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Language and theory of mind in autism spectrum disorder: The relationship between
complement syntax and false belief task performance

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Abstract

This study aimed to test the hypothesis that children with autism spectrum disorder (ASD) use their knowledge of complement syntax as a means of “hacking out” solutions to false belief tasks, despite lacking a representational theory of mind (ToM). Participants completed a “memory for complements” task, a measure of receptive vocabulary, and traditional location change and unexpected contents false belief tasks. Consistent with predictions, the correlation between complement syntax score and location change task performance was significantly stronger within the ASD group than within the comparison group. However, *contrary to predictions*, complement syntax score was not significantly correlated with unexpected contents task performance within either group. Possible explanations for this pattern of results are considered.

Keywords: Autism spectrum disorder; complement syntax; false belief; language; theory of mind.

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Language and theory of mind in autism spectrum disorder: The relationship between complement syntax and false belief task performance

The term “theory of mind” (ToM) refers to the ability to attribute mental states, such as beliefs and desires, to self and others to explain and predict behaviour (Premack & Woodruff, 1978). The ToM hypothesis of autism spectrum disorder (ASD) states that attenuated ToM underlies the social and communication impairments that characterise ASD (e.g., Baron-Cohen, 1989; Frith, 1989; Leslie, 1987). False belief tasks are thought to index a representational ToM because successful performance requires an individual to impute a false belief to a mistaken protagonist in order to correctly predict their behaviour (Dennett, 1978). To succeed on such tasks, children must appreciate that people’s actions are determined not by the real state of the world, but by their mental representations of the world, which may or may not be accurate.

The two most commonly used types of false belief task are location change (Wimmer & Perner, 1983) and unexpected contents (Perner, Leekam, & Wimmer, 1987) tasks. In the “Sally-Anne” location change task (Baron-Cohen, Leslie, & Frith, 1985), the child is presented with the following scenario: “Sally puts her marble in the basket. Then she goes out for a walk. While she is gone, Anne takes the marble out of the basket and puts it in the box. When Sally comes back, where will she look for her marble?” In order to correctly predict that Sally will look in the basket, the child must impute a false belief (that the marble is in the basket) to Sally. In the “Smarties” unexpected contents task (Perner et al., 1987), the child is shown that a tube of Smarties contains pencils rather than the expected sweets, and is then asked what someone else, who has not seen inside the tube, will think is in there before it is opened. Once again, the child must invoke the notion of a false belief in order to

respond correctly. Although ToM abilities become increasingly sophisticated during the preschool years, it is not until around 4 years of age that typically developing children are able to pass false belief tasks (Wellman, Cross, & Watson, 2001). If individuals with ASD have impaired ToM, they should not be able to pass such tasks reliably.

Although dozens of studies indicate that, as a population, individuals with ASD have difficulty with ToM tasks, there is nonetheless a proportion of affected individuals who pass such tasks in the presence of severe social and communication impairments (e.g., Happé, 1995; Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998). If the core features of ASD are the result of attenuated ToM, as many researchers have maintained, then such findings must be accounted for.

One suggestion, which may preserve the integrity of the ToM hypothesis, is that individuals with ASD use compensatory, verbally-mediated, non-ToM strategies to “hack out” solutions to ToM tasks (Bowler, 1992; Happé, 1995). If this is the case then successful ToM task performance amongst individuals with ASD does not reflect the same underlying process that operates in typically developing individuals. This proposal is consistent with a substantial amount of data showing a particularly strong relationship between language (e.g., receptive vocabulary and grammar) and ToM task performance amongst individuals with ASD (e.g., Fisher, Happé, & Dunn, 2005; Tager-Flusberg & Joseph, 2005).

Drawing on de Villiers’ (e.g., 1995) work on typical development, Tager-Flusberg (2000) has argued that a specific type of grammatical competence – the syntax of complementation – may facilitate ToM task performance in ASD. De Villiers suggests that once a typically developing child has acquired complement syntax and understood the semantics of complementation, they have available a new

capacity for representing false beliefs. Complementation is a syntactic process, which allows one propositional argument to be embedded under another proposition. Both communication (e.g., “say”, “tell”) and mental state verbs (e.g., “think”, “believe”, “know”) can take embedded sentential complements. For example:

1. “She said *she was drawing a face*, but it was really a scribble.”
2. “Sally thought *the marble was in the box*, but it was really in the basket.”

The semantics of complement structures mean that the embedded proposition – the complement [depicted in italics in 1 and 2 above] – can express either a true or false proposition, without affecting the truth value of the sentence as a whole. It is this property of sentential complements that is said to make them ideal for representing false beliefs. Hence, sentence 2, above, may be a true statement as a whole, despite the fact that the embedded proposition (“*the marble was in the box*”) is false.

De Villiers and Pyers (2002) conducted a longitudinal study to examine the relation between complement syntax competence and false belief task performance in typical development. A “memory for complements” task was used to assess complement syntax competence, and location change and unexpected contents tasks were used to assess false belief understanding. The memory for complements paradigm involves presenting children with short stories containing embedded complements, which are followed by questions requiring the child to extract the complements from the sentences. For example, “She said *she found a monster under her chair*, but it was really the neighbour’s dog. What did she say?” The researchers found that memory for complements embedded under communication verbs was significantly correlated with concurrent performance on both false belief tasks.

Longitudinally, memory for communication complements predicted false belief understanding three months later, even after controlling for mean length of utterance and grammatical complexity. False belief understanding did not predict later memory for complements. Two training studies also support the hypothesised link between complement syntax and false belief task performance (Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003).

As explained above, de Villiers argues that complement syntax provides a representational format for encoding false beliefs. However, this capacity is not tantamount to a representational ToM. Rather, it represents an important stage in ToM development that, amongst typically developing children, ultimately leads to a fully-fledged ability to reason about mental states (de Villiers & Pyers, 2002). It is possible that some children *with ASD* utilise their knowledge of complement structures to facilitate their false belief test performance, without going on to develop a mature ToM. Indeed, some 15 years ago, Leslie and Roth (1993) proposed that “verbally able autistic children are eventually able to exploit the fact that verbal expressions lay out the structure of propositional attitudes...using a unique verb-argument structure where the object of the verb is another sentence” (pp.103-104).

Previously, Tager-Flusberg (2000) and Tager-Flusberg and Joseph (2005) have attempted to assess the relationship between complement syntax and ToM task performance in ASD. The results of their studies generally appear to show a positive relationship between these variables amongst children with ASD. For example, Tager-Flusberg (2000, Study 1) found that communication verb complement syntax competence significantly predicted location change false belief task performance amongst older children and adolescents with ASD, but not amongst age- and language-matched participants with mental retardation. However, concerns over

aspects of the methods used, the way these studies were reported, and the types of statistical analyses used may lead to the reliability of this relationship being questioned. Tager-Flusberg's (2000) chapter does not include details of participant characteristics and, in some cases, inappropriate statistical analyses were used (e.g., the use of multiple regression, including four predictor variables, with a sample size of only 20). More critically, the statistics reported did not assess whether the relationship between complement syntax and false belief task performance was significantly stronger within the ASD group than within the comparison group. Without comparing within-group associations, it is not possible to draw valid conclusions regarding the possibility that children with ASD exploit their knowledge of complement syntax to aid ToM task performance to a greater or lesser extent than children without ASD. Tager-Flusberg and Joseph (2005) provided a more thorough report of their study. However, they did not include a comparison group, once again precluding the possibility of addressing this question. On the basis of these results, Tager-Flusberg's conclusion, that children with ASD are "more reliant [than children without ASD] on the structural relationship between complements and propositional attitudes to bootstrap their way into a representational understanding of mind" (p.143), seems premature.

Thus, it is still unclear whether complement syntax competence genuinely plays a special role in the false belief task performance of children with ASD, although there is some suggestive evidence that this may be so. To test this hypothesis, the current study adopted similar measures to those used by de Villiers and Pyers (2002) in their study of typically developing children. A memory for complements task was selected as the measure of complement syntax competence, and the Sally-Anne location change (Baron-Cohen et al., 1985) and Smarties

unexpected contents (Perner et al., 1987) tasks were used to assess false belief understanding. If knowledge of complement syntax plays a special role in the false belief task performance of individuals with ASD, mastery of complement syntax should be associated with performance on each of the false belief measures, and these associations should each be significantly stronger within the ASD group than within the comparison group. On the basis of Tager-Flusberg's (2000, Study 1) results obtained with children/adolescents with mental retardation, it was predicted that complement syntax and false belief task performance would not be significantly related within the comparison group.

Although all participants in the current study completed both false belief tasks, given that each task entails different cognitive demands, the results from each were considered separately, rather than as a composite. For example, whereas the Sally-Anne task involves a narrative and a relatively simple test question, the Smarties task does not involve a narrative but involves a more complex test question (Milligan, Astington, & Dack, 2007). In typical development, it is generally assumed that a shift to a representational ToM underlies successful false belief task performance, regardless of task-specific factors (Wellman et al., 2001). However, in the current study, it was postulated that successful performance in ASD might not be underpinned by such a conceptual change, but rather by compensatory mechanisms. Because it could not be assumed that compensatory strategies would be deployed equally across different false belief problems, the tasks were considered separately.

Method

Participants

Approval for this study was obtained from City University Research Ethics Committee. Participants were recruited through schools in South-East England. The parents of all participants gave informed, written consent for their children to take part in the study. Verbal ability was assessed using the British Picture Vocabulary Scale (Dunn, Dunn, Whetton, & Burley, 1997). All participants completed the Sally-Anne and Smarties false belief tasks as well as the complement syntax task. However, the results are presented in two sections which include overlapping, but not identical, samples of participants. The analyses concerning the Sally-Anne and Smarties tasks are presented in Sections 1 and 2 of the results, respectively.

In order to assess the relationship between complement syntax and false belief task performance, it was essential to make certain that participants passed the control questions for the relevant false belief task. This ensured that any failure on the test question was due to a specific difficulty with representing false beliefs as opposed to extraneous task demands. However, a number of participants failed the control questions for one of the false belief tasks but passed the control questions for the other. It was decided that such individuals should not be excluded from analyses concerning the false belief task for which they had passed the control questions. So, for example, a child who failed the Sally-Anne control questions, but passed the Smarties control questions, would be included in the analysis of the relationship between complement syntax and Smarties task performance but excluded from the analysis of the relationship between complement syntax and Sally-Anne task performance. This strategy maximised the power of the planned statistical analyses

but meant that the participant characteristics for the Sally-Anne and Smarties samples differed somewhat.

The Sally-Anne and Smarties samples each consisted of a group of participants with ASD and an age and verbal ability matched comparison group. The participants in the ASD groups attended specialist autism schools or units, for which entry required a formal diagnosis of autistic disorder, Asperger's disorder, pervasive developmental disorder not otherwise specified or atypical autism (American Psychiatric Association, 1994; World Health Organisation, 1993). All participants in the current study met the criteria for autistic disorder or Asperger's disorder.

The comparison groups consisted of children with general learning disability (to act as matches for those children with ASD who also had learning disability) and typically developing children (to act as matches for those children with ASD who did not have learning disability). Potential comparison participants were excluded if they had received specific diagnoses, such as dyslexia, Down syndrome or attention deficit hyperactivity disorder. Any mention of social communication difficulties in any comparison child's Statement of Special Educational Needs resulted in exclusion from the comparison group, as this may have been indicative of ASD-related symptoms or even undiagnosed ASD.

Within the "Sally-Anne sample" (which was used in Section 1 of the results), the ASD group consisted of 48 children/adolescents with autistic disorder ($n = 43$) or Asperger's disorder ($n = 5$), and the comparison group consisted of 48 children/adolescents with general learning disability ($n = 26$) or typical development ($n = 22$). In the "Smarties sample" (which was used in Section 2 of the results), the ASD group consisted of 53 children/adolescents with autistic disorder ($n = 46$) or Asperger's disorder ($n = 7$), and the comparison group consisted of 53

children/adolescents with general learning disability ($n = 27$) or typical development ($n = 26$). The characteristics of the ASD and comparison groups in the Sally-Anne and Smarties samples, respectively, are presented in Table 1.

[Table 1 about here]

Within the Sally-Anne sample, the groups did not significantly differ in terms of chronological age (CA), $t(71.55) = 1.21$, $p = .23$, $r = .14$, or verbal mental age (VMA), $t(94) = 1.21$, $p = .23$, $r = .12$. Within the Smarties sample, the groups did not significantly differ in terms of CA, $t(71.48) = 0.53$, $p = .59$, $r = .06$, or VMA, $t(104) = 0.36$, $p = .72$, $r = .04$.

Materials and Procedure

Participants completed the BPVS first, then the false belief tasks, and finally the complement syntax task. However, the order in which they completed the Sally-Anne and Smarties tasks was counterbalanced.

The complement syntax task involved the experimenter reading 8 one-line stories (e.g., “She told her husband *she saw a ghost* but it was really a blanket.”) to the participant in a fixed order and, after each one, asking them a question (e.g., “What did she tell her husband?”) which required them to extract the complement embedded within it. Each story was accompanied by two illustrative photographs. The experimenter pointed to the relevant parts of the photographs as she read the stories aloud. Each story contained a complement embedded under a tensed communication verb (either “say” or “tell”). Communication verbs, rather than mental state verbs, were used to avoid confounding complement syntax and ToM

competence. Participants' responses were recorded verbatim at the time of testing. Appendix 1 provides details of each story.

The Sally-Anne procedure involved the experimenter acting-out the following sequence using dolls and other props, whilst describing the ongoing events: "Sally's going to put her marble in the blue box. Now Sally's going out to play. While Sally's out, naughty Anne takes the marble out of the blue box and puts it in the pink box. When Sally comes back..." The following questions were then asked: (a) "Where will she look for her marble first?" (test question); (b) "Where is the marble really?" (reality control question); and (c) "Where was the marble in the beginning?" (memory control question).

For the Smarties task, the usual Smarties tube and pencils were substituted with a "Pringles" (well-known type of potato crisp/chip) tube and a tennis ball. The procedure involved the experimenter removing the Pringles box from a plastic bag, showing it to the child, and asking them, "What's in here?" They were then shown the true contents and told, "No, it's a ball." The ball was then replaced and the box was closed again. The child was then asked the following questions: (a) "What's in here? (first reality control question); (b) "Your teacher hasn't seen this box. When (s)he comes in later, I'll show her/him this box just like this and ask her/him what's in here. What will (s)he say?" (test question); (c) "Is that what's really in the box?" (second reality control question).

Scoring

Both the Sally-Anne and Smarties tasks were scored dichotomously as pass/fail, according to performance on the test questions. For a participant's data to be included, they were required to pass the relevant control questions. Children could

score a maximum of eight points on the complement syntax task – one point per question. For a response to be deemed correct, the participant had to extract the complement from the story. However, they were not required to repeat the complement precisely, as they had heard it. If their response captured the gist of the complement (i.e., the counterfactual state of affairs), it was coded as correct. Any mention of the final clause of the sentence (which indicated the true state of affairs) resulted in a response being coded as incorrect. This was because such responses were considered to reflect a failure to distinguish and selectively extract the complement from the complete sentence. Irrelevant (e.g., “I was OK, I hope”, “Yuk!”) or “don’t know” responses were also coded as incorrect.

Results

Section 1: Sally-Anne and complement syntax analyses

The complement syntax scores and VMAs of Sally-Anne passers and failers, within the ASD and comparison groups, are displayed in Table 2.

[Table 2 about here]

The ASD and comparison groups did not differ significantly in terms of complement syntax score, $U = 1088.00$, $z = 0.49$, $p = .63$, $r = .05$, indicating that they had similar levels of complement syntax competence. A total of 26/48 (54.2%) participants with ASD passed the Sally-Anne task, compared to 40/48 (83.3%) comparison participants. The association between group and Sally-Anne task performance was

significant, $\chi^2(1, N = 96) = 9.50, p < .01, \phi = .32$, demonstrating that the ASD group performed significantly less well on the task than the comparison group.

In order to assess the relationship between complement syntax and Sally-Anne task performance, separate correlation analyses were planned for the ASD and comparison groups. A series of preliminary correlations were computed in order to establish whether any covariates should be included in the main analyses. Within each group, Sally-Anne performance was significantly correlated with VMA (ASD: $r_{pb} = .33, p < .02$; comparison: $r_{pb} = .35, p < .02$) but not CA (ASD: $r_{pb} = .19, p = .20$; comparison: $r_{pb} = .18, p = .22$). Thus, partial correlations, controlling for the effect of VMA, were computed in addition to the bivariate correlations between complement syntax and Sally-Anne. Both the bivariate (ASD: $r_{pb} = .50, p < .001$; comparison: $r_{pb} = -.03, p = .85$) and partial (ASD: $r_{pb} = .44, p < .01$; comparison: $r_{pb} = -.22, p = .14$) correlations indicated that complement syntax was significantly associated with Sally-Anne performance within the ASD group only. The bivariate correlation for the ASD group was strong and the partial correlation was moderate (Cohen, 1992). Each of the correlations for the comparison group was weak. It was also important to establish whether complement syntax and Sally-Anne task performance were significantly more strongly related within the ASD group than within the comparison group. Fisher's Z transformations were used to compare the coefficients for each of the groups. These analyses confirmed that both the bivariate, $Z_{r1-r2} = 2.75, p < .01$, and partial, $Z_{r1-r2} = 3.30, p < .01$, correlations were significantly stronger within the ASD group than within the comparison group.

Section 2: Smarties and complement syntax analyses

The complement syntax scores and VMAs of Smarties passers and failers, within the ASD and comparison groups, are displayed in Table 3.

[Table 3 about here]

The groups did not differ significantly in terms of complement syntax score, $U = 1348.00$, $z = -0.37$, $p = .71$, $r = .04$, replicating the results from the Sally-Anne sample. A total of 26/53 (49.0%) participants with ASD passed the Smarties task, compared to 35/53 (66.0%) comparison participants. The association between group and Smarties performance approached significance, $\chi^2(1) = 3.13$, p (one-tailed) = .06, $\phi = .17$.

Preliminary analyses were conducted as background to the planned correlations. Within the ASD group, Smarties performance was significantly correlated with VMA, $r_{pb} = .38$, $p < .01$, but not CA, $r_{pb} = .25$, $p = .07$. Within the comparison group, Smarties performance was significantly correlated with VMA, $r_{pb} = .46$, $p < .01$, and CA, $r_{pb} = .39$, $p < .01$. Thus, partial correlations, controlling for VMA, and VMA and CA, respectively, were computed in addition to the bivariate correlations between complement syntax and Smarties task performance.

The bivariate correlations indicated that complement syntax and Smarties task performance were significantly related within each group (ASD: $r_{pb} = .27$, $p < .05$; comparison: $r_{pb} = .28$, $p < .05$). However, these relationships did not remain significant after controlling for the effect of VMA (ASD: $r_{pb} = .15$, $p = .29$; comparison: $r_{pb} = .05$, $p = .75$), or VMA and CA (ASD: $r_{pb} = .15$, $p = .30$; comparison: $r_{pb} = .02$, $p = .87$). Fisher's Z transformations indicated that neither the

bivariate nor the partial correlations between complement syntax and Smarties task performance differed significantly in strength between the groups (all Z_{r1-r2} s < 0.67 , all $ps > .51$).

Thus, in contrast to the results reported in Section 1, which showed complement syntax to be significantly correlated with Sally-Anne performance within the ASD group but not the comparison group, these results indicated that complement syntax was not significantly related to Smarties performance within either group after controlling for VMA and CA.

Discussion

It was hypothesised that whereas some children with ASD may use knowledge of complement syntax as a compensatory linguistic strategy to perform successfully on measures of false belief understanding in the absence of ToM competence, amongst children without ASD, successful false belief task performance reflects their accurate representation of others' false beliefs, and not a compensatory linguistic strategy. Therefore, it was predicted that the relationship between complement syntax competence and false belief task performance would be significantly stronger within the ASD group than within the comparison group. The current data provided clear support for this prediction in relation to the Sally-Anne task but, importantly, not in relation to the Smarties task.

Correlation analyses revealed that complement syntax scores were strongly associated with Sally-Anne performance ($r = .50$) within the ASD group. Crucially, controlling for the effect of vocabulary only slightly weakened this relationship ($r = .44$), highlighting the specific association between Sally-Anne task performance and

complement syntax competence. However, within the comparison group, complement syntax scores were not significantly correlated with Sally-Anne performance ($r = -.03$).

The current results are in close alignment with those of Tager-Flusberg (2000, Study 1) who found that communication verb complement syntax competence was a significant predictor of location change false belief task performance amongst participants with ASD only, and not amongst participants with mental retardation. Although the reliability of Tager-Flusberg's results was initially questioned, the concurrence of her results with those of the present study provides reassurance about the validity of her findings. However, the current study went further than Tager-Flusberg's by analysing whether the inter-task correlations were significantly *greater* amongst individuals with ASD than amongst comparison participants. Only a positive result in this regard can support the notion that complement syntax competence and false belief task performance are uniquely related (in terms of strength) in ASD, as Tager-Flusberg suggests (p.135). In fact, the current results did support this notion, showing that the inter-task correlation was significantly stronger for the ASD group than the comparison group.

These results, particularly in connection with those of Tager-Flusberg (2000), may suggest that knowledge of complement syntax plays a special role in the Sally-Anne task performance of children with ASD, allowing them to succeed on this widely-used false belief task in the absence of false belief competence. Alternatively, as suggested by Ruffman, Slade, Rowlandson, Rumsey, and Garnham (2003), the direction of causality could be opposite to this, with successful performance on such complement syntax tasks presupposing a theory of false belief. They suggest that "without such a theory...the child has no basis for reconstructing what was said, and

remembering a mistaken proposition” (p.141). In the memory for complements task used here, for example, the protagonists in the stories could be construed as either lying (trying to induce a false belief in another person) or holding a false belief. On this account, a memory for complements task amounts to a type of false belief task.

Although it is never possible to infer the direction of causality from a correlation between two variables, there are notable reasons to favour the hypothesis that complement syntax competence facilitates false belief task performance rather than the hypothesis that false belief competence facilitates complement syntax task performance. In the current study, the ASD group demonstrated impaired false belief understanding but unimpaired memory for complements. If the memory for complements task relied on false belief understanding, the ASD group should have been impaired on this task also. Thus, rather than relying of false belief understanding, the task appears simply to require recall and parsing of complement structures.

Findings from previous studies also support the interpretation that these results reflect the fact that knowledge of complement syntax is utilised by some children with ASD to facilitate Sally-Anne task performance. As previously discussed, longitudinal studies of typical development (e.g., de Villiers & Pyers, 2002) show that complement syntax predicts later false belief task performance amongst 3- to 5-year-olds (independent of general linguistic ability), but false belief task performance does not predict later complement syntax competence. More pertinently, Tager-Flusberg and Joseph (2005) found that this same pattern applied in a sample of 20 children with ASD¹. Together these findings support the interpretation that complement syntax may be used as a means of passing location change false belief tasks amongst some children with ASD.

Despite the arguments presented above, it remains the case that the design of the current study was limited in terms of its ability to distinguish between competing explanations of the relationship between complement syntax competence and false belief task performance. Indeed, it will be important to follow-up these findings with longitudinal or training studies in order to firmly establish a causal model. However, the main purpose of this study was to establish whether complement syntax knowledge plays a stronger role in the false belief task performance of children with ASD than in children without ASD. In this respect, the current results are informative, showing that in the case of the Sally-Anne task, these variables were significantly more strongly related within the ASD group than within the comparison group.

Consistent with the findings of Tager-Flusberg (2000), within the comparison group, the relationship between complement syntax and Sally-Anne performance did not reach significance at all. By contrast, previous studies of typical development have reliably demonstrated a relationship between complement syntax and location change false belief task performance. This discrepancy is likely to be attributable to the fact that the characteristics of the present sample and Tager-Flusberg's sample are considerably different to those in previous studies of typical development, which have generally assessed children aged 3 to 5 years. The current sample were not only considerably older in terms of CA ($M = 9.28$) but also in terms of VMA ($M = 6.37$) (Tager-Flusberg's sample was described as consisting of older children and adolescents with mental retardation). This notable difference between samples may account for the different patterns of results.

Although complement syntax may play an important ontogenetic role in the typical development of ToM, the relationship between complement syntax and false

belief task performance may not hold throughout the course of development. In this respect, complement syntax may still be said to play a special role in ASD, when considered in relation to the specific age and ability groups concerned. Thus, although the relationship *per se* may not be unique to ASD, the strong relationship between complement syntax and location change task performance amongst individuals with higher developmental levels does appear to be unique to ASD.

In relation to the Smarties task, there was no evidence to suggest that children with ASD were using alternative strategies to negotiate the task. These findings are incompatible with the notion that children with ASD use complement syntax as a means of hacking out a solution to the Smarties task. It is important to consider why the initial predictions were confirmed in relation to the Sally-Anne but not the Smarties false belief task. It is possible that task-specific factors make the Sally-Anne task more conducive to the implementation of compensatory strategies. The cognitive and linguistic demands of the Sally-Anne and Smarties tasks are somewhat different. Most conspicuously, the Sally-Anne task involves a narrative and a relatively simple test question, whereas the Smarties task does not involve a narrative but involves a more complex test question. Children who have a good grasp of complement syntax may have the *potential* to linguistically represent a false belief, but their ability to deploy such representations may be dependent on multiple factors. Moreover, the fact that there were no group differences in complement syntax performance, but the ASD group performed significantly less well on the Sally-Anne task, demonstrates that good complement knowledge is not always sufficient to enable successful Sally-Anne task performance amongst individuals with ASD. Further research will be required to establish the reasons for the inconsistent pattern of results observed within the present study, with respect to the two false belief tasks, and to fully elucidate the relationship

between language and ToM amongst individuals with ASD. Clearly, there is much left to be explained.

To summarise, the results of this study, although not conclusive, are at least partially compatible with the hypothesis that children with ASD are more reliant than children without ASD on their linguistic knowledge of complement structures to succeed on false belief tasks. This is the first study to suggest that complement syntax may play a special role in the false belief task performance of children with ASD on at least one type of false belief task. If this interpretation is correct, it follows that successful false belief task performance amongst children with ASD may not invariably reflect a genuine representational ToM, but rather the operation of compensatory linguistic strategies. As suggested above, some children with ASD may be able to use complement syntax to represent false beliefs in certain structured test situations, without going on to develop a mature ToM. Such strategies are likely to be poorly suited to the task of attributing mental states in complex, dynamic real-life social situations. This may explain why even those individuals with ASD who reliably pass false belief tasks nevertheless demonstrate markedly diminished awareness mental states in their everyday lives.

References

- American Psychiatric Association (1994). *Diagnostic and statistical manual (4th edn.)*. New York: Author.
- Baron-Cohen, S. (1989). The autistic child's theory of mind. A case of specific developmental delay. *Journal of Child Psychology and Psychiatry*, 30, 285-297.
- Baron-Cohen, S., Leslie, A.M., & Frith, U. (1985). Does the autistic child have a theory of mind? *Cognition*, 21, 37-46.
- Bowler, D.M. (1992). "Theory of mind" in Asperger's syndrome. *Journal of Child Psychology and Psychiatry*, 33, 877-893.
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112, 155-159.
- Dennett, D.C. (1978). Beliefs about beliefs. *Behavioural and Brain Sciences*, 1, 568-570.
- De Villiers, J.G. (1995). Questioning minds and answering machines. In D. MacLaughlin & S. McEwen (Eds.), *Proceedings of the 19th Boston University Conference on Language Development* (pp.20-36). Somerville, MA: Cascadilla.
- De Villiers, J.G., & Pyers, J. (2002). Complements to cognition: A longitudinal study of the relationship between complex syntax and false belief understanding. *Cognitive Development*, 17, 1037-1060.

- Dunn, L.M., Dunn, L.M., Whetton, C., & Burley, L. (1997). *British Picture Vocabulary Scale (2nd edn.)*. NFER-Nelson.
- Fisher, N., Happé, F., & Dunn, J. (2005). The relationship between vocabulary, grammar, and false belief task performance in children with autistic spectrum disorders and children with moderate learning difficulties. *Journal of Child Psychology and Psychiatry*, 46, 409-419.
- Frith, U. (1989). *Autism: Explaining the Enigma*. Oxford: Blackwell.
- Hale, C.M., & Tager-Flusberg, H. (2003). The influence of language on theory of mind: A training study. *Developmental Science*, 6, 346-359.
- Happé, F. (1995). The role of age and verbal ability in the theory of mind task performance of subjects with autism. *Child Development*, 66, 843-855.
- Leslie, A.M. (1987). Pretense and representation: The origins of “theory of mind”. *Psychological Review*, 94, 412-426.
- Leslie, A.M., & Roth, D. (1993). What autism teaches us about metarepresentation. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), *Understanding other minds: Perspectives from autism* (pp.83-111). Oxford: Oxford University Press.

- Lohmann, H., & Tomasello, M. (2003). The role of language in the development of false belief understanding: A training study. *Child Development*, 74, 1130-1141.
- Milligan, K., Astington, J.W., & Dack, L.A. (2007). Language and theory of mind: Meta-analysis of the relation between language ability and false belief understanding. *Child Development*, 78, 622-646
- Perner, J., Leekam, S., & Wimmer, H. (1987). Three-year-olds' difficulty with false belief: The case for a conceptual deficit. *British Journal of Developmental Psychology*, 5, 125-137.
- Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *The Behavioural and Brain Sciences*, 4, 515-526.
- Ruffman, T., Slade, L., Rowlandson, K., Rumsey, C., & Garnham, A. (2003). How language relates to belief, desire, and emotion understanding. *Cognitive Development*, 18, 139-158.
- Tager-Flusberg, H. (2000). Language and understanding minds: Connections in autism. In S. Baron-Cohen, H. Tager-Flusberg, & D.J. Cohen (Eds.), *Understanding other minds: perspectives from developmental cognitive neuroscience (2nd edn.)* (pp.124-149). Oxford: Oxford University Press.

Tager-Flusberg, H., & Joseph, R.M. (2005). How language facilitates the acquisition of false beliefs in children with autism. In J.W. Astington & J.A. Baird (Eds.), *Why Language Matters for Theory of Mind*. Oxford: Oxford University Press.

Wellman, H., Cross, D., & Watson, J. (2001). Meta-analysis of theory of mind development: The truth about false belief. *Child Development*, 72, 655-684.

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, 13, 103-128.

World Health Organisation (1993). International classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines (10th edn.) Geneva, Switzerland: Author.

Yirmiya, N., Erel, O., Shaked, M., & Solomonica-Levi, D. (1998). Meta-analysis comparing theory of mind abilities in individuals with autism, individuals with mental retardation, and normally developing individuals. *Psychological Bulletin*, 124, 283-307.

Appendix 1

Complement syntax task stories and questions

- (1) The girl said she was reading a book, but she was really playing cards. What did she say?
- (2) She told the girl there was a bug in her hair, but it was only a leaf. What did she tell the girl?
- (3) She told her husband she saw a ghost, but it was really a blanket. What did she tell her husband?
- (4) She said she had a hole in her trousers, but it was really a piece of paper. What did she say?
- (5) She told her dad he had a cut, but it was really ketchup. What did she tell her dad?
- (6) She told the teacher she drew a face, but it was really a scribble. What did she tell her teacher?
- (7) Her friend said she was eating an egg, but it was really a ball. What did she say?
- (8) She said there was a spider in her cereal, but it was really a raisin. What did she say?

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Footnotes

(1) However, it should be noted that a degree of caution should be exercised before drawing strong conclusions on the basis of Tager-Flusberg and Joseph's (2005) findings alone. The sample size in their study was insufficient for the multiple regression analysis that was used, and the results of this analysis were not fully reported. These results may not, therefore, be reliable.

Table 1*Participant characteristics*

	Sally-Anne sample		Smarties sample	
	ASD	Comparison	ASD	Comparison
	(<i>n</i> = 48, 6 female)	(<i>n</i> = 48, 15 female)	(<i>n</i> = 53, 9 female)	(<i>n</i> = 53, 18 female)
CA: years	10.17 (2.39)	9.28 (4.51)	9.17 (2.01)	8.81 (4.55)
VMA: years	6.87 (1.97)	6.37 (2.08)	6.34 (2.00)	6.20 (2.07)

Table 2*Mean (SD) VMA and complement syntax scores for Sally-Anne sample*

Group	Sally-Anne	<i>N</i>	Complement syntax	VMA
ASD	Pass	26	6.38 (2.80)	7.45 (1.91)
	Fail	22	3.18 (2.87)	6.18 (1.85)
Comparison	Pass	40	5.13 (3.45)	6.69 (1.93)
	Fail	8	5.39 (2.62)	4.76 (2.11)

Table 3*Mean (SD) VMA and complement syntax scores for Smarties sample*

Group	Smarties	<i>N</i>	Complement syntax	VMA
ASD	Pass	26	5.54 (3.11)	7.11 (2.04)
	Fail	27	3.86 (2.98)	5.60 (1.68)
Comparison	Pass	35	5.43 (3.35)	6.87 (2.04)
	Fail	18	3.44 (3.18)	4.89 (1.45)