Review article

Potential neural mechanisms underlying the effectiveness of early intervention for children with autism spectrum disorder

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ABSTRACT

Although evidence supports the efficacy of early intervention for improving outcomes for children with autism spectrum disorder (ASD), the mechanisms underlying their effectiveness remain poorly understood. This paper reviews the research literature on the neural bases of the early core deficits in ASD and proposes three key features of early intervention related to the neural mechanisms that may contribute to its effectiveness in improving deficit areas. These features include (1) the early onset of intensive intervention which capitalizes on the experience-expectant plasticity of the immature brain, (2) the use of treatment strategies that address core deficits in social motivation through an emphasis on positive social engagement and arousal modulation, and (3) promotion of complex neural networks and connectivity through thematic, multi-sensory and multi-domain teaching approaches. Understanding the mechanisms of effective early intervention will enable us to identify common or foundational active ingredients for promoting optimal outcomes in children with ASD.

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1. Introduction

Collective efforts in the fields of genetics, neurobiology, and psychology are being made to address the etiology, identification, and treatment of autism spectrum disorder (ASD). Studies of early intensive behavioral intervention for young children with ASD embody such integrated approaches and reveal substantial improvements for a large subset of children, particularly when initiated during toddlerhood or preschool age and continued for 2–3 years (Wallace & Rogers, 2010). Such behaviorally based interventions are associated with improvements in the domains of cognition, adaptive behavior, and language (Rogers & Vismara, 2008), suggesting a certain level of plasticity in these aspects of development, especially when intervention is started early (Drew et al., 2002; Harris and Handleman, 2000).

Research on early brain development in ASD suggests that the way in which young children with ASD interact with their environment affects brain connections and neural responses, potentially having long-term implications for both behavior and brain development. Early intervention, therefore, has a role in shaping the brain to be receptive to the social world, and in doing so, preventing or mitigating the symptoms and severity associated with ASD (Dawson, 2008; Redcay & Courchesne, 2005; Sigman, Dijamco, Gratier, & Rozga, 2004; Wallace & Rogers, 2010). What are the mechanisms underlying the effectiveness of early intervention for ASD? The current paper aims to answer this question by proposing three key features of effective early intervention that promote development and address early core deficits by engaging experience-expectant neural mechanisms. The Early Start Denver Model (ESDM) is used as an exemplar to demonstrate the relation between these features of intervention and the mechanisms through which they enhance learning and plasticity. The three key features include (1) the early onset of intensive intervention, which capitalizes on the experience-expectant plasticity of the immature brain, (2) the use of treatment strategies that address core deficits in social motivation through an emphasis on positive social engagement and arousal modulation, and (3) promotion of complex neural networks and connectivity through thematic, multi-sensory and multi-domain teaching approaches. In the next section, we will review progress in the design and implementation of evidence-based interventions with toddlers with ASD, devoting particular attention to components of early intervention design that have been established as essential to its effectiveness.

2. Components of effective early intervention approaches

Studies of early intensive behavioral intervention in ASD reveal substantial improvements for many children with ASD when initiated during toddlerhood or preschool age and continued for at least 2 years (see Warren et al., 2011 for a review). With advances in the early detection of ASD and the reliable diagnosis in 2 year olds (Chawarska, Klin, Paul, & Volkmar, 2007; Turner & Stone, 2007), comprehensive intervention models for children with ASD beginning treatment before 30 months of age now exist and show promising results for improving children's outcomes (Dawson et al., 2010; Landa, Holman, O'Neill, & Stuart, 2011; McConachie, Randle, Hammal, & Le Couteur, 2005; Vismara, Colombi, & Rogers, 2009; Wetherby and Woods, 2006).

Dawson and Osterling (1997) described common elements of successful early intervention programs for children with ASD, which include (a) curriculum content (attention to social stimuli, imitation, receptive and expressive language, appropriate play, social interaction), (b) highly supportive teaching environments and generalization strategies, (c) predictability and routine, (d) functional approach to problem behaviors, (e) plans for transition from preschool classroom (teaching independent "survival" skills), and (f) family involvement (parents as co-therapists). In 2001, the National Research Council formed the Committee on Educational Interventions for Children with Autism to determine common features of effective early intervention for autism (National Research Council, 2001). Based on the integration of scientific, theoretical, and policy literature, the committee proposed six critical features of early interventions, preschools, and school programs designed for children with ASD from birth to age 8: (a) entry into intervention programs as soon as an autism spectrum diagnosis is seriously considered; (b) active engagement in intensive instructional programming for a minimum of the equivalent of a full school day, 5 days (at least 25 h) a week, with full year programming varied according to the child's chronological age and developmental level; (c) repeated, planned teaching opportunities generally organized around relatively brief periods of time for the youngest children (e.g., 15–20 min intervals), including sufficient amounts of adult attention in one-to-one and very small group instruction to meet individualized goals; (d) inclusion of a family component, including parent training; (e) low student/teacher ratios (no more than two young children with autistic spectrum disorders per adult in the classroom); and (f) mechanisms for ongoing program evaluation and assessments of individual children's progress, with results translated into adjustments in programming (National Research Council, 2001).

In recent years, notable progress continues to be made in the area of early intervention for young children with ASD, but adequate evidence pinpointing specific and necessary active ingredients of intervention is still lacking. In an effort to identify evidence-based characteristics on which to build interventions for infants and toddlers with ASD, Wallace and Rogers (2010) conducted a systematic review of 32 controlled, efficacious interventions for infants and toddlers with developmental disorders or developmental risks other than ASD. These target populations included infants born prematurely, those with developmental delays including Down syndrome, and those at risk for intellectual disability due to family characteristics (e.g., poverty or parental intellectual disability). Wallace and Rogers (2010) identified the specific intervention procedures that were used consistently across the studies including: (1) involving parents through ongoing coaching (specifically focusing on parental responsivity and sensitivity to child cues) and teaching parents to provide the interventions, (2) individualizing the intervention with consideration of each infant's developmental profile, (3) targeting a broad rather than