



## Cognitive and adaptive correlates of an ADOS-derived joint attention composite



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### ABSTRACT

Joint attention skills have been shown to predict language outcomes in children with autism spectrum disorder (ASD). Less is known about the relationship between joint attention (JA) abilities in children with ASD and cognitive and adaptive abilities. In the current study, a subset of items from the Autism Diagnostic Observation Schedule (ADOS), designed to quantify JA abilities, were used to investigate social attention among an unusually large cross-sectional sample of children with ASD ( $n = 1061$ ). An examination of the association between JA and a range of functional correlates (cognitive and adaptive) revealed JA was significantly related to verbal (VIQ) and non-verbal (NVIQ) cognitive ability as well as all domains of adaptive functioning (socialization, communication, and daily living skills). Additional analyses examined the degree to which the relation between adaptive abilities (socialization, communication, and daily living skills) and JA was maintained after taking into account the potentially mediating role of verbal and nonverbal cognitive ability. Results revealed that VIQ fully mediated the relation between JA and adaptive functioning, whereas the relation between these adaptive variables and JA was only partially mediated by NVIQ. Moderation analyses were also conducted to examine how verbal and non-verbal cognitive ability and gender impacted the relation between JA and adaptive functioning. In line with research showing a relation between language and JA, this indicates that while JA is significantly related to functional outcomes, this appears to be mediated specifically through a verbal cognitive pathway.

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## 1. Introduction

Deficits in social communication and interaction are a core feature of autism spectrum disorder (ASD; [American Psychiatric Association, 2013](#)). Although individuals with ASD commonly have a heterogeneous profile of social impairment, deficits in joint attention (JA) are consistently observed within this population ([Bruinsma, Koegel, & Koegel, 2004](#); [Dawson, Meltzoff, Osterling, & Rinaldi, 1998](#); [Dawson et al., 2004](#); [Mundy, Sigman, Ungerer, & Sherman, 1986](#)) and JA is frequently

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examined as a prognostic indicator (Charman et al., 2003). JA behaviors consist of triadic social attentional exchanges between individuals and some object in the social world for the purpose of social sharing. JA appears to be related to a range of important functional outcomes. For example, research demonstrating a relation between JA and other early social behaviors such as social orienting and imitation (e.g., Hobson & Hobson, 2007; Johnson, Gillis, & Romanczyk, 2012; Leekam & Ramsden, 2006) aligns with theory suggesting that JA is one of the key components of a complex cluster of social impairment in ASD (Schultz, 2005). Moreover, JA behaviors have been found to predict positive social outcomes in infants at risk for autism (infant siblings of children with ASD; Malesa et al., 2013) and in children at risk for poor developmental and behavioral outcomes secondary to prenatal drug exposure (Sheinkopf, Mundy, Claussen, & Willoughby, 2004). While less research has examined the impact of JA deficits in older children, evidence from longitudinal research demonstrates that impairments in JA among infants with ASD remain stable later in childhood (Mundy, Sigman, & Kasari, 1990; Sigman et al., 1999). Such findings indicate that research examining functional outcomes related to JA impairment later in childhood would be beneficial.

Early JA skills also predict later language ability in both children with autism and in typical development (e.g., Charman et al., 2003; Mundy & Gomes, 1998; Mundy et al., 1990). Research has shown that language impairment in ASD is not only directly related to adaptive impairment across domains of communication and socialization, but also, daily living skills (Liss et al., 2001). These prior findings indicate that the relationship between JA and social outcomes may in some ways be mediated by language development. For example, in both Malesa et al. (2013) and Sheinkopf et al. (2004), the infants' initiation of JA with others was related to language outcomes, whereas responding to the JA bids of others was related to measures of social competence and skill. A review by Koegel (2000) discusses the importance of incorporating precursor skills such as JA into interventions to improve language outcomes. More recent treatment approaches have also conceptualized JA as a pivotal skill that may be related to positive language and social outcomes (e.g., Kasari, Gulsrud, Wong, Kwon, & Locke, 2010).

In spite of the pivotal role JA plays in language development, it is often not included as a key phenotypic variable in epidemiological studies or genetic investigations of ASD. Additionally, little research has conducted large-scale studies to examine how JA relates specifically to functional outcomes such as cognition or adaptive measures of communication, socialization, and daily living skills. This void in the research is driven in part by methodological challenges associated with quantifying JA. However, given that JA appears to be a pivotal early social skill, increased research is needed to understand how it relates to impairment in other functional outcomes such as adaptive skills (Szatmari et al., 2009). In addition, we need to provide a clearer picture of this behavioral phenotype for inclusion in future genetic research. Additional investigations of the relation between JA and adaptive correlates may help to enhance efforts to tailor interventions for maximum effectiveness across these domains. For example, there is evidence that interventions targeting JA also result in improvement in other domains of social functioning, such as imitation (e.g., Ingersoll & Schreibman, 2006; Whalen, Schreibman, & Ingersoll, 2006). Furthermore, research supports that interventions designed specifically to target improvements in JA result in collateral gains in language (e.g., Jones, Carr, & Feeley, 2006; Kasari, Gulsrud, Freeman, Paparella, & Helleman, 2012; Whalen et al., 2006).

### 1.1. Importance of new methods for assessing joint attention

Specific paradigms designed to elicit and quantify JA typically require time-intensive administration and behavioral coding protocols (Mundy et al., 1986; Seibert, Hogan, & Mundy, 1982; Wetherby & Prizant, 1993). The strengths of this approach include the ability to capture: (1) moment-to-moment counts of behaviors allowing for time series analyses, (2) counts of subcategories of behaviors, and (3) estimates of rates of behaviors. However, these methods require a great deal of time and labor resulting in limited efficiency and, as a result, are infrequently used in studies with large samples of children with ASD, such as phenotypic examinations within genetic investigations. These limitations have rendered it difficult to comprehensively assess the relation between JA and functional outcomes among large samples of children with ASD and to generalize findings. Methods that would enable a more efficient examination of JA may also help facilitate large scale studies aimed at understanding the genetic underpinnings of social attention deficits.

Given the high frequency of JA impairment among children with ASD, items assessing the amount or quality of both initiating and responding to JA (IJA or RJA, respectively) have been incorporated into ASD specific diagnostic instruments (e.g., the Autism Diagnostic Observation Schedule [ADOS]; Lord, Rutter, DiLavore, & Risi, 2002). Extrapolating information about JA ability from widely used measures such as the ADOS enables researchers to quantify JA in large samples of children with ASD using relatively minimal resources. Such a method would potentially help to advance ASD research across genetic and epidemiological domains. Several studies that have used factor analysis to examine ADOS subfactors have revealed an additional JA factor (Gotham et al., 2008; Gotham, Risi, Pickles, & Lord, 2007; Oosterling et al., 2010; Robertson, Tanguay, Lecuyer, Sims, & Waltrip, 1999). The JA factor identified by Gotham et al. (2007, 2008) and replicated by (Oosterling et al., 2010) was comprised of a range of discrete social behaviors including JA but also including behavioral requesting (i.e., pointing, response to joint attention, gesturing, showing, initiation of joint attention and unusual eye contact). Even more broad, the JA factor identified by Robertson et al. (1999) was comprised of items assessing overall social functioning (i.e., quality of social overtures, quality of social responses). Both of these studies are an important step forward in identifying subfactors that may make quantifying JA in larger samples more feasible; however, a JA factor containing only items that

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