

Understanding early social cognition through brain-behavior integration

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Understanding how young children make sense of the social world is crucial in developmental science. From birth, infants show a strong orientation toward the social environment, observed in their behavior. They prefer human faces and biological motion, attend to socially salient cues, discriminate emotional expressions, follow others' gaze, and engage in reciprocal exchanges with caregivers (Striano & Reid, 2006). Early social cognition encompasses a cluster of abilities that gradually develop to support infants' perception, processing, interpretation, and response to social information (Adolphs, 2001; Frith & Frith, 2007; Mateus et al., 2018). These foundational abilities include recognizing faces, interpreting emotions, following gaze, engaging in joint attention, detecting intentions, and attributing mental states to others. Because these early competencies scaffold later social, emotional, and cognitive development, understanding how social cognition unfolds from the very beginning is essential for advancing theory and informing applied contexts.

During the first years of life, the infant's brain is highly plastic and profoundly shaped by social experience, with development reflecting a continuous, dynamic interplay between genetic

maturation and environmental input (Gabard-Durnam & McLaughlin, 2020; Nelson & Gabard-Durnam, 2020). Within this framework, predictable and sensitive caregiving, social engagement with caregivers, and the accumulation of positive daily interactions all contribute to the maturation of neural networks that support social functioning (Ilyka et al., 2021; Stern et al., 2024). In contrast, inconsistent interactions or atypical caregiving environments can alter or disrupt these developmental pathways, affecting both brain function and emerging socio-emotional behaviors (Mateus et al., 2021; McLaughlin et al., 2014). By examining how these environmental factors shape neural activity and behavioral responses, researchers can clarify the mechanisms through which early experiences become biologically embedded, thus, integrating behavioral and contextual influences with measures of brain function to provide a more comprehensive account of how the social mind develops.

Recent methodological advances have greatly expanded our ability to study the developing brain in ecologically valid ways. Techniques such as electroencephalography (EEG) and functional near-infrared spectroscopy (fNIRS) are particularly well-suited for infants, as they can be used during naturalistic interactions, allowing researchers to capture infants' brain activity during real-world social engagement (Gervain et al., 2023; Grossmann, 2015; Underwood et al., 2025). Even more promising are hyperscanning paradigms, in which the brain activity of infants or young children and their caregivers is recorded simultaneously. These approaches reveal shared patterns of neural activity associated with joint attention (Piazza et al. 2020), social contingency (Nguyen et al., 2023) and natural interactions (Turk et al., 2022), underscoring that social cognition emerges not only within individual brains but also through dynamic interpersonal exchanges.

Within this context, accumulating evidence supports the concept of a “social brain” as a framework linking brain function to social behavior. The social brain encompasses a network of regions such as the medial prefrontal cortex (mPFC), temporoparietal junction (TPJ), superior temporal sulcus (STS), and amygdala, which support processes such as mentalizing, emotion processing, biological motion perception, and joint attention (Adolphs, 2009; Frith, 2007; Van Overwalle, 2009). The functional involvement of these regions in social interactions is evident remarkably early in development. For example, activation over the STS-TPJ and prefrontal regions has been observed during joint attention interactions in infants aged 11–13 months (Hakuno et al., 2018; Piazza et al., 2020); greater activation in the superior temporal cortex for face processing at 7 months predicts higher sociability at 18 months (Grossmann, 2024); and TPJ activity in 7-month-old infants reliably distinguishes false-belief scenarios from control conditions (Hyde et al., 2018).

Integrating brain and behavior measures in developmental science provides clear added value by highlighting the neural basis of emerging behaviors and showing how these skills develop over time. Such approaches may deepen our understanding of whether different neural pathways may lead to similar social behaviors, and of how early atypical neural responses could signal risk of later social difficulties long before such traits become behaviorally detectable. These insights are crucial for clarifying both common trajectories and individual differences, and their underlying mechanisms, in both typical and atypical development.

To advance our understanding of early social cognition, we must embrace the complexity and richness of development, integrating brain-based and behavioral approaches. Multimodal longitudinal studies are a powerful way of clarifying how early neural and behavioral indicators jointly predict long-term outcomes. In the context of intervention design, neural markers can help to identify sensitive periods, tailor interventions to individual profiles, and detect subtle improvements in behavior that are not yet observable. In the context of neurodevelopmental disorders such as autism, which are characterized by impairments in social cognition and atypical activity within core regions of the social brain (Pelphrey et al., 2011), integrated approaches can refine early detection and guide more personalized therapeutic strategies.

Social cognition does not arise from either neural maturation or social interaction alone, but from the continuous dialogue between the two. Uniting these perspectives brings us closer to understanding the mechanisms through which the social mind emerges, and to supporting children's social development in a more informed, effective, and equitable way from the outset.

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