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Further evidence of benefits of thought-bubble training for theory of mind development in children with autism spectrum disorders

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ABSTRACT

Children with autism spectrum disorders (ASDs) routinely fail false belief tests of theory of mind (ToM), even at advanced chronological and mental ages. Initial training efforts were largely disappointing for those with ASD, suggesting an intractable deficit. However, more recently, children with ASD trained with various pictorial strategies (like thought bubbles to depict beliefs) have made modest gains on trained ToM tasks, despite poor generalization and unanswered methodological questions. The present study therefore aimed to further examine the possible benefits of thought-bubble training for children with ASD while overcoming past methodological limitations. Our design advanced upon past thought-bubble studies by incorporating: (a) a non-intervention control group to test specificity of gains to the training intervention, (b) a broad ToM Scale to examine generalization of gains to other steps in ToM growth besides (trained) false belief, (c) a comprehensive assessment of children's verbal and nonverbal abilities, and (d) a delayed follow-up test. Results from 24 children with ASD aged 4.67–12.25 years revealed even stronger evidence than previously that thought-bubble training is genuinely beneficial in the context of autism. Statistically significant gains were made by trained children that, furthermore, (a) generalized beyond false-belief to other ToM concepts and (b) were maintained for at least 3 weeks. Control children showed no significant gains of any kind despite their close match to trained children at pretest. Theoretical and practical implications of the findings are discussed.

Theory of mind (ToM) describes the child's understanding of mental states (e.g., knowledge, beliefs) and how they influence behavior (Wellman & Liu, 2004). A key measure is the inferential false belief task requiring predictions about the actions (e.g., search strategies) of protagonists with false beliefs (e.g., about displaced objects' locations). Typically developing children routinely pass these tests by age 5 (Wellman, Cross, & Watson, 2001) but severe delays often accompany a diagnosis of autism (e.g., Happé, 1995). Training children with autism to understand false beliefs has produced mixed and uncertain results, raising theoretically provocative questions about the basis for ToM deficits in autism. Many studies suggest that training children with autism spectrum disorders (ASDs) to pass false belief tests of ToM is very laborious and of limited value, with much research suggesting apparent ToM gains may not be due to genuine gains in understanding of others' minds but rather to rote, non-mentalistic (or "hacked out") solutions specific aspects of problems used in training (e.g., Swettenham, 2006). For example, Begeer et al. (2011) concluded from a results of their

Abbreviations: ASD, autism spectrum disorder; ToM, theory of mind; PPVT, Peabody Picture Vocabulary Test.

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recent training study that: ''The current study does not indicate strong evidence for the effectiveness of ToM training on daily life mindreading skills'' (p. 997).

However some modest success has recently been achieved through the use of ToM training that incorporates pictorial representations of thinking, especially when the pictures take the form of cartoon thought bubbles (e.g., McGregor, Whiten, & Blackburn, 1998; Swettenham, Baron-Cohen, Gomez, & Walsh, 1996; Wellman et al., 2002). Even so, whereas picture-in-the-head (e.g. McGregor et al., 1998; Swettenham et al., 1996) and thought-bubble training (e.g., Wellman et al., 2002) has often demonstrated modest success on trained ToM tasks, evidence for generalization to new ToM concepts remains limited. Pass rates by children with ASD often on the exact task that children eventually mastered in these past studies typically showed little or no generalization either to new kinds of false belief tests or even to the same task with different stimuli. These findings are in line with a theoretical view that ToM deficits in ASD are so intractable that the appearance of gains after training is illusory. Perhaps non-mentalistic ''hacking'' (Happé, 1995) strategies enable children to passed trained tasks without using ToM. In other words, rather than acquiring genuine understanding of mental states, successfully trained children with ASD are thought, according to the hacking view, to have improved simply by acquiring non-ToM-related heuristics (e.g., ''always say the wrong answer'') that are narrow and task-specific. Even though a more recent study (Wellman et al., 2002) produced stronger evidence of gains on the trained (changed location) false belief concept than much past research (including generalization to new stimuli), Wellman et al. did not discount a hacking interpretation. There was so little evidence of generalization to new, untrained false belief concepts that they concluded success was probably via acquisition of ''an an alternative to a theory of mind'' (p. 343) by the children with ASD.

However, there are unresolved questions about Wellman et al.'s pioneering research. Methodologically, perhaps the most serious limitation of this study was its lack of a non-intervention control group. Control children with ASD can sometimes improve upon their own pretest false-belief scores simply via repeated testing and elapsed time, as was highlighted by Fisher and Happé (2005) study of training in executive functioning. Indeed, using pre- and post-false belief tests very similar to those used by Wellman et al. (2002) across a similar 5–10-day training period, Fisher and Happé found that an untrained control group with ASD gained significantly on a deceptive container false-belief task, even without intervention of any kind. Thus, since Wellman et al.'s study lacked a control group, it is unclear whether their findings of benefits supposedly from thought bubbles may have reflected a similar pattern. To examine this, our study will include a non-intervention control group of children with ASD who are matched with trained children at pretest.

Another issue that is important both theoretically and practically is whether any genuine benefits that may conceivably accrue via children's learning to use thought bubbles to pictorially represent false beliefs may, in fact, be more capable to generalize to novel ToM tests than the hacking theory would suggest. To examine this in the present study, we will explore generalization of ToM gains in more depth than previous thought picture and bubble training studies have attempted. Not only will we look for generalization beyond the specifically trained (changed location) ToM concept to other false belief concepts (i.e., false beliefs about misleading containers) but we will also study generalization beyond false belief to other related ToM concepts, as assessed by a well-established, psychometrically reliable ToM Scale (Wellman & Liu, 2004). This scale identifies five separate steps in ToM mastery, including three that precede, and one that follows, false belief.

In summary, we tested the (a) replicability, (b) specificity (to training), (c) generalizability (within and beyond false belief) and (d) persistence (over time) of Wellman et al. (2002) promising training procedure that uses thought-bubble pictures to visually depict thinking. We wanted to examine whether this visual approach to picturing thinking may indeed be capable of yielding generalizable gains in ToM understanding in children with ASD and, unlike Wellman et al. (2002) we included a non-intervention control group to explore specificity of training gains. Our sample of 24 children with ASD was subdivided into a training group ($n = 17$) and a closely matched control group ($n = 7$). Unlike Wellman et al. (2002) we (a) had a control group, (b) gave both an immediate and a delayed follow-up test, and (b) assessed generalization more broadly via a developmentally sequential ToM Scale of five steps leading up to and beyond, false belief.

1. Method

1.1. Participants

Our sample of 24 Australian children (21 boys; 3 girls) had all been diagnosed with an autism spectrum disorder (ASD) via the published criteria laid out in the fourth-edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV: American Psychiatric Association, 2000). Diagnosis was performed by qualified clinicians who were independent of the present research. As such, childrens' confirmed diagnoses qualified each one in this sample for enrolment in special classes reserved for children with autism. Chronological ages ranged from 4.67 to 12.25 years (mean = 7.00, $SD = 1.95$). Though this age range was broad, it is consistent with much past research that has effectively used the Sally–Ann false belief task to assess ToM understanding in children with ASD. This research has shown less than 50% success on Sally–Ann by children with ASD throughout this age range. (For example Happé, 1995 reviewed eight such studies, all with sample ranging at least as broadly in age than ours: modally from under 6 to over 16 years.) Furthermore most children in our sample (79%) occupied the narrower age band of 6–9 years and, as Table 1 shows, there was no age difference between our training and control groups.