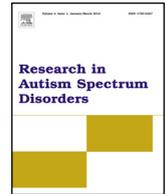




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The language cognition interface in ASD: Complement sentences and false belief reasoning



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ABSTRACT

Theory of Mind (ToM) deficits are often attested in Autism Spectrum Disorders (ASD). Previous work on ASD has identified links between ToM abilities and knowledge of sentential complements, with the hypothesis that this component of language provides a tool for individuals with ASD to figure out solutions to ToM tasks. However studies on ASD are yet to show if the impact of complementation on ToM performance carries over to instances where ToM is assessed nonverbally. As such, the links identified between ToM tasks and complementation tasks may stem from linguistic difficulties that impact scores across the measures used, rather than from the role played by sentential complements in mental representation. This study is the first to evaluate associations between complements and nonverbal ToM in children with ASD compared to typically developing children of similar nonverbal intellectual ability and general language level. Correlations controlling for nonverbal abilities were found between complements and non-verbal ToM success in the ASD group only. Furthermore, regression analyses showed that competence with complement sentences of verbs of communication explained 30% of the variance in their performance at non-verbal ToM. These findings provide new evidence in favour of the view that sentential complements play a role in ToM reasoning in ASD.

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1. Introduction

The capacity to impute mental states to others and to capitalize on this knowledge in order to predict behaviours is referred to as Theory of Mind (ToM) (Premack & Woodruff, 1978). One way of measuring ToM in children consists in using false belief (FB) tasks (Wimmer & Perner, 1983), such as the Sally and Anne paradigm in which children are asked to predict where a character, Sally, will first look for an object that was moved to a new location (by Anne) in her absence (Baron-Cohen, Leslie, & Frith, 1985). In order to answer the critical 'belief' question accurately (i.e. "Where will Sally look for her marble?") children must grasp that Sally has a mental state which is different to reality and that her false belief will make her look for

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the object in the original location, that is to say where she left it, rather than where it really is (Dennett, 1978). ‘Control’ questions ensure that children are keeping track of the story by confirming that they are aware of where the marble is in reality and that they remember where it was initially placed. Typically developing (TD) children generally perform well at this sort of task at around 4–5 years of age (Milligan, Astington, & Dack, 2007; Thommen, 2007; Wellman, Cross, & Watson, 2001). However in their seminal study, Baron-Cohen et al. (1985) showed that 80% of the 20 children with autism they tested, despite having a mean nonverbal mental age of 9 years 3 months, still failed the belief question, despite succeeding at the control questions, in striking contrast to comparison groups of equivalent or lower mental age. This result, the authors argued, stems from the underlying inability of individuals with ASD to appreciate the difference between their own knowledge and the mental state of others. ToM impairments in ASD have been subsequently confirmed by a number of studies (Happé, 1995; Yirmiya et al., 1998; Naito and Nagayama, 2004), leading some researchers to suggest that core communicative and social difficulties associated with this population are the result of a mentalizing deficit (Frith, Morton, & Leslie, 1991; Tager-Flusberg, 2007). However in all of these studies, a paradoxical finding is that a subset of children with ASD always manages to pass ToM tasks. If ToM is a core deficit of this condition, then what is it that allows certain individuals to figure out solutions to FB tasks?

1.1. The role of language and complement sentences in ToM

One hypothesis that has been gaining ground is that successful performance on FB tasks is due to the ability of some individuals with ASD to apply linguistic knowledge as a strategy to bootstrap their way into a representational understanding of mind (Fisher, Happé, & Dunn, 2005; Happé, 1995; Tager-Flusberg, 2000). Because of their attenuated ToM, they would rely particularly heavily on this compensatory verbalizing strategy as an alternative route to mental state representation, explicitly computing correct answers for FB tasks rather than depending on a conceptual understanding of other minds. This could explain why an even higher level of linguistic skills appears necessary in the ASD population than in others for FB success (Happé, 1995; Lind & Bowler, 2009; Tager-Flusberg & Joseph, 2005). Regarding which precise component of language enables FB success in ASD, some studies report the importance of vocabulary (Happé, 1995) while others claim that grammar plays a key role (Fisher et al., 2005; Tager-Flusberg & Sullivan, 1994; Paynter & Peterson, 2010) and, most crucially, grammatical knowledge of complementation (Lind & Bowler, 2009; Tager-Flusberg, 2000; Tager-Flusberg & Joseph, 2005). Sentential complements have specific semantic and syntactic properties that arguably render them well suited to the purpose of mental representation (De Villiers, 1995, 2000; de Villiers & de Villiers, 2000; De Villiers & Piers, 1997a, 1997b), explaining why they have also been found to impact FB success in a special way in TD (see Milligan et al. (2007) for a review and meta-analysis). As can be seen in the examples below, these complements often occur after verbs expressing attitudes or beliefs such as verbs of cognition (1) or verbs of communication (2) and, crucially, such complements may be false without affecting the truth-value of the whole sentence.

- (1) Certain researchers *think/believe* [that children with autism rely on language for false belief success].
 (2) Most children with autism *said/replied* [that the marble was in the box].

The sentence in (1) is true once certain researchers entertain the belief that children with autism rely on language for FB success, independently of whether or not reliance on language is indeed essential for FB success by children with autism. Similarly, (2) remains true as long as most children with autism provided the response that the marble was in the box, whether or not the marble was there in reality. These sentences are thus an ideal tool for entertaining the possible world of others’ minds and it has even been claimed that “without (it), the child cannot hold in mind the structures necessary for judging the truth and falsity of the content of beliefs” (De Villiers, 2007).

Children with autism have been reported to produce few complements in their spontaneous speech (Durrleman & Zufferey, 2013). While certain types of complements have yet to be experimentally assessed in this population (e.g., those occurring with verbs of perception: *John sees that the marble is in the box*), complements occurring with verbs of cognition and comprehension have already been studied. Not surprisingly, children with autism have difficulties with the comprehension of complement clauses of verbs of cognition and they tend to perform better with complements of verbs of communication, which are the less abstract of the two (Lind & Bowler, 2009; Tager-Flusberg, 2000). Interestingly, it is the performance with complements of verbs of communication, and not verbs of cognition, which has been found to correlate with FB success in ASD (Tager-Flusberg, 2000; Lind & Bowler, 2009) as well as to predict their FB performance (Tager-Flusberg & Joseph, 2005). It is thus plausible that an understanding of a potential conflict between what someone says and reality helps those on the autistic spectrum to grasp the concept of erroneous belief. Indeed, the finding of a relationship between the ability to manipulate complements of verbs of communication and ToM has led certain authors to hypothesize that children with ASD are able to bootstrap FB understanding through speaking about what people say rather than about what they think (Tager-Flusberg & Joseph, 2005). However a limitation of the studies to date is that the FB tasks contained an overlapping measure with the task assessing sentential complements, namely they both presupposed a certain level of linguistic sophistication. For example, both FB and complementation assessments rely on the accurate parsing of questions and the past tense. Interestingly, both questions and past tense have been reported to pose problems for children with ASD (Roberts, Rice, & Tager-Flusberg, 2004; Zebib, Tuller, Prévost, & Morin, 2013). As such, it is not obvious that the links between performance at these verbal FB tests and performance at tasks assessing sentential complements are attributable to the

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