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THE IMPACT OF SENSORY HYPERSENSITIVITY ON EXECUTIVE FUNCTION DEVELOPMENT IN PRESCHOOLERS WITH ASD

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Abstract

Autism Spectrum Disorder (ASD) in preschoolers is often associated with sensory hypersensitivity, which affects executive functions such as attention, working memory, planning, and problem-solving. Hyper- or hypo-responsiveness to sensory stimuli disrupts neural connectivity between the prefrontal cortex, amygdala, and sensory cortices, leading to cognitive and adaptive difficulties. Early assessment and interventions, including sensory integration therapy and cognitive-behavioral strategies, can improve executive function and support neurodevelopment. Understanding this relationship is crucial for individualized educational and therapeutic approaches in ASD children.

Keywords

Autism Spectrum Disorder, Sensory hypersensitivity, Executive functions, Prefrontal cortex, Preschool children.

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social communication, linguistic development, and cognitive functions in preschool-aged children. Sensory sensitivity, defined as either hyper- or hypo-responsiveness to environmental stimuli, is a common feature of ASD and significantly affects neurobehavioral development. Sensory hyperresponsiveness refers to an exaggerated reaction to visual, auditory, tactile, gustatory, or olfactory stimuli. This phenomenon is associated with atypical neural activity in the amygdala, thalamus, and sensory cortex. Executive functions, governed primarily by the prefrontal cortex, encompass cognitive processes such as selective attention, working memory, cognitive flexibility, planning, and problem-solving. In preschool-aged children, these functions are crucial for learning and adaptive behavior. Research indicates that excessive sensory input in children with ASD disrupts functional integration in the prefrontal cortex, resulting in delayed development of executive functions. Therefore, examining the relationship between sensory sensitivity and executive function development is essential for tailoring individualized diagnostic, therapeutic, and educational strategies for preschoolers with ASD.

Main part

Sensory sensitivity refers to a child's responsiveness to environmental stimuli, including visual, auditory, tactile, gustatory, and olfactory modalities. In children with ASD, this sensitivity can manifest as hyperresponsiveness or hyporesponsiveness. Hyperresponsiveness is

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linked to hyperactivity in the amygdala and thalamus, increasing cortisol secretion and activating the limbic system. Hyporesponsiveness, on the other hand, may result in under-attention to certain stimuli, affecting adaptive behavior and learning. Neurobiological studies demonstrate reduced functional connectivity between the sensory cortex and prefrontal cortex in children with ASD, which impairs selective attention and working memory. Excessive sensory stimuli trigger overactivity of the autonomic nervous system, making children more susceptible to stress and reducing emotional regulation. Sensory profiles are assessed through clinical observation and standardized neuropsychological tests, such as the Sensory Profile. Individualized therapeutic and educational interventions, including cognitive-behavioral therapy, sensory integration therapy, and emotional regulation exercises, are implemented based on these assessments. Environmental modifications, such as light modulation and acoustic control, optimize attention and executive function performance. This approach enhances social interaction and learning outcomes, supporting overall neurodevelopment in children with ASD.

Executive functions are high-level cognitive processes managed by the prefrontal cortex, encompassing selective attention, working memory, cognitive flexibility, planning, and problem-solving. In preschool-aged children, these functions develop early and support learning, play, and social interaction. In ASD, excessive sensory stimuli impair the integration of the prefrontal cortex and limbic system, slowing the development of executive functions. This results in difficulties with attention, working memory, problem-solving, and planning. Research demonstrates a strong neurobiological link between executive function and emotional regulation. Targeted pedagogical interventions can strengthen working memory, attention, and planning skills. Short-duration task exercises improve working memory, attention training enhances concentration, and planning activities promote problem-solving abilities. Enhancing emotional regulation increases stress resilience and adaptive behavior. Assessment tools such as clinical observation, NEPSY, and the Behavior Rating Inventory of Executive Function (BRIEF) are used to evaluate executive functions. Consequently, individualized development plans can be designed, and tailored pedagogical strategies can be applied. Early development of executive functions is critical for future academic achievement and adaptive functioning in children with ASD.

Studies indicate a strong relationship between sensory sensitivity and executive function development in children with ASD. Excessive sensory input disrupts selective attention, reducing working memory and problem-solving capacity. Hyperresponsive children experience heightened stress due to overactivation of the amygdala-prefrontal cortex circuit, further impairing cognitive flexibility and planning abilities. Hyporesponsiveness, conversely, may result in inattentiveness to essential stimuli, also affecting executive functions. Therapeutic and educational strategies, including sensory integration therapy, cognitive-behavioral exercises, and emotional regulation training, help optimize executive function while managing sensory sensitivity. Individual sensory profiles guide the design of personalized developmental programs. These interventions improve cognitive, social, and emotional outcomes. Understanding the link between sensory sensitivity and executive functions allows early interventions to be more effective. Consequently, preschoolers with ASD can develop stronger executive functions and achieve better academic and social outcomes. Research in this area provides a foundation for future clinical and educational applications, emphasizing the need to account for sensory sensitivity when supporting executive function development in ASD children.

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Conclusion

Sensory hypersensitivity in preschoolers with ASD significantly affects the development of executive functions, including attention, working memory, cognitive flexibility, planning, and problem-solving. Hyperresponsiveness disrupts prefrontal cortex and limbic system connectivity, increasing stress and emotional dysregulation. Hyporesponsiveness also limits cognitive engagement. Early assessment of sensory profiles allows individualized interventions. Approaches such as sensory integration therapy, cognitive-behavioral exercises, and emotional regulation training can improve executive function and adaptive behavior. Understanding this relationship is essential for supporting learning, social interaction, and overall neurodevelopment in children with ASD.

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