



Original Article

Predictive Value of Children's Sensory Processing Patterns for Parent-Child Attachment in Children Aged 7- 36 Months

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ABSTRACT

Background: Healthy child development is strongly influenced by the quality of parent-child attachment. Atypical sensory processing, which is common during early childhood, may affect parent-child interactions and attachment, thereby influencing children's developmental outcomes. Early identification of sensory processing patterns may facilitate timely intervention and help prevent subsequent difficulties in relationships and development. This study aimed to examine the predictive value of children's sensory processing patterns for parent-child attachment in children aged 7-36 months.

Methods: This cross-sectional descriptive-analytical study was conducted in Tehran, Iran, in 2024. A total of 175 parents of children aged 7-36 months completed a demographic questionnaire, the Sensory Profile 2, and the Parent-to-Infant Attachment Questionnaire. All questionnaires were completed during a single assessment session. The questionnaires were self-administered under the supervision of an occupational therapist familiar with sensory processing concepts, who was available to answer participants' questions. The collected data were analyzed using SPSS version 24.

Results: The findings indicated that all four sensory processing patterns—sensory seeking, sensory avoiding, sensory sensitivity, and sensory registration—were significantly associated with parent-child attachment and could predict its quality. However, the direction of these associations differed across the four sensory processing patterns.

Conclusion: This study highlights the importance of recognizing and understanding sensory processing patterns during early childhood to improve the quality of parent-child attachment and promote healthy child development. It also suggests incorporating the assessment of sensory processing patterns into therapeutic protocols to support optimal developmental outcomes during early childhood.

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Introduction

One of the most important aspects of family interactions that profoundly influences children's health and well-being is parent–child attachment. Parent–child attachment is defined as a lasting emotional bond between parents and their children. This bond lays the foundation for children's future development and independence and is characterized by parents' sensitivity and responsiveness to their children's cues [1].

Establishing a secure parent–child attachment during early childhood is critically important. Research has shown that secure attachment contributes to children's cognitive development, including reading and mathematical abilities [2]; social and emotional development, including better emotion regulation, more effective coping skills [3], greater social competence, and higher-quality friendships [4]; and physical development, such as a reduced risk of obesity and increased levels of physical activity [5]. Conversely, disruptions in parent–child attachment may place children at greater risk for behavioral problems [6], mood disorders [7], difficulties in social relationships [8], and other psychological problems, including depression [9] and anxiety [10].

Despite its importance, problems related to parent–child attachment is highly prevalent. Studies indicate that approximately 35% of parent–child relationships in the general population are characterized by insecure attachment. This attachment pattern is associated with numerous adverse outcomes affecting children's future development, growth, and social functioning [11]. Therefore, identifying the factors that influence the quality of parent–child attachment is essential for promoting healthy child development.

Research has shown that parent–child attachment is influenced by a wide range of factors [12–14]. Among the most important are parental sensitivity and responsiveness [13], infant temperament [12], and environmental and contextual factors [14]. One environmental factor that may influence children is their exposure to sensory experiences throughout the day, which may at times be either excessive or insufficient.

From the earliest days of life, infants are exposed to a wide range of sensory inputs. However, these sensory experiences are often overlooked in early intervention programs designed to promote child development. Several studies have investigated the relationship between specific sensory processing patterns and parent–child attachment in older children, although small sample sizes have limitations [15–17].

Wallbam (2019) reported associations among tactile and auditory sensory processing, responsiveness to sensory stimuli, and attachment in children. The author recommended that all sensory processing patterns and experiences be considered from the earliest stages of development to provide a more comprehensive understanding of their influence on parent–child attachment [15]. Similarly, Whitcomb et al. (2015) concluded that difficulties in children's sensory processing negatively affect parent–child attachment.

However, that study focused only on sensory modulation and did not examine the relationships between the four distinct sensory processing patterns and the quality of parent–child attachment separately [18]. Investigating the predictive role of these sensory processing patterns is important because attentive and responsive caregivers provide a secure base from which children can safely explore their sensory environment. Such support facilitates effective sensory modulation and adaptive responses to sensory experiences [18]. Therefore, a dynamic and reciprocal relationship appears to exist between children's sensory processing patterns and parent–child attachment.

Studies suggest that in infants with sensory processing concerns, parent–child co-regulation—the supportive process through which caregivers help children regulate their emotions and behavior—is often disrupted. This disruption may occur because infants may display cues that are difficult for caregivers to interpret, and despite appropriate parental responses, they may continue to exhibit behaviors such as irritability or inattention [19]. In addition, research has shown that children with sensory processing disorders often experience difficulties with self-regulation, including emotional and affective regulation. These challenges may contribute to problematic behaviors, which can, in turn, negatively affect parent–child attachment [20]. Furthermore, interactions between children and their parents are inherently rich in sensory experiences [21].

If a child has a low neurological threshold, sensory inputs may be perceived as overwhelming, potentially resulting in avoidant behaviors [22]. In response to these behaviors, parents may lose confidence [23] and become more cautious or hesitant in their interactions with the child [24]. Such changes in parental behavior may negatively affect the development of parent–child attachment [25]. For healthcare professionals involved in child and family development, the early identification and assessment of factors that influence children's development and parent–child interactions are essential [26, 27].

However, research on the predictive role of sensory processing patterns in parent–child attachment, particularly among children younger than three years of age, remains limited. Meanwhile, evidence suggests that timely interventions during early childhood have direct and lasting effects on multiple aspects of child development [28]. During this period, the brain exhibits its greatest neuroplasticity and substantial potential for adaptive change. Consequently, interventions implemented during this stage can play a significant role in children's cognitive development [29] and serve a preventive function by reducing the risk of physical problems and developmental disorders in at-risk children [30]. In addition, studies indicate that early interventions, together with preventive services, can make an important contribution to promoting children's mental health. Therefore, the present study aimed to examine the predictive role of different sensory processing patterns in children aged 7–36 months in relation to parent–child attachment.

Method

Participants: A total of 175 parent–child dyads participated in this study. Participants were randomly selected from comprehensive health service centers, urban health centers, and kindergartens located in the northern, southern, eastern, and western regions of Tehran.

The inclusion criteria were: (1) children aged 7–36 months; (2) parents who were able to complete the study questionnaires; and (3) children with no known or significant developmental disorders. Participants who were unwilling or withdrew their consent at any stage of the study were excluded from further participation.

This study was conducted under the supervision of the University of Social Welfare and Rehabilitation Sciences, Tehran, and was approved by the university's Ethics Committee (Approval No. IR.USWR.REC.1403.215).

Instruments: In this study, a demographic questionnaire was used to collect participants' demographic characteristics. The Sensory Profile 2 was administered to assess children's sensory processing patterns, and the Parent-to-Infant Attachment Questionnaire was used to evaluate the quality of parent–child attachment.

a) Demographic Questionnaire

The researcher-developed demographic questionnaire collected participants' demographic and background information, including age, sex, and relevant medical history.

b) Sensory Profile 2

The Sensory Profile 2, developed by Dunn, is a standardized and reliable instrument for assessing sensory processing. It evaluates the interaction among sensory systems, sensory processing functions, and related behavioral responses [31]. The toddler version of the questionnaire consists of 54 items and is designed for children in early childhood. The child's caregiver completes it and typically takes approximately 10–15 minutes.

Items are rated on a 5-point Likert scale. The questionnaire includes several sensory domains, including auditory, visual, tactile, movement, and oral sensory processing, as well as behavioral responses associated with sensory processing.

The Persian version of the Toddler Sensory Profile 2 has been validated in Iran. The content validity index for its items exceeded 0.78, while internal consistency coefficients ranged from 0.67 to 0.91. Test–retest reliability coefficients ranged from 0.72 to 0.95, demonstrating satisfactory reliability [32].

c) Parent-to-Infant Attachment Questionnaire

The Parent-to-Infant Attachment Questionnaire (PIAQ), developed by Condon and Corkindale, is a standardized instrument designed to assess parent–infant attachment during the postnatal period [33]. The questionnaire consists of 19 items and measures three dimensions of attachment: attachment quality, absence of hostility, and pleasure in interaction. Responses are rated on a 5-point Likert scale to assess the overall level of parent–child attachment.

The validity and reliability of the questionnaire have been evaluated in several studies conducted both in Iran and internationally, with findings supporting its satisfactory psychometric properties [34, 35]. The questionnaire has demonstrated an internal consistency coefficient of 0.78. Test–retest reliability coefficients were reported as 0.86, 0.68, and 0.48 over intervals of 2, 4, and 32 weeks, respectively [35].

Procedure: This cross-sectional descriptive-analytical study was conducted in Tehran, Iran, in 2024. Ethical approval and the necessary permissions were obtained from the University of Social Welfare and Rehabilitation Sciences before data collection began. The researchers then visited the selected health service centers and kindergartens across different districts of Tehran. The study objectives and procedures were explained to the administrators of each center, and their permission to conduct the research was obtained.

Eligible participants were identified from records of individuals who attended the selected centers and met the study's inclusion criteria. Participants were then randomly selected using a random number generator based on random number tables. The study procedures were explained to the selected participants, and written informed consent was obtained before enrollment.

Data collection began with the completion of the demographic questionnaire, followed by the Sensory Profile 2 and the Parent-to-Infant Attachment Questionnaire. All questionnaires were completed under the supervision of an occupational therapist with expertise in sensory processing and parent–child attachment, who was available to answer participants' questions throughout the process.

Participants were provided with appropriate support during data collection, including opportunities for rest when needed. They were also informed about the study's data management procedures and assured that all personal information would remain confidential. To protect participants' privacy, all data were coded to remove personal identifiers, and access to the dataset was restricted to the research team. Finally, the collected data were entered into SPSS version 24 for statistical analysis.

Data Analysis: Data were analyzed using SPSS version 24. First, the normality of the data was assessed using the Kolmogorov–Smirnov test. Descriptive statistics were then calculated to summarize the participants' demographic characteristics.

Simple linear regression and multiple regression analyses were performed to examine the relationships between children's sensory processing patterns and parent–child attachment and to determine the predictive value of sensory processing patterns for parent–child attachment. A p -value ≤ 0.05 was considered statistically significant throughout the analyses.

Result

a) Demographic Characteristics

The key qualitative demographic characteristics of

the children included in the study, along with their frequencies and percentages among the 175 participants, are presented in Table 1. The key quantitative demographic characteristics are summarized in Table 2, with the corresponding means and standard deviations.

b) Sensory Processing Patterns and Parent–Child Attachment

The distribution of the children's sensory processing patterns, including their frequencies and percentages, is presented in Table 3. The parent–child attachment scores, together with their means and standard deviations, are presented in Table 4.

c) Relationship Between Children's Sensory Processing Patterns and Parent–Child Attachment

The results of the regression analyses demonstrated

significant associations between children's sensory processing patterns and parent–child attachment. The p-values indicated that all four sensory processing patterns were significantly related to parent–child attachment. Positive beta coefficients indicated a positive association, whereas negative beta coefficients indicated an inverse association between the variables (Table 5).

After adjusting for potential confounding variables, the associations between children's sensory processing patterns and parent–child attachment remained statistically significant. The corresponding beta coefficients and p-values are presented in Table 6. Overall, the findings suggest that children's sensory processing patterns have meaningful predictive value for parent–child attachment.

Table 1: Demographic Characteristics.

Variable		n	Percentage
Gender	boy	114	65.1
	girl	61	34.9
	first	112	64
Born rate	second	50	28.6
	third	13	7.4
Babies in family	1	97	55.4
	2	63	36
	3	15	8.6

Table 2: Age and Weight Status of Participating Children in the Study.

Variable	min	max	Mean	SD
Age	7	36	23.9	10.9
Birth weight	1800	4500	3105.9	379.8

Table 3: Sensory Processing Patterns of Children.

Variable		n	Percentage
Sensory seeking	Very low	33	18.9
	low	39	22.3
	normal	95	56
	high	8	2.9
	Very high	0	0
Sensory avoidance	Very low	5	2.9
	low	14	8
	normal	109	62.3
	high	27	15.4
	Very high	20	11.4
Sensory sensitivity	Very low	3	1.7
	low	19	10.9
	normal	116	66.3
	high	23	13.1
	Very high	14	8
Sensory registration	Very low	14	8
	low	26	14.9
	normal	113	64.6
	high	14	8
	Very high	8	4.6

Table 4: Attachment Scores Status

Variable	min	max	Mean	SD
Attachment total	55.3	88.6	75.4	7.7
Quality of attachment	24.9	45	37.3	4.0
Absence of hostility	7	25	17.2	3.4
Joy in interaction	11	25	20.8	3.3

Table 5: Relationship Between Children's Sensory Processing Patterns and Parent–Child Attachment

Variable	P value	Beta
Sensory seeking	0.018	0.18
Sensory avoidance	≤0.001	-0.33
Sensory sensitivity	0.013	-0.23
Sensory registration	0.007	0.25

Dependent Variable: attachment

Table 6: Relationship Between Children's Sensory Processing Patterns and Parent–Child Attachment After Adjusting for Confounding Variables

Variable	P value	beta	CI
Sensory seeking	0.032	0.16	0.13 – 3.04
Sensory avoidance	0.002	-0.33	(-4.82) – (-1.10)
Sensory sensitivity	0.022	-0.22	(-4.07) – (-0.31)
Sensory registration	0.009	0.25	0.56 – 4.02
Age	0.48	-0.05	(-0.15) – (0.07)
Gender	0.19	0.09	(-0.79) – (3.88)
Born rate	0.74	-0.05	(-4.30) – (3.07)
Babies in family	0.34	0.14	(-1.87) – (5.38)

Dependent Variable: attachment

Discussion

This study aimed to investigate the relationship between children's sensory processing patterns and parent–child attachment. The findings indicated that higher levels of sensory-seeking behavior were associated with better parent–child attachment.

Bodrova and Leong (2012) suggested that pretend play, which often arises from children's sensory exploration of their environment, creates opportunities for both structured and unstructured interactions between children and their parents [36].

During early childhood, play is a fundamental means of sensory exploration and parent–child interaction. Children who engage more frequently in sensory-based play may also be more likely to involve their parents in these activities, thereby strengthening the parent–child relationship.

Therefore, it can be inferred that children's sensory-seeking behaviors often encourage activities that parents and children can participate in together. These shared experiences and positive interactions may contribute to strengthening the parent–child attachment [37, 38].

The findings also showed that higher levels of sensory-avoiding behavior were associated with lower-quality parent–child attachment. Similarly, Brangierporn et al. (2021), in a study of mother–infant attachment, reported that sensory avoidance in children was associated with weaker mother–child attachment [39].

Research suggests that one of the key components of a healthy and secure parent–child attachment is emotional connectedness, which is fostered through sensory interactions such as touch, eye contact, and shared activities. Children with sensory-avoiding patterns often avoid these sensory interactions and joint activities with their parents, thereby reducing emotional connectedness within the parent–child relationship [40].

Children with a sensory-avoiding pattern typically show reluctance to engage with sensory stimuli because many sensory environments may be overwhelming or uncomfortable for them [41, 42]. Consequently, they may spend less time participating in positive interactions with their parents [41, 43]. This reduction in shared experiences may decrease the frequency and quality of parent–child interactions, ultimately negatively impacting attachment.

Additionally, the findings of this study indicated that increased sensory sensitivity in children was associated with reduced quality of parent–child attachment. Children with sensory sensitivity tend to respond to

sensory stimuli in an intense and unpredictable manner [44, 45]. These inconsistent responses may influence parent–child interactions and contribute to a decline in the quality of attachment [43].

Moreover, children with sensory sensitivity often avoid environments or situations involving high levels of sensory stimulation. This avoidance may increase the challenges associated with meeting the child's needs and managing daily interactions, thereby contributing to greater parental stress [46–48].

Davis et al. (2008) also concluded that maternal stress levels were associated with children's sensory modulation difficulties, with sensory sensitivity identified as one of its key subscales [49]. This elevated stress may, in turn, affect the quality of caregiver–child attachment. Parents experiencing high levels of stress may have greater difficulty responding sensitively and consistently to their children's needs. Previous studies have shown that caregiver stress is associated with reduced responsiveness toward children, which can influence the attachment relationship [50].

According to the present study, lower levels of sensory registration in children were associated with reduced quality of parent–child attachment.

Lane et al. (2019) also reported that when sensory information from the environment is not accurately interpreted and integrated, children may experience regulatory, emotional, cognitive, and other difficulties that can substantially affect their social interactions and relationships [51]. Research suggests that when sensory registration functions appropriately, children are better able to understand their environment and interact effectively with their caregivers. In contrast, children with low sensory registration may have difficulties with emotional regulation and may not respond appropriately to different situations [41].

These difficulties may interfere with the child's ability to engage in effective interactions with caregivers, thereby reducing opportunities for establishing a secure parent–child attachment [43, 52].

Considering the points mentioned above, children's sensory processing patterns are important child-related factors that may predict the quality of parent–child attachment. The findings of this study may contribute to the early identification of children at risk of insecure attachment based on their sensory processing patterns. These results may also support the development of targeted interventions focusing on sensory regulation and parent training to improve parent–child interactions. Therefore, sensory processing assessment should be considered as part of early intervention strategies.

Additionally, previous studies have indicated that parental factors, particularly parental mental health, can significantly influence the quality of parent-child attachment. Therefore, future studies are recommended to consider parental mental health as an important contributing factor.

Conclusion

The results demonstrated that children's sensory processing patterns are significantly associated with parent-child attachment and may serve as predictors of attachment quality. These findings suggest that children with different sensory processing patterns may respond differently to sensory experiences, and these responses can influence parent-child interactions and the quality of attachment. The findings highlight the importance of understanding and identifying children's sensory processing patterns to improve parent-child attachment and promote healthy child development.

Author Contributions

Initial protocol design: Dr. Zahra Ghorbanpour. Preparation of study groundwork: Dr. Zahra Ghorbanpour, Dr. Nazila Akbarfahimi, Dr. Ebrahim Pishyareh, Sina Soltani. Data collection: Dr. Zahra Ghorbanpour, Sina Soltani. Statistical analysis: Dr. Mehdi Norouzi, Sina Soltani. Manuscript writing: All authors.

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