn,

2002), a 60-item self-report scale designed for adult populations based on Dunn's (2001) two-dimensional model of sensory responsiveness. The scale consists of four 15-item subscales, one for each sensory profile, including sensory sensitivity (e.g., 'I startle easily to unexpected or loud noises'), low registration (e.g., 'I do not seem to notice when someone touches my arm or back'), sensory avoidance (e.g., 'I stay away from noisy places'), and sensory seeking (e.g., 'I seek out all kinds of movement activities'). Participants were asked to rate each item on a frequency-based 5-point scale, ranging from 1 (*almost never*) to 5 (*almost always*). The AASP was validated using measures of skin conductance and habituation (Brown et al., 2001).

The Experiences in Close Relationships Scale (ECR; Brennan et al., 1998) is a 36-item scale with 18 items assessing attachment anxiety (e.g., 'my desire to be very close sometimes scares people away') and 18 items assessing attachment avoidance (e.g., 'I want to get close to my partner, but I keep pulling away'). Participants were asked about the extent to which each item was self-descriptive of their thoughts, feelings, and behaviours in relationships; they rated their level of agreement with each item on a 7-point scale ranging from 1 (disagree strongly) to 7 (agree strongly).

The DASS (Lovibond & Lovibond, 1995) is a self-report measure listing negative emotional symptoms associated with depression, anxiety, and stress. In this study, we used the seven anxiety items from the short version of the DASS (Antony et al., 1998), which includes twenty-one items overall. The anxiety scale assesses autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect (e.g., 'I was worried about situations where I might panic and make a fool of myself'). Participants rated the extent to which they experienced each symptom over the past week on a 4-point scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time). The DASS scales have been shown to have high internal consistency and to yield meaningful discriminations in a variety of settings (Antony et al., 1998; Clara, Cox, & Enns, 2001).

**Table 1** Scale reliabilities and zero-order correlations between study variables

|                         | 1       | 2       | 3        | 4       | 5       | 6      | 7    |
|-------------------------|---------|---------|----------|---------|---------|--------|------|
| 1. Anxiety symptoms     | 0.77    |         |          |         |         |        |      |
| 2. Low registration     | 0.21**  | 0.75    |          |         |         |        |      |
| 3. Sensory seeking      | -0.04   | -0.14   | 0.67     |         |         |        |      |
| 4. Sensory sensitivity  | 0.26*** | 0.37*** | -0.20**  | 0.68    |         |        |      |
| 5. Sensory avoiding     | 0.18*   | 0.26*** | -0.25*** | 0.57*** | 0.64    |        |      |
| 6. Attachment anxiety   | 0.35*** | 0.36*** | -0.13    | 0.41*** | 0.41*** | 0.90   |      |
| 7. Attachment avoidance | 0.18*   | 0.01    | -0.24*** | 0.10    | 0.20**  | 0.21** | 0.88 |

Note. Values on the diagonal are Cronbach's alphas.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .



sensitivity on anxiety symptoms failed to reach significance, whereas bootstrapped CI for the indirect effect via attachment anxiety indicated it was significant. These results indicated that the effect of sensory sensitivity on anxiety symptoms was mediated by attachment anxiety.

The pattern of results for low registration was somewhat similar. Once all other sensory profiles were statistically controlled, the total effect of low registration on anxiety symptoms was only marginally significant ( $p = .07$ ). However, low registration was positively associated with attachment anxiety, which was positively associated with anxiety symptoms. The direct effect of low registration on anxiety symptoms was not significant, whereas bootstrapped CIs indicated that the indirect effect through attachment anxiety was significant. These results were also consistent with mediation, suggesting that low registration indirectly increases anxiety symptoms through attachment anxiety.

A different pattern was found for sensory seeking. The total effect of sensory seeking on anxiety symptoms was not significant. However, sensory seeking was negatively associated with attachment avoidance, which was a marginally significant positive predictor of anxiety symptoms. Bootstrapped CI for the indirect effect via attachment avoidance indicated it was significant, suggesting that sensory seeking predicts fewer anxiety symptoms through lower attachment avoidance.

The total effect of sensory avoiding on anxiety symptoms was also non-significant once other sensory profiles were statistically controlled. However, sensory avoiding was positively associated with attachment anxiety and avoidance, both of which were positively associated with anxiety symptoms. Bootstrapped CIs indicated that both indirect effects were significant, suggesting that sensory avoiding increases anxiety symptoms indirectly through both attachment anxiety and attachment avoidance.

### Alternative models

The cross-sectional nature of the data necessitated the consideration of alternative causal models. First, we examined an alternative model in which sensory profiles are the mediators and attachment orientations are the IVs. This model did not reveal any mediated paths from attachment orientations to anxiety symptoms, supporting our original specification. Second, we examined possible moderation models in which sensory profiles interacted with the two attachment orientations in their effect on anxiety symptoms. None of the two-way interactions reached significance.

## DISCUSSION

In this study, we investigated the relationships between sensory responsiveness profiles and anxiety symptoms, and

explored the possibility that these relationships are mediated by adult attachment orientations. Our findings indicated that some of the previously reported relationships between sensory profiles and anxiety symptoms (e.g., Engel-Yeger & Dunn, 2011; Kinnealey et al., 2011) disappear when other sensory profiles are statistically controlled. In fact, only sensory sensitivity had a significant unique effect on anxiety symptoms, via attachment anxiety. Other sensory profiles showed indirect relationships with anxiety symptoms through attachment orientations.

The association between profound sensitivity to sensations and mood and behavior symptoms has been described in a relatively large body of theoretical (Dunn, 2001; Miller et al., 2007), clinical, and physiological work (e.g., Bart et al., 2009). Ayres (1979) noted that children with hypersensitivity to tactile sensations showed high anxiety levels during tactile experiences that were not self-initiated. Heller (2003) emphasised that in severe sensory hypersensitivity, stress and anxiety can increase together with other psychological problems, even in emotionally healthy environments. Kinnealey and Fuiiek (1999) described a relationship between sensory hypersensitivity, anxiety, depression, and perception of pain in adults. Recently, it was demonstrated in rodents that hypersensitivity to vestibular challenges is associated with anxiety symptoms (Shefer, Gordon, Avraham, & Mintz, 2010). This association was also reported among children (Bart et al., 2009; Erez et al., 2004). In addition, interventions that optimise vestibular functioning were found to significantly reduce anxiety levels (Bart et al., 2009; Erez et al., 2004).

Although the association between sensory sensitivity and anxiety seems robust, our mediation analysis indicated that this and other associations between sensory processing patterns and anxiety symptoms can be accounted for by adult attachment orientations. None of the sensory profiles had a significant direct effect on anxiety once attachment orientations, especially attachment anxiety, were taken into account. These results suggest that if there is a causal relationship between sensory sensitivity and anxiety, it is likely mediated by attachment anxiety. It is conceivable that being very sensitive to incoming stimuli without attempting to regulate them can lead to an exaggerated interpretation of social cues. In addition, an infant that is often irritated can be misinterpreted by the caregiver and perceived as 'difficult' (Jaegermann & Klein, 2010). Consequently, frequent maladjusted infant-caregiver interactions may evolve into an anxious attachment style and impaired emotional development.

Sensory seeking, sensory avoiding, and low registration did not have significant unique effects on anxiety. However, like sensory sensitivity, they did relate to anxiety indirectly, through attachment anxiety or avoidance. Unlike low registration and sensory avoiding that indirectly predicted more

anxiety, sensory seeking predicted less anxiety through lower attachment avoidance. This is not surprising, as sensory seekers who enjoy sensations are unlikely to avoid the rich sensational experiences that personal interactions provide. On the contrary, they will seek and enhance these interactions, thereby creating a resilience-promoting environment around them (Masten, 2007). Taken together with previous findings that showed that sensory seeking is associated with attachment security (Jerome & Liss, 2005) and vitality (Kinnealey *et al.*, 2011), it seems that this sensory processing pattern can be considered an 'asset' in terms of resilience factors. However, a question remains as to which is contributing more to resilience, the high neurological threshold or the active regulation strategy. Further research is warranted to clarify this point.

### Limitations and future directions

Due to the cross-sectional nature of our data, some questions may arise regarding our choice of this causal model over plausible alternative models in which attachment anxiety and avoidance are independent variables rather than mediators, or models wherein sensory profiles are the mediators of the relationship between attachment and anxiety symptoms. After all, insecure attachment may lead to failure to regulate arousal levels or to high levels of stress (e.g., Mikulincer & Florian, 1998), which may lead to extreme sensory responsiveness patterns. This alternative causal specification, however, was not supported by our data. A similar criticism can be made as to why we specified anxiety symptoms as the dependent variable and sensory profiles as the independent variables, rather than the other way around. Anxiety can both be a cause and an outcome of extreme sensory processing patterns (Ayres, 1972). It is, however, important to remember that the DASS inquires about symptoms experienced in the last week, and hence it may be more appropriate to treat it as an outcome, rather than a cause. Yet, since our data were cross sectional, we cannot categorically exclude alternative causal directions. In fact, a reciprocal process, in which all variables are both causes and outcomes, seems likely.

Nevertheless, a significant body of literature supports the validity of the causal sequence proposed here. Unique sensory profiles, particularly extreme ones, are evident at a very early age (DeGangi & Greenspan, 1988). Numerous studies have shown that behavioral symptoms of extreme sensory patterns at infancy and toddlerhood predict social, behavioral, emotional, cognitive, attention, learning, and communication problems at an older age (e.g., DeGangi, Breinbauer, Roosevelt, Porges, & Greenspan, 2000; DeSantis, Coster, Bigsby, & Lester, 2004). Moreover, the behavioral challenges often experienced by children with extreme sensory patterns have been reported to have a negative effect on the quality of their interactions with both

their human and physical environments (DeSantis *et al.*, 2011; Jaegermann & Klein, 2010; Williamson & Anzalone, 2001). For example, mothers of toddlers with extreme sensory patterns and self-regulation difficulties have reported feelings of depression and decreased feelings of attachment to their toddlers (DeGangi & Breinbauer, 1997). In addition, work by Shefer *et al.* (2010) supports the sensory-sensitivity-leading-to-mental-health directionality by demonstrating that progressive vestibular mutations lead to elevated anxiety, and that moderating these abnormalities in children alleviates anxiety levels (Bart *et al.*, 2009; Erez *et al.*, 2004; Shefer *et al.*, 2010). Taken together, these findings support our proposed causal model.

Although our findings emphasise the temperamental dimension of the attachment system (i.e., the influence of one's sensory temperamental characteristics on the attachment style one will develop), it is important to remember that there is another participant in the dyad that can up- or down-regulate this influence. An attuned caregiver can serve as a protective agent and attenuate the negative effects of a maladaptive sensory profile. A recent study has demonstrated that when caregivers were aware of their infant's sensory profile and showed more sensitive behaviour, they were able to support their child's communication behaviour better, and used teaching behaviours more appropriately, than caregivers that were not aware or did not show more sensitive behaviour (Jaegermann & Klein, 2010). Conversely, a caregiver with an extreme sensory processing profile can be either over-responsive or under-responsive to an infant, which may lead to problematic situations even if the infant has a sensory profile within the normative range. Both developmental and dyadic perspectives are missing in our analysis and require further study.

### Conclusions

The present investigation has not only corroborated and extended previous work but has also uncovered some intriguing relationships between sensory profiles, anxiety symptoms, and attachment orientations. Our findings indicate that attachment orientations account for most of the relationship between sensory profiles and anxiety symptoms, suggesting a possible mediating role for attachment in this relationship.

Overall, our findings suggest that the way we are 'tuned' to the external world can influence vulnerability or resilience to affective disorders, and this influence can occur via interactions with attachment figures. Although some psychological constructs, such as Aron and Aron's (1997) sensory processing sensitivity, address sensory processes, these are intertwined with emotional, empathic, and arousal processes. Our work implies that physiological sensory profiles should be given more specific attention in developmental psychology, neurobiology, and developmental psy-

chopathology. Extreme sensory profiles can serve as early markers for vulnerability even in low-risk environments. A further understanding of how good parenting can positively regulate sensory processes (e.g., Jaegermann & Klein, 2010) can help advance the development of prevention and resilience promoting programs.

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