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EDITORIAL

New boundaries in neurodevelopmental disorders

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The term "neurodevelopment" refers to the development and maturation of pathways and structures in the central nervous system that influence the acquisition and functioning of sensory, motor, cognitive, communicative, attentional, social skills, all of which are useful for better adaptation to the environment. It is a multidimensional process, characterized by dynamic inter-relationship between genetic, brain, cognitive, emotional, and behavioral factors across the developmental lifespan.[1] Especially in the early years of life, improvements, and acquisitions in one domain or area of neurodevelopment often act as triggers for progression in others with a slower or later maturation path. Sensory experiences, particularly visual ones, are vital across all neurodevelopmental domains, influencing the structure, function, and maturation of the brain. The human brain undergoes significant changes from conception to adulthood, with a rapid increase in synapses during early years. These changes, involving increasingly complex brain microstructures and neural circuits, prepare individuals for learning through neuroplasticity, the brain's ability to change its structure and function in response to experiences and environmental influences. The concept of critical periods is crucial in brain development, indicating periods in the life of an organism during which certain experiences or conditions are mandatory (either for harm or benefit) for the development of a specific function.[2] Very few critical periods have been identified in brain development, with the critical period for the development of the visual system being one of them. Scientists have shown that the visual system requires exposure to light during the first six months of life to stimulate the connections that allow an infant to see. The connection between the visual system and experience is intimate and dual: the visual system serves as the primary means of analyzing reality, while the environment and experiences concurrently shape the plastic development of this system.[3] Development is most influenced also by sensitive periods, "windows of opportunity"[4] when the brain is especially receptive to learning specific information. Synapse density measures neuroplasticity, the brain's ability to adapt and change in response to experiences. Some functions, like motor skills, have prolonged windows, while others are shorter. Persistent damage during these periods from environmental or constitutional genetic factors can lead to neurodevelopmental disorders (NDDs). NDD arise from

divergent architecture, maturation and function of the developing nervous system,[5] are heterogeneous in clinical manifestations, neurobiology and aetiology[6] and have been reported to be present in about 17.8% of US pediatric population.[7] Considering the Italian context, it is estimated that 1 in 77 children suffers from an autism spectrum disorder;[8] learning disorders are very common among the school-age population (5%),[9] as are attention deficit hyperactivity disorder,[10, 11] to mention just a few of the most frequent NDD. They present a wide variety of manifestations in terms of type, course, and prognosis: from autism spectrum disorders, which affect communication and social interaction, to language and learning disorders, attention disorders, psychiatric disorders, and neuromotor disorders such as developmental coordination disorder, up to cerebral palsy, which can also be considered a neurodevelopmental disorder. A systematic understanding of the etiology and natural history of NDD, their co-occurrence with other conditions, and their overlapping features during childhood and adolescence remains incomplete.[12] Although no specific "neurodevelopmental genes" have been identified, genetic studies on affected families reveal genetic risks often combined with environmental factors, such as perinatal risks or toxic substance exposure. Most NDDs persist into adolescence and adulthood, causing social and behavioral difficulties and reduced independence. Recent research emphasizes homotypic co-occurrence, where NDDs commonly coexist, suggesting a shared underlying basis.[13] Unlike psychiatric disorders that have fluctuating courses, NDDs typically onset in childhood before puberty and follow a steady progression, primarily affecting males. These disorders are highly heritable and multifactorial, with significant overlap justifying their collective consideration, despite their clinical heterogeneity and lack of distinct traits separating them from other psychiatric disorders. Therefore, the most current theories suggest using the term NDD as an umbrella term to indicate overlapping conditions requiring a trans-nosographic approach that considers developmental trajectories, maturation timelines of each function, sensitive windows, and various factors integrating constitutional and genetic aspects with risk factors, with a significant role of the environment and epigenetic factors.[14] Thus, an early assessment of the child's developmental domains using a holistic approach to detect early sign risks,[15] and a flexible approach in clinical practice, that takes into consideration the high level of heterogeneity and overlap in NDD,[6] is important to manage early and individualized intervention programs. Through these interventions, we can influence developmental trajectories, reducing the impact on affected children and their families. In the context of promoting neurodevelopment in all children, whether they are at risk of NDD or are typically developing, we can suggest some recommendations to ensure the best possible neuropsychomotor development from the early stages of life: 1) healthy habits before conception (*e.g.*, no smoking, no alcohol, avoiding environmental pollutants, reducing stress, engaging in physical activity); 2) promotion of maternal breastfeeding; 3) care and hygiene of sleep; 4) Promotion of all sensory/multisensory experiences (tactile, auditory-music-visual) and motor activities to encourage curiosity for exploring the environment; 5) promotion of mutual gaze between mother/father and newborn/infant; 6) promotion of communicative interaction through play (imitation, symbolic activities, joint attention); 7) promotion of reading within the family; 8) creating life rules and healthy relationship habits (*e.g.*, setting constructive limits); 9) prevention of excessive use, and especially conscious and age-appropriate use of digital devices (cell phones, tablets, internet); and 10) promotion of social interactions and relationship-building in all contexts of life.

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Conflicts of interest
The author certifies that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions
The author read and approved the final version of the manuscript.

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