Teaching Perspective-Taking Skills to Children with Autism Spectrum Disorders

by

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Abstract

Perspective-taking is the ability to see the world from another person's viewpoint and is often measured using "false belief" (FB) tasks. Although most typically developing children pass FB tasks between 4 and 5 years of age, approximately 80% of children with an autism spectrum disorder (ASD) do not. Failure on FB tasks remains a persistent deficit among individuals with ASDs. However, relatively little evidence is available on teaching perspective-taking to children with ASDs. The purpose of this study was to evaluate whether teaching perspective-taking skill components would produce generalization to untrained task materials and to three perspective-taking tasks with children with autism. Perspective-taking was broken down into 6 behavioural components and each component was taught in a multiple-baseline design within each child. Procedures in the training program included prompt-fading, positive reinforcement, error correction, multiple exemplar training, forward chaining, and narrative response training. Participants consisted of 4 children with a diagnosis of an ASD. The results showed that the training program produced generalization to variations of the training materials for 14 of the 17 components. Generalization to the three perspective-taking tasks, however, was modest. This study contributes to the body of behavioural research on teaching perspective-taking skills to children with ASDs, and provides procedures for teaching component skills of perspective-taking.

Keywords: teaching perspective-taking, false belief, autism

Teaching Perspective-Taking Skills to Children with Autism Spectrum Disorders

Introduction

Since Premack and Woodruff's seminal paper on Theory of Mind in 1978, research has focused on identifying the processes involved in typical childhood development of this skill. Theory of mind is operationalized as taking another person's perspective and is often studied using experimentally arranged "false belief" (FB) tasks. Typically developing children are able to perform FB tasks between the ages of 4 and 5 (Baron-Cohen, Leslie, & Frith, 1985; Perner, Frith, Leslie, & Leekam, 1989). Conversely, children with autism spectrum disorders (ASDs) are significantly delayed in their development of these skills (Baron-Cohen et al., 1985; Perner et al., 1989; Swettenham, 1996). Much research has focused on identifying the skill components of and/or prerequisite skills needed to perform FB tasks. However, a substantial gap remains between basic and applied research in this field (Ozonoff & Miller, 1995). To date, there is minimal evidence available to guide practitioners in identifying empirically-based training strategies. Because perspective-taking is essential in social interactions (a core deficit of individuals with autism) and given the increasing prevalence of ASDs (Fombonne, 2007), there is a need to evaluate effective training procedures in this area. One promising training approach has involved breaking down the FB task into components, and teaching and linking the components together. This procedure has produced improved task performance and has produced some generalization of the skill across tasks. This area of research, however, could be improved in several ways, including: (a) a better description of strategies for prompting correct responses and fading out those prompts to produce independent correct responding; (b) consistent use of a mastery criterion to ensure independent and correct responding before proceeding to subsequent training components and generalization assessments; (c) consistent use of reinforcement following correct responses; (d) improved description of error correction procedures during training; (e) improved strategies to promote generalization; and (f) consistent use of pre- and post-test measures. In addition, not all previous intervention research has provided confirmation of ASD diagnoses among participants. The purpose of this study was to systematically replicate previous research and address the above limitations. In subsequent sections, I will provide an introduction to ASDs, a description of perspective-taking tasks, a review of previous intervention research, and the method, results, and discussion of this study.

Autism Spectrum Disorders

ASD refers to a subgroup of pervasive developmental disorders (American Psychiatric Association, 2000) including autistic disorder, Asperger disorder, and pervasive developmental disorder-not otherwise specified (PDD-NOS). ASDs are characterized by impairments in social interactions and by restricted behaviour and interests (e.g., ritualistic and repetitive movements). Autistic disorder and PDD-NOS are further characterized by deficits in communication skills, including expressive and receptive language. Children who exhibit characteristics associated with autistic disorder, but who do not meet the diagnostic criteria, would be given a diagnosis of PDD-NOS. The onset of an ASD occurs before 3 years of age and ASDs are diagnosed more frequently in boys (ratio of 4 boys to 1 girl; Pelios & Lund, 2001). In 2007, Fombonne reported that the prevalence of ASDs for the combined pervasive developmental disorders (all ASDs, Childhood Disintegrative Disorder, and Rett Disorder) is approximately 1 in 150 children and more recent prevalence estimates have been as high as approximately 1 in 100 (Stevens et al., 2007).

Perspective-Taking

People with autism experience substantial social impairments that have an impact on almost every aspect of their interactions with others (Carr & LeBlanc, 2007). Impairment in social skills is a primary characteristic of ASDs and deficits in perspective-taking skills have been a suggested impediment to social skills development among individuals within this population (Baron-Cohen, 1988; Fein, Pennington, Markowitz, Braverman, & Waterhouse, 1986; Premack & Woodruff, 1978; Rutter, 1983). Much of the literature on perspective-taking has adopted a cognitive approach, focusing on what has been referred to as *theory of mind*. Theory of mind has been described as "… an appreciation that human action is a consequence of invisible mental concepts such as thoughts, beliefs, desires and intentions" (Frye & Moore, 1991) and individuals "use them to predict and explain behavior" (Heyes, 1998). Gopnik and Slaughter (1991) reported that by age 2, typically developing children understand that other people have desires different from their own, and that these desires are responsible for governing their behaviour. Siegler (1986) went on to say that by age 3, they understand that beliefs influence behaviours; and after age 3, they understand that even when such beliefs are false, people will behave according to their beliefs.

Although the majority of literature has approached perspective-taking from a cognitive paradigm, few researchers have adopted a behaviour analytic approach to perspective-taking. Among those are Schlinger (2009) and Spradlin & Brady (2008) who provided behavioural interpretations of perspective-taking rooted in Skinner's description of how the verbal community teaches its members to tact or describe private events. Skinner indicated that public events often accompany private stimuli. "For example, if a child experiences a sharp blow, cut, or scratch, the parent will very likely teach the child to tact the private pain stimuli. The parent doesn't feel the pain, but does respond to the accompanying stimuli" (Spradlin & Brady, 2008, p. 339). A common way in which a child learns to label their private events involves public behaviour that accompanies those private events. "For example a child with a headache may cry and hold his head. Such behavior may lead the parent to teach the child to tact the private stimuli of pain" (Spradlin & Brady, 2008, p. 339).

Spradlin and Brady (2008) indicated that in a series of studies, Lewis and colleagues ". . . demonstrated that children's performances on false belief tests were highly related to their narrative skills. That is, children who could describe the sequence of events involved in a false belief test coherently nearly always succeeded on the false belief test, while those who did not demonstrate such good narrative skills often failed" (Spradlin & Brady, 2008, p. 342). Spradlin and Brady indicated that children's development of descriptive or narrative skills occurs in conjunction with their observation skills of the behaviour of others. Further, they reported that at about 2 years of age, parents begin asking their children questions about behaviours that happened in the past (e.g., "Did you wash your hands?"). During this time and through these interactions, children come to learn the occasions in which terms such as "think" and "know" are used (Spradlin & Brady). Given the delays experienced in language development by children with ASDs, it is possible that these narrative scripts involving the labelling of ongoing events either are not learned, or are learned at a later age than their typically developing peers, ultimately leading to a delayed development of perspective-taking skills.

False Belief (FB) Tasks

Researchers have devised several FB tasks to measure perspective-taking. Typically developing children are able to perform FB tasks between the ages of 3 and 5 years (Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge, 1996; Lewis & Osborne, 1990). In contrast, approximately 80% of children with ASDs with verbal mental ages between 4 and 5 years were unable to perform the same tasks (Baron-Cohen et al., 1985; Perner et al., 1989; Swettenham, 1996). Furthermore, Holroyd and Baron-Cohen (1993) demonstrated that without intervention, failure on FB tasks remained a persistent deficit among participants with ASDs between the ages of 13 and 26 years. It is possible that children with ASDs either fail to develop, or have a significant delay in acquiring the perspective-taking skills necessary to perform such tasks (Baron-Cohen et al.).

Several FB tasks have been used frequently in research. Behaviourally, FB tasks require the child to: (a) discriminate his or her own perspective from that of others (e.g., what the child sees and what another person can see may be different), and (b) predict the behaviour of another person based on that person's perspective as opposed to one's own (Walters, 2006). The FB tasks fall into two categories, false location and false content.

False location FB tasks. A common false location FB task is called the *Sally-Anne false location FB task* (Baron-Cohen et al., 1985). During this task, a child is presented with two dolls named Sally and Anne, a basket, and a box. Sally puts a marble in the basket and leaves the room. Anne then removes the marble from the basket and places it in a box located beside the basket on the table in front of Anne. The experimenter then asks the child: (a) “Where will Sally look for the marble when she comes back?” (the correct answer would be “in the basket”); (b) “Where is the marble really?” (the correct answer would be “in the box”); and (c) “Where did Sally and Anne put the marble before Sally left the room?” (the correct answer would be “in the basket”).

False content FB tasks. A common false content FB task is called the *Smarties® False Content FB task* (Perner et al., 1989). During this task, a child is shown a box of Smarties® and is asked “What do you think is inside of this box?” (the correct answer would be Smarties® or candy). Following the child’s response, the box is opened to reveal a pencil. The child is then asked what another child, who has not seen the contents, will think the box contains (i.e., “What will Jon say is inside of this box?”). Finally, the child is asked “Do you remember when I first showed you this box. What did you say was inside of it?”

Both tasks contain: (a) a prediction question requiring the child to indicate what another person would say about an event, (b) a reality question requiring the child to indicate the true state of events, and (c) a memory question requiring the child to recall the state of events before the FB was introduced. A task is scored as a “pass” if all three questions are answered correctly.

Assessing and Teaching Perspective-Taking

The literature on teaching perspective-taking skills can be categorized into three general strategies. The first strategy focuses on teaching perspective-taking as part of a social skills training program, the second focuses on teaching visual perspective-taking skills often involved in more elaborate FB tasks, and the third teaches component perspective-taking skills required to pass FB tasks. Each strategy is described below.

Social skills training program. Ozonoff and Miller (1995) carried out a social skills training package with children diagnosed with autistic disorder or PDD-NOS according to the criteria established by the DSM-III-R (American Psychiatric Association, 1987), and evaluated the impact of the training program on FB task performance. Nine children participated in the study, five of whom received social skills training and the others were in a control group. The social skills training program improved FB task performance from baseline to post-training. Children in the treatment group improved on 65.4% of the perspective-taking tasks not passed during baseline, while the control group improved on only 23.5%. Although the sample size was small, the authors reported a moderately large effect size of 0.64 (Cohen, 1992) between the control and treatment groups at post-testing, providing support for the positive impact of their training package. Because this training package taught many social skills (e.g., how to begin, maintain, and appropriately end conversations; how to choose topics that interest others; how to read interpret, and appropriately express nonverbal signals and emotional expressions; how to give compliments), it is not clear how training on the other social skills contributed to the improvement in perspective-taking. Further, the procedures were not described in sufficient detail for replication.

Feng, Lo, Tsai, and Cartledge (2008) taught an 11-year-old boy with autism (diagnosed according to the DSM-IV, American Psychiatric Association, 1994) eight skills, including social and perspective-taking skills. The intervention was evaluated using a single-subject multiple-probe design across behaviours and settings. Training involved presenting an animation episode of a script using a laptop computer. The instructor then orally explained the episode to the participant and subsequently asked a series of questions about the episode (e.g., “What was Lung’s birthday wish?”, “When Lung got a jacket for his birthday, how did he feel?”, “Why did he feel this way?”). Praise was provided for correct responses to the questions. Following incorrect responses verbal prompts were provided to remind the participant of the contents of the episode after which the question was repeated. If the question was answered incorrectly two consecutive times, the correct answer was provided. Next, the trainer and participant role-played the episode. Finally, the trainer summarized the key points in the episode and asked the participant to share his experiences related to the taught skill (e.g., “Did you have a wish for your last birthday? Did your wish come true? How did you feel?”). A learning probe was conducted after each training session that involved administering a live assessment of the same scenario as the one provided in the animated episode at the beginning of the session. If the participant was able to answer the questions correctly during the learning probe, a reward was provided for the participant at the end of the probe session. The authors did not provide any information regarding what consequences were delivered if he did not answer the questions correctly during the learning probe. Subsequent training was also provided in natural settings with small groups of peers using the same training procedures. However, the participant role played with peers rather than the instructor and training focused on the group sharing their own experiences each day rather than presenting a story using the laptop computer. Pre- and post-test measures were conducted using the Test of Theory-of-Mind (TToM; Feng et al., 2008). The TToM consisted of 38 questions that included contents in the areas of situation-based emotion, desire-based emotion, basic belief, first-order FB, second-order FB, and factrecall-, or hint-type questions. The test had demonstrated developmental (construct) validity for children between the ages of 3 and 12 in Taiwan (Feng et al., 2008). Following training on all eight skills, the participant's overall performance on the TToM improved from 56.4% during the pre-test to 92.3% during the post-test. Overall, the training program improved the student's perspective-taking skills and social interaction skills in various forms and in multiple settings. Although generalization was reported based on direct observations of the participant following mastery of the taught skills, pre-training assessments were not collected. Therefore, the performance under the generalization conditions could not be attributed to the intervention.

Visual perspective-taking. Gould, Tarbox, O'Hora, Noone, and Bergstrom (2011) taught three children with an ASD to identify what another person could see using a concurrent multiple-probe design across participants in which all participants received training, baseline, and generalization probes simultaneously. All three children had a diagnosis on the autism spectrum from an independent professional as defined by the DSM-IV (American Psychiatric Association, 1994). Participants ranged in age from 3 years 10 months to 5 years 1 month (average 4 years 6 months). Training involved using visual prompts in the form of red dotted arrows drawn from the person's eyes to the picture they were looking at, a most-to-least prompt-fading procedure (which involved shortening the length of the arrows in order to increase the distance between the eyes and the picture), and reinforcement for correct responses. Children were taught multiple exemplars after meeting a mastery criterion of 100% across two consecutive training sessions on each task. The target response required the children to name the picture of the object that the person was facing when presented with the verbal instruction "What does he/she see?" The direction in which the person was looking and the object being looked at varied across trials. Two of the children learned to label which picture the person was looking at, and one child required the addition of the error correction procedure when no improvements were observed after 13 training sessions. Following the introduction of the error correction procedure, mastery occurred in three sessions. All participants showed improved performance during the generalization probe sessions, improving from less than 30% during baseline to 80% or higher following training, and natural environment probe sessions improving from 0% during baseline to 50% or higher following training. Maintenance was assessed for two participants and both performed at or above 80% 3 weeks following the intervention. The authors recommended that future research is needed to examine the importance of this target behaviour in the performance of perspective-taking.

Teaching skills required for FB tasks. The third category of perspective-taking training studies focused on interventions aimed at teaching children how to perform the component skills of perspective-taking tasks similar to the Sally-Anne false location FB task. Three different procedures have been employed which include video modelling, computer training, and "thought bubble" training.

Charlop-Christy and Daneshvar (2003) used video modelling to teach perspective-taking behaviours to three boys with a diagnosis of autistic disorder (diagnosed by two independent agencies in accordance with the DSM-IV; American Psychiatric Association, 1994) between the ages of 7 and 13 years. A multiple-baseline design across children, and within child across tasks, was used. Probes were administered to evaluate generalization to untrained stimuli. Prior to training, a variation on the Sally-Anne false location FB task (the Barney and Bugs Bunny task) was administered to evaluate FB task performance. Five tasks were used for training along with two similar variations on each task to assess generalization. Video modelling was used for training in which the videotapes for a specific task were viewed by the participants while the other perspective-taking tasks continued to be probed under baseline conditions. The video was presented twice to the child, after which the child was tested three times on the *live* version of a FB task. Once criterion was met the next video task was presented while the remaining tasks continued to be probed under baseline conditions. When all training tasks had reached criterion, the post-test (identical to baseline) was administered. Following video modelling intervention, two of the three participants passed the post-test measure. Of the five generalization tasks, one child generalized to four variations of the training task and a second child generalized to all five variations. The child who failed the post-test also showed inconsistency in his generalization performance during maintenance. Video modelling was effective in teaching the children to perform the perspective-taking tasks trained in the videos and the authors demonstrated generalization to variations of the trained tasks. Given the variability in producing generalization both to variations of the training tasks, and across perspective-taking tasks, further examination of strategies for training and programming for generalization of perspective-taking is warranted.

LeBlanc et al. (2003) also evaluated video modelling to teach perspective-taking in a multiple-baseline design across two training tasks (M&M® false content FB and hide and seek; Chandler, Fritz, & Hala, 1989) with three boys with autism. The M&M® false content FB task is procedurally identical to the Smarties® false content FB task however, the candy brand that was used was M&M® in place of Smarties®. The Sally-Anne false location FB task, which was not used during the training sessions, served as a pre- and post-test for all participants. Baseline with the two training tasks began immediately following the completion of the pre-test. Video modelling was carried out by providing a video of an adult correctly completing the training task. The video was paused to have the child respond to perspective-taking questions immediately after the correct response was modeled and correct responses were praised and consequated by preferred edible items or stickers. Training continued until the child responded correctly to three consecutive trials during the session. In order to evaluate stimulus generalization three stimulus variations were developed for the hide-and-seek task and five stimulus variations were developed for the M&M® false content FB task. These variations were probed during baseline, and were assessed following completion of training. All three participants successfully generalized to the untrained task variations and two of the three participants showed generalization to the Sally-Anne false location FB task.

In 1996, Swettenham examined whether computers could be used to teach an FB task. Eight children with autism, all of whom had been diagnosed according to the DSM-III-R (American Psychiatric Association, 1987) criteria, eight children with a diagnosis of Down syndrome, and eight 3-year-old children without any known diagnosis participated in their study. Only children who failed the pre-test transfer tasks (i.e., generalization tasks) were included in the study. All transfer tasks were administered before and after training and during a 3-month follow-up. Rather than teaching to a mastery criterion, all children received 48 training trials (i.e., six trials per session over eight sessions). Training was conducted using a computerized version of the Sally-Anne false location

FB task. Correct responses were followed by music and a flashing message on the screen reading "YES, WELL DONE." After the child selected the correct container (i.e., the one where Sally would think the ball was), Sally searched the selected container for the ball and explained that "the ball is not there anymore", a statement that was accompanied by her waving her arms and stamping her feet to denote disappointment. Incorrect responses were followed by the character appearing on the screen and reading a statement about where she thought the ball was, after which a message appeared instructing the child to "try again." A second incorrect response was then followed by the direct instruction "try the red/blue box", at which point the program would only allow the child to continue if he or she selected the correct box. During training a steady increase in correct trials per session was observed across all three groups, although children in the Down syndrome group had a lower mean score throughout training. All eight children in the autism and no diagnosis groups reached mastery, which required correct responding on five out of the six trials during one session. Six of the eight children from the Down syndrome group met this criterion as well. Post-tests were conducted to evaluate generalization. Two *close transfer tasks*, both variations on the training task, and three *distant transfer tasks* which differed from the training task in sequence, task materials, scripts, characters, etc., were administered. At post-testing, all eight children in the autism and no diagnosis groups passed the two close transfer tasks, while the children in the Down syndrome group passed an average of 1.5 tasks. However, none of the children in the autism group were able to pass any of the three distant transfer tasks, while the other two groups each passed an average of 1.5 tasks.

Another teaching procedure has been referred to as the "picture-in-the head" (e.g., McGregor, Whiten, & Blackburn, 1998a; 1998b) or “thought-bubble” (e.g., Wellman et al., 2002) approach. In these studies, pictures or thought-bubbles were used as physical representations to depict private events such as thoughts. The first of these studies (McGregor et al., 1998a) evaluated the picture-in-the-head procedure with sixteen 3-year-old typically developing children, and eight adults and eight children with autism. Training was conducted using a variation of the Sally-Anne false location FB task (Baron-Cohen et al., 1985). Three phases were carried out. The first phase involved what the authors referred to as “highlighting intention”. The experimenter explained to the child that the doll, Sally, intended for her marble to be in one of the two containers before she left the room and would therefore look for it there when she returned, regardless of whether someone had moved the marble. Over four training steps the experimenter provided less and less information about Sally’s intention until the final step involved administering the Sally-Anne false location FB task to test whether the information provided about Sally’s intention during the first three steps was successful in producing a pass performance on the FB task. All participants were taught two versions of the task (i.e., a variation of the Sally-Anne false location FB task). If a participant passed all steps of this phase, training was completed and post-tests were administered one week later. If a participant failed any of the steps he/she progressed to the second phase which incorporated the use of pictures in the doll’s head. The FB story was acted out and pictures of what Sally had seen were inserted into a slot in the doll’s head at appropriate times to depict where the doll had seen the object, and to therefore prompt the participants as to where Sally would look for the object. To pass this phase the children were required to correctly identify where Sally would look for the marble based on which picture was slotted inside of the doll's head on two consecutive administrations. Following six unsuccessful attempts at teaching during this phase, a second version of the task (i.e., a variation on the Sally-Anne false location FB task) was trained. If again six teaching attempts of this phase were completed without criterion being met the intervention was terminated. Those children who met criterion progressed to the third phase, during which all the picture cues were faded out. If a participant failed any fading step during this phase, training was immediately terminated. Thirteen of the 16 typically developing children successfully completed training following the first phase. Ten of the 16 participants in the autism group and the remaining three typically developing children learned to perform the Sally-Anne false location FB task following the second and third training phases. Post-test measures included five variations of perspective-taking tasks and the Sally-Anne false location FB task. Generalization was observed in the typically developing group to a greater extent than for the autism group. Two of the 16 individuals in the autism group and six of the eight children in the typically developing group generalized to the variation of the Smarties® false content FB task, while two participants from each group generalized to the deception task during post-test measures. A limitation of this study is that although five generalization perspective-taking tasks and the Sally-Anne false location FB task were administered during post-testing, only three of those measures were assessed during baseline making a comparison of pre- and post-testing on those tasks impossible. Also, although the authors attributed post-test success to the picture-in-the-head procedure for the children in the autism group, the possibility of sequential intervention effects across the three phases could not be discounted.

McGregor et al. (1998b) evaluated the picture-in-the-head procedure with five adults (age 22 to 39 years) and five children (age 9.6 to 17.3 years) with autism, although the diagnostic criteria were not described. All assessments in this study were variations of the Sally-Anne false location FB task, referred to as the Coat, Letter, Bike, Keys, Sandwich, and Football tasks. Prior to training, measures were taken by presenting two video-recorded FB tasks, the Coat and Letter tasks, both of which were later used during the third component of the study. Three of the 10 participants passed the Coat task and two passed the Letter task during baseline. Following baseline, training was carried out for the following three components. First, participants were taught that seeing leads to knowing. Two experimenters engaged in a variety of situations in which one of them knew about the contents of a box. Photos were presented of the real and possible contents of the boxes depicting the experimenters' thoughts and the experimenters talked about the relationship between the pictures and what they could see. For the second component, the picture-in-the-head procedure was used to teach participants a variation of the Sally-Anne false location FB task, but a mastery criterion was not described. For the third component, a video of the procedure used in the second component was shown and the picture-in-the-head was faded out across successive showings, although the details of the fading procedure were not described. Training continued across two additional false location FB tasks using the same sequence. However, mastery was not required, making it unclear what constituted the completion of training. Following training, participants were shown three new video-recorded FB scenes as post-tests – the Keys, Sandwich, and Football tasks – none of which were assessed prior to training. Five of the 10 participants passed all three post-tests and an additional two participants passed two of the three post-tests. Because the post-tests were not administered as pre-tests it is not possible to attribute the successful post-test performance to training.

In 2002, Wellman et al. taught the Sally-Anne false location FB task using the "thought-bubbles" procedure to 10 children with autism, between the ages of eight and 18 years, whose verbal mental ages ranged from 4.0 to 6.6 (mean 5.6) years. Using thought-bubbles, the children were taught four components of the Sally-Anne false location FB task: (a) objects that were out of sight that remained as they were; (b) objects out of sight that changed; (c) hidden objects that remained unmoved; and (d) false beliefs, that is, how the doll would behave after the hidden objects had been moved without the doll seeing the change. During training the participants were required to perform three correct responses within a block of five presentations in order to proceed to the next training component. Following training, participants were tested on the "Bears" false location FB task (not administered at pre-testing) which was a variation of the Sally-Anne task, and the Smarties® false content FB task. Six of the seven children passed the Bears false location FB task, none of whom had passed the Sally-Anne false location FB task during the pre-test assessment. The same two children who had passed the Smarties® false content FB task at pre-testing were the only two to pass the Smarties® task at post-testing. These findings were replicated in a second phase of the study, which included additional pre- and post-test measures. Four pre-test perspective-taking assessments were conducted which consisted of two versions of the false location FB task (Sally-Anne and Bears false location FB tasks), the Smarties® false content FB task, and a fourth perspective-taking task, the Seeing-Knowing task (Baron-Cohen & Goodhart, 1994). In the Seeing-Knowing task, one doll looked into a box while the second doll did not look, but touched the box. The child was then asked "Which one knows what is in the box?"

None of the 10 children passed the Sally-Anne or Bears false location FB tasks, four passed the Smarties® false content FB task and two passed the Seeing-Knowing task during the pre-tests. At post-testing, six of the 10 children passed the Sally-Anne false location FB task, seven passed the Bears false location FB task, eight passed the Smarties® false content FB task, and five passed the Seeing-Knowing task. These results suggested that when false location tasks were taught with thought-bubbles, participants were able to learn to perform the training task and demonstrated generalization to variations and alternative versions of perspective-taking tasks. Wellman et al. were the first to report this type of generalization.

Of all studies teaching perspective-taking, the six reported interventions that appeared to be the most effective were those used by Charlop-Christy and Daneshvar (2003), LeBlanc et al. (2003), McGregor et al. (1998a, 1998b), Swettenham (1996), and Wellman et al. (2002). The six studies combined produced improved training task performance with 31 of the 50 participants and demonstrated some generalization to variations of the trained tasks with 21 of the 50 participants. Three of the six studies (Charlop-Christy & Daneshvar, 2003; Leblanc et al., 2003; &McGregor et al., 1998a) produced generalization to the FB task (Smarties® false content FB task) with a total of 13 participants and the Wellman et al. study produced the largest generalization effect to other FB and perspective-taking tasks – eight of their 10 participants generalized to at least one post-test measure. These six studies appear to share the following procedures: (a) all used some prompt-fading techniques to teach the component skills; (b) three studies required that the participants reached a mastery criterion before proceeding to the next training component or to the tests for generalization; (c) three studies delivered praise or a tangible reward following correct response; (d) four studies attempted to program for generalization by manipulating task materials which included varying the dolls' names and details of the instructions delivered by the computer (Swettenham, 1996), varying the characteristics of the dolls during the training phases (Charlop-Christy & Daneshvar; LeBlanc et al.; McGregor et al., 1998b), and varying the dolls' names and FB and perspective-taking tasks (Charlop-Christy & Daneshvar; LeBlanc et al.). Despite their demonstrated success, 19 of the 50 children did not learn to perform the training tasks, 29 children did not generalize to variations of the trained tasks, and 37 children did not generalize to FB tasks.

Given the complexity of perspective-taking tasks and the various skills involved in performing such tasks it has been suggested that perspective-taking is a complex construct requiring a comprehensive training program that extends beyond teaching the FB tasks themselves (Bauminger, 2002; Chin & Bernard-Opitz, 2000). Gould et al. (2011) suggested that additional research which identifies, specifies, and teaches the component skills involved in perspective-taking is needed. Therefore, the purpose of this study was to evaluate the effectiveness of a training program to promote generalization of perspective-taking skills to children with autism. A task analysis of perspective-taking was conducted to identify six behavioural components, and training was implemented in a multiple-baseline design across behavioural components. Generalization to untrained task variations and to three perspective-taking tasks was assessed before and after each component had met mastery criterion. Ethical approval was obtained from the Psychology/Sociology Research Ethics Board of the University of Manitoba and written informed consent to participate in the study was obtained from the legal guardians of each participant before the study began.

Method

Participants

Four children (Stephan, Liam, Randy, and Ava) with an ASD participated. Their ages were 5 years 7 months, 9 years 6 months, 5 years 1 month, and 5 years 10 months, respectively. Randy was receiving 35 hours per week of early intensive behavioural intervention in a home and daycare setting, and Ava was receiving 35 hours per week of behavioural intervention in a home and school setting. Liam had previously received 35 hours per week of early intensive behavioural intervention prior to age 6 and he was attending school full time during the study. Stephan had never received intensive behavioural intervention and he was attending school full time during the study. Participant characteristics are shown in Table 1.

Diagnosis. All children had a confirmed ASD diagnosis from an independent Psychologist or Developmental Paediatrician prior to the study. The PDDBI-Parent Rating Form (Cohen & Sudhalter, 2005) was administered within the first year of their participation in the study. The PDDBI is a normative assessment developed for clinical, educational, and research applications, normed with children aged 2 through 12 diagnosed with Pervasive Developmental Disorders, and is intended as a tool for assisting in the diagnosis and treatment of this population. The Autism Composite score considers scores on all the core domains related to the DSM-IV-*TR* (American Psychiatric Association, 2000) diagnostic criteria for autism and allows for comparison with the normative sample. The PDDBI has been shown to have high internal consistency, testretest reliability, and good criterion validity (Cohen, Schmidt-Lackner, Romanczyk, & Sudhalter, 2003). The T-score for the PDDBI Autism Composite scale for each child is shown in Table 1. Liam's and Randy's T-scores were within the average range (between 40 and 60) compared with the normative sample (other children with PDD). Stephan's T-score score was below the average range indicating that he had fewer challenges in comparison to the normative sample and Ava's T-score was above the average range indicating that she had greater challenges in comparison to the normative sample.

Verbal age. Stephan, Randy, and Ava were assessed using the Preschool Language Scale 4th ed. (PLS-4; Zimmerman, Steiner, & Pond, 2002) and Liam was assessed using the Clinical Evaluation of Language Fundamentals 4th ed. (CELF-4; Wiig & Secord, 2004). The CELF-4 was administered with Liam because he was too old to be assessed using the PLS-4. The PLS-4 assesses expressive and receptive language skills for children between birth and 6 years 11 months, and the CELF-4 for children between the ages of 5 and 21 years. The PLS-4 generates age equivalent scores for Auditory Comprehension, Expressive Communication, and Overall Language. Liam's verbal mental age (VMA) score was calculated as follows: Chronological age in months multiplied by Core Language standard score generated by the CELF-4. In order to participate in this research children were required to have an age-equivalent (PLS-4) or VMA (CELF-4) of approximately 4, given that typically developing children are able to pass FB tasks by age 4 (Baron-Cohen et al., 1985, Perner et al., 1989; Swettenham, 1996).

Prerequisite skill requirements. Object labelling, picture labelling, and container labelling were requirements for inclusion in this study. These skills were assessed by presenting the child with each of the training and generalization objects (Appendix A), one at a time, and the child was asked to name each object. If the child erred on any of the labels a brief intervention was implemented which involved: vocal prompting, prompt fading, error correction following incorrect labels, and reinforcement for correct independent responses. Once the child was able to independently and correctly label all of the objects required for use in the study during one session he or she was next required to label photographs of the same objects. Labels for the containers listed in Appendix A and pictures of those containers were assessed in the same fashion, and taught to the same criterion when necessary, using the same procedures as those used for object labelling.

Setting

Sessions were conducted in the children's respective homes. During a session, the experimenter and the child sat directly across from each other on the floor or at a table with the apparatus (described below) positioned between them. The child was seated at one end of the apparatus, while the experimenter was seated directly across from the child at the opposite end of the apparatus. This permitted the child to see the doll, the partition, the objects, and the containers during all steps of each trial.

Materials and Apparatus

Training materials. Training materials included: seven dolls; seven objects, consisting of items for which the child could name correctly prior to commencing training of the perspective-taking task components; a 25 cm high x 1 m wide partition; seven containers; and 10 cm x 15 cm photographs of the objects and containers. A list of all training materials is provided in the Training Materials section of Appendix A.

Generalization materials. Two types of generalization tasks were assessed. The first involved assessing each skill component that was being taught using task materials that were not used during training. These materials included three dolls, nine objects, a brown box with multi-coloured dots, a purse, and a Dora® bag. A list of generalization materials is provided in the Generalization Materials section of Appendix A. The second type of generalization, also not trained, involved assessing the Sally-Anne false location FB task, the Smarties® false content FB task, and the Seeing-Knowing task. Materials for the Sally-Anne false location FB task included two dolls, named Sally and Anne, a small white ball (5 cm diameter), a wooden basket (15 cm x 15 cm x 10 cm), and a heart shaped box (15 cm x 15 cm x 10 cm). Materials for the false content FB task included an empty Smarties® box and a pencil. Materials for the Seeing-Knowing task consisted of two dolls, John and Fiona, two identical boxes with lids (10 cm x 10 cm x 5 cm), a puzzle piece, and a Mr. Potato Head® Moustache.

Design and Dependent Measure

A multiple-baseline design (Kazdin, 1982; Martin & Pear, 2011) across task components was used to evaluate the effectiveness of training in producing generalization to untrained tasks. The dependent measure was generalization to untrained component materials and to the three untrained perspective-taking tasks: Sally-Anne false location FB task (Baron-Cohen et al., 1985), Smarties® false content FB task (Perner et al., 1989), and Seeing-Knowing task (Baron-Cohen & Goodhart, 1994). Generalization assessments using the untrained component materials and on the FB and Seeing-Knowing tasks were conducted before and after training each component. Training was implemented for each component, one at a time, in a staggered fashion until the last component was trained.

Generalization was measured as the percentage of correct trials on untrained tasks and on FB and Seeing-Knowing tasks. Although percent correct trials was reported, I also examined the FB and Seeing-Knowing tasks using a pass/fail criterion that was commonly used in the literature. On the Sally-Anne false location FB task, a pass was scored if the child responded correctly on the belief question ("Where does Sally think the ball is?"), the reality question ("Where is the ball really?"), and the memory question ("Where did Sally and Anne put the ball before Sally went to the bathroom?"). The wording used on these questions was a variation on the original script from Baron-Cohen, Leslie, and Frith (1986). If the child responded incorrectly to any of these questions a fail was scored. If the child did not respond within 15 s, the question was asked again. If the child did not respond a second time the experimenter scored the question as incorrect and proceeded to the next question. Nonvocal responses (such as pointing and head nodding) were accepted (Baron-Cohen et al., 1986).

On the Smarties® false content FB task, a pass was scored if the child responded correctly on the belief/prediction question ("What does <name> think is in the box?"), the reality question ("What's really in the box?"), and the memory question ("Do you remember, when I took the box out of my bag and asked you what was in it, what did you say?"; Perner et al., 1989). Non-vocal responses (such as head nodding) to yes/no questions were accepted.

On the Seeing-Knowing task, five trials were presented. On each trial the experimenter placed two boxes and two dolls, John and Fiona, in front of the child and told the following story while moving the dolls accordingly. "Look. I've got some boxes here. There is something inside each box. I am going to show the boxes to John and

Fiona." The experimenter made one of the dolls pick up the closed box and said "John lifts the box up." The other doll was made to open the lid of the box and look inside accompanied by the statement "Fiona opens the box and has a look inside." A pass was scored if the child responded correctly to the question "Who knows what is in the box, John or Fiona?" on all five trials. The dolls' roles changed randomly across trials in that on some trials John looked in one of the boxes while Fiona lifted the other box, and on other trials John lifted one of the boxes while Fiona looked inside the other one. The order in which the two dolls were mentioned in the question was randomized. On each trial the experimenter ensured that the child was not able to see inside the box when the doll opened it, keeping the child unaware of the contents of the box until the end of each trial. The contents of the boxes remained the same across trials.

Task Analysis of Perspective-Taking

The perspective-taking task was broken down into six components for assessment and training. The antecedents and target behaviours for each component are shown in Table 2. Component 1 was designed to teach the child to correctly identify which object the doll was looking at. The dolls and questions were systematically varied across trials to promote generalization (see Training Materials in Appendix A and question variations in Table 2). Component 2 taught the child to discriminate between seeing an object and not seeing an object based on line of sight. Component 3 taught the child to respond to questions about what the doll *thinks* is on the table (i.e., by labelling the object in the doll's line of sight). Component 4 taught the child to indicate that after the doll saw an object and if that object was then changed without the doll seeing the change, the doll's behaviour would still be under the control of the object that they last saw. Component 5 taught the child to identify the container where the object was located and whether the doll saw the experimenter place the object in the container. Component 6 taught the child to indicate that when the doll saw the object placed in one of the two containers, when that object was moved to the other container out of the doll's view, the doll would still respond as if the object was in the container that he or she saw it placed.

Generalization Assessment Using Untrained Component Materials

Each generalization assessment consisted of three trials using the materials described in the Generalization Materials section of Appendix A. On each trial, all six components of the perspective-taking task were presented in order. No programmed feedback or consequence was given for correct or incorrect responses except that the child was thanked for helping at the end of each trial, regardless of their performance. The child was then asked to perform a behaviour unrelated to the experimental materials and reinforced with praise and an edible for correctly performing that behaviour before the next trial. This procedure was also used during a 1-week and a 1-month follow-up assessment after completing training on Component 6.

Generalization Assessment Using False-Belief and Seeing-Knowing Tasks

Each assessment lasted approximately 30 min during which time three tasks were administered with a 5-min break between tasks. Each child was tested on the Sally-Anne false location FB task, the Smarties® false content FB task, and the Seeing-Knowing task using the procedures described by Baron-Cohen et al. (1985), Perner et al. (1989), and Baron-Cohen and Goodhart (1994), respectively. The detailed scripts for administering the tasks are shown in Appendix B. For all tasks, the child was seated approximately 1 m in front of the experimenter who puppeteered the dolls and administered the assessment.

No reinforcement was delivered contingent upon correct responding. Upon completion of each task, the child was thanked for helping regardless of their performance.

Training Procedures

For Liam, Stephan, and Ava, a training session consisted of five trials each during Components 1 through 3. Six trials per session were presented for Components 4 through 6 to ensure that an equal number of trials were presented under each discriminative condition within those components (see Table 2). For Randy who began the study after the others, his sessions consisted of 6 trials each for all task components. Each session was separated by at least a 5-min break from the preceding session. On each training trial, the new component was trained using a combination of prompt-fading, reinforcement, error correction, multiple exemplars (antecedents), and forward chaining.

Forward chaining. A modified forward chaining procedure was used to link the components. Training began with Component 1, then Components 1 and 2, then Components 1, 2, and 3, and so on until the last component was learned. Thus, as each new component was added, the child was still required to perform the previously learned component(s) on each training trial. Component 4 included some skills previously mastered in Components 1 through 3 (i.e., labelling what the doll was looking at, and indicating whether the doll could see the object when the partition was lowered). Component 5 built on the skills mastered during Components 1 through 4 and Component 6 included skills mastered during Components 1 through 5.

Prompt-fading. Pictorial and verbal prompting techniques were used initially during teaching in order to establish correct responding. Once correct responding was established, prompt fading occurred to increase independent responding to questions. For

Stephan, Liam, and Ava, picture prompts were used during all six components and involved providing a pictorial representation of the correct target object or container for a particular question. Randy did not require picture prompts during teaching. Pictures were faded by gradually reducing the contents depicted in the picture by 25% across successive fading steps, and by a time-delay procedure (Charlop, Schreibman, & Thibodeau, 1985; Charlop & Trasowech, 1991). The latter involved systematically increasing the amount of time between issuing the question and presenting the picture prompt until the child was able to independently respond to the question in the absence of the picture prompt. Prompting strategies also included delivering verbal prompts in conjunction with the pictorial prompts, in which the experimenter asked the target question and vocally provided the answer to the child in the presence of the pictorial prompt. Verbal prompts were faded by providing less and less of the required vocal response over trials until the child was able to independently respond to the question in the presence of the pictorial prompt alone. For example, when teaching Component 3, picture and verbal prompts were introduced to increase correct responding to the questions “What is the doll looking at?” and “What does the doll think is on the table?” Following each question the experimenter presented the picture depicting the target object and saying the name of the object (e.g., phone). Verbal prompts were faded by decreasing the amount of the word spoken (e.g., “phone”, “pho”, “ph”). For questions that did not involve objects or pictures (e.g., Component 2, “Can the doll see the object?”), only the verbal prompt was provided and faded.

Because Liam was relying on the picture prompt by waiting for the delivery of the picture prompt after the question “What is the doll looking at?” on Component 1, modifications to the training procedure were introduced that involved sliding the doll forward towards the object before posing the question “What is <doll’s name> looking at?”, and after presenting the question the experimenter drew an imaginary line between the doll’s eyes and the correct object by pointing her index finger at the doll’s eyes and then moving her finger in a straight line to the target object. The proximity of the doll to the object was gradually increased until the doll was in its original position. Next, before the question “What is <doll’s name> looking at?” was asked, the doll’s body was turned towards the object and the imaginary line pointing prompt was provided until he was able to respond based on which object the doll was facing. Eventually just the doll’s head was turned in the direction of the correct object (as described in Component 1 in Table 2) until Liam was able to independently respond to the target question. The imaginary line pointing prompt was faded by shortening the length of the line drawn by approximately 3 cm at each fading step until the prompt was completely removed. During training on Components 1 and 2, manipulations were made to the position of the apparatus so that Liam was positioned directly behind the doll, giving him the same vantage point as the doll, and once he was able to respond to the target questions “What is <doll’s name> looking at?” and “Can the doll see the object?” from that vantage point, the apparatus was turned back to its original position in 45 degree increments.

Positive reinforcement. At the start of each training session, the child was presented with several food items and asked to select one, or if the child requested a reinforcer used in a previous session, the selected or requested item was used as the reinforcer. Praise and an edible were given for each correct response within the component being trained, and praise only was given for correct responses in previously learned components. For example, if a child had mastered Component 1 and was being trained on Components 1 and 2 as a chain, praise only was given for correct responses in Component 1 and praise and an edible were given for correct responses in Component 2. Additional reinforcement was given for general on-task behaviours (i.e., attending, sitting, and following instructions not related to performing the task that were delivered by the experimenter) during sessions for Stephan, Ava, and Randy. Liam did not require additional reinforcement for on-task behaviours. Stephan received an additional reward (e.g., balloons, a cupcake, dancing to music with the experimenters, playing tag) at the end of each session for earning tokens for engaging in on-task behaviours throughout each trial. Ava earned tokens towards taking a break to play with her sister in the middle of the session (i.e., once she earned three tokens, delivered intermittently for engaging in on-task behaviours, she could take a break to play with her sister for 5 min). The remaining tokens could be earned towards watching a video or playing with the experimenter and her sister after the session. Randy received checkmarks for placing his hands in his lap and not touching the materials, sitting appropriately, and looking at the instructor and materials during trials, which could be exchanged for playing with a cell phone or a toy at the mid-point and end of a session.

Error correction. Following an incorrect response, the experimenter reconstructed and repeated the antecedents for the target response, and provided the least amount of prompting necessary for the child to perform the behaviour correctly. A correct response following an error correction was praised, however, the edible was not given. For example, in teaching Component 6 if an error occurred following the question "Where did Dolly see me put the <object>?" the task materials were returned to the state they were in just prior to asking the question, the question was repeated, the child was prompted as much as necessary to respond correctly, and the experimenter praised the response before moving on to the next question in the trial.

Multiple exemplars. The characteristics of the dolls (e.g., name, hair colour, clothing, gender), objects, containers, and the wording of the questions across trials were varied for all training components (see Training Materials section of Appendix A and Table 2 for wording of the questions).

Mastery criteria. During training, a component was considered mastered when the child was able to independently and correctly answer all questions in a trial (including all previously mastered components) for all trials within one session.

Narrative response training. After failure to obtain generalization following training (described below in the Results section), a narrative response training procedure was implemented to teach Component 6 for all four participants. Participants were taught to vocally describe three events immediately after each event occurred during a trial (i.e., where the object was initially placed while the doll was looking, where the doll thought the object was, and where the object was moved out of the doll`s sight). The purpose of teaching these narrative responses was to provide the participants with a narrative script that could later be used in responding to the belief, reality, and memory questions. A script for this procedure is shown in Appendix C. For example, the experimenter asked Liam to describe each event immediately after it had occurred during a trial using the following questions: "Where did Dolly see me put the <object>?", "Where does Dolly think the <object> is?", and "What did I just do?" His responses contained the statements "She saw you put it in the <container 1>", "She thinks it's in the <container

1>", and "You moved it to the <container 2>", respectively. These statements were then used by the experimenter as prompts for the child to use in response to the belief, reality, and memory questions (e.g., "Where does Dolly think the <object> is? She thinks it's in the _______".) For Stephan, Ava, and Randy, their responses were shortened to "Saw <container 1>", "Thinks <container 1>", and "Moved to <container 2>", respectively, because they preferred to use fewer words and displayed fewer errors in imitating the narrative response when fewer words were presented to them. Narrative response training was used in combination with the same verbal prompting and prompt-fading techniques, reinforcement for correct responses, error correction, multiple exemplars (antecedents), and forward chaining procedures.

During the addition of the narrative response training procedures Ava received a further modification to the prompt-delay procedure because she began waiting for the experimenter to issue the prompt and was not initiating responses independently. An additional reinforcer (Mini M&M® candy) was given for initiating her response independently before the prompt, regardless of the correctness of the response. If she initiated an incorrect response, the experimenter interrupted and prompted the correct response, and an error was recorded. If she initiated a correct response she was reinforced according to the reinforcement procedure described below for correct responding. Correct responses were reinforced using a token system and after earning five tokens for correct responses a Cadbury Mini Egg® was placed in a basket to be used in an egg hunt at the end of the teaching session. Delivery of tokens for independent responses continued throughout training and was not faded out.

During the addition of the narrative response training procedures used in Component 6, Randy earned minutes on a timer for each correct response (whether prompted or independent) that could be cashed in for minutes to play on a cell phone or an IPod touch® at the end of the session.

Interobserver Reliability

Generalization assessment with untrained component materials. Live reliability checks were conducted if a research assistant was available on the randomly selected session date. The observer independently scored the child's responses at the same time as the experimenter during live observations. If a research assistant was not available, the session was videotaped and observed and scored at a later date. The experimenter's recordings for each trial were compared with the observer. A trial was considered an agreement if both the experimenter and the observer recorded the same response to all questions (i.e., for one question on Component 1 and for five questions on Component 6); otherwise, it was a disagreement. Percentage of trials scored as agreements were computed for each session (Kazdin, 1982; Martin & Pear, 2011). Across all participants reliability checks were conducted for an average of 71% of baseline and generalization sessions and percent agreement per session averaged 99% (range 67-100%). Across all participants reliability checks were conducted for an average of 75% of training sessions, and percent agreement per session averaged 97% (range 60-100%).

Generalization assessment with false-belief and seeing-knowing tasks. Live reliability checks were conducted if a research assistant was available. If no research assistant was available, the session was videotaped and observed at a later date. An observer independently recorded the child's responses on each question for each task. The experimenter's recordings were compared with the observer's. For the Sally-Anne false location FB and Smarties® false content FB tasks, an agreement was scored only if both the observer and experimenter agreed on the child's responses to all three questions. A disagreement occurred if the observer and experimenter disagreed on the child's response on any of those three questions. Therefore, agreement for each FB task assessment was either 100% or 0%. For the Seeing-Knowing task, which consisted of five trials per assessment, a trial was scored as an agreement if the observer and experimenter recorded the same response and the percentage of trials with agreement was calculated. Across all participants, reliability checks were conducted for an average of 56% of the FB and Seeing-Knowing assessments and the agreement was 100% (no range) in all cases.

Procedural Integrity

Generalization assessment with untrained component materials. Procedural integrity checks were also conducted by an observer using a checklist to evaluate whether the experimenter had carried out the procedures correctly (see Appendix D). A trial was scored as correctly administered if all the steps on the checklist were carried out correctly and as incorrectly administered if the experimenter deviated from the procedure on one or more steps. Percentage of trials correctly delivered per session was calculated to measure procedural integrity. Across all participants procedural integrity checks were conducted for an average of 71% of baseline and generalization sessions, and trials correctly delivered per session averaged 99% (range 67-100%). Across all participants procedural integrity checks were conducted for an average of 77% of training sessions, and trials correctly delivered per session averaged 97% (range 60-100%).

Generalization assessment with false-belief and seeing-knowing tasks. Procedural integrity of FB and Seeing-Knowing assessments were evaluated using the scripts in Appendix B. For the FB tasks, it was scored as correctly administered if all steps in the scripts were conducted correctly and incorrectly administered if one or more steps in the scripts were incorrect. Therefore, the score for each assessment was either 100% or 0%. Across participants procedural integrity checks were conducted for an average of 58% of the FB assessments and all but one observed assessments were administered correctly. For the one assessment that did not attain 100%, the experimenter missed administering one of the questions, however, the question missed was not one of the belief, reality, or memory questions. For each Seeing-Knowing assessment, which consisted of five trials, a trial was scored as correctly delivered if the experimenter conducted all steps in the script correctly and the percentage of trials correctly administered per session was computed. Across participants procedural integrity checks were conducted for an average of 56% of the assessments and the mean percentage of correctly delivered trials per session was 97% (range 95-100%).

Results

Stephan's generalization assessment results across the six components are presented in the first six graphs in Figure 1 and his generalization assessment results on the three perspective-taking tasks are shown in the bottom graph. Training using the training materials for each component is indicated in Figure 1 by an arrow and the number beside each arrow denotes the number of training sessions provided until 100%

accuracy was reached. During the first assessments before training, Stephan performed at 67% correct for Components 1 and 2, 100% for Component 3, 0% for Component 4, 33% for Component 5, and 0% for Component 6. Stephan failed all three perspective-taking tasks at that time. Stephan mastered Component 1 after four training sessions. Following mastery of Component 1, he continued to perform at 67% during the generalization assessment for that component and he failed all three perspective-taking tasks. The second and third pre-training sessions for Components 2 through 6 showed that his performance was stable for all components except that he improved to 100% during session 2 for Component 2. Given his performance for Components 2 and 3, training was not provided for these components.

Stephan mastered Component 4 after 15 teaching sessions. Following mastery, his performance during the generalization assessment improved to 67%, compared to 0% at pre-training. During assessment probes of other components, his maintenance performance of Component 1 decreased to 33% and his pre-training performance was relatively stable for all other components. Re-assessments of the perspective-taking tasks at this time showed that he failed both FB tasks but passed the Seeing-Knowing task.

Training was introduced for Component 5 and Stephan met the mastery criterion after 12 sessions. Generalization performance improved to 67% for Component 5. A probe of all components following mastery showed that maintenance performance accuracy returned to 67% for Component 1, declined to 33% for Component 2, remained at 100% for Component 3 and 67% for Component 4. Pre-training performance remained at 0% for Component 6. Re-assessments of the perspective-taking tasks at this time showed that he failed all three perspective-taking tasks.

Stephan mastered Component 6 after 80 teaching sessions. Following mastery, one generalization session was conducted and he performed at 100%. His maintenance performance on Components 1, 2, 3, and 5 was 100%, and was 33% on Component 4. Two maintenance sessions were conducted to evaluate whether the skills were maintained at 1 week and 10 days following mastery of Component 6. Performance remained stable on Components 2, 3, and 4 however, performance decrements were observed in Components 1, 5, and 6 during the first session. During the second maintenance session performance remained stable on Components 2, 3, and 4, improved to 100% on Components 1 and 5, and because one additional trial was administered on Component 6 due to observations of behaviour that suggested he might not have been attending, his performance was 75%. He did not pass the perspective-taking tasks.

Since Stephan did not pass the perspective-taking tasks and his Component 6 maintenance performance declined, narrative response training was introduced. In addition, the order of the last three questions for Component 6 was randomized across training, but not generalization or maintenance, trials. The narrative responses, however, were too long for Stephan to repeat and were shortened after eight training sessions. Stephan then mastered Component 6 after 20 training sessions with the shortened narrative responses. During generalization assessment, Stephan responded correctly on 100% of Component 6 trials, 100% of Components 1, 2, and 3 trials, 0% for Component 4, and 67% for Component 5 and he passed all three perspective-taking tasks.

The generalization assessments were repeated 1 week and 1 month following mastery of Component 6 with the narrative response training. At the 1-week assessment, Stephan responded correctly on 100% of trials of Components 1 through 3, 0% of

Component 4 trials, and 67% of Components 5 and 6 trials; and he passed the Sally-Anne and Seeing-Knowing tasks. At the 1-month assessment, he responded correctly on 100% of trials of Components 1, 3, 5, and 6, 67% of Component 2 trials, and 0% of Component 4 trials; and he passed all three perspective-taking tasks.

Liam's generalization assessment results across the six components are presented in the first six graphs in Figure 2 and his generalization assessment results on the three perspective-taking tasks are shown in the bottom graph. Training using the training materials for each component is indicated in Figure 2 by an arrow and the number beside each arrow denotes the number of training sessions provided until 100% accuracy was reached. During the first session before training, Liam performed at 33% correct for Component 1, 67% for Component 2, and 0% for Components 3 through 6; and he failed all three perspective-taking tasks. Liam's first two training attempts for Component 1 did not meet mastery, however, Liam mastered Component 1 after 25 training sessions. Data collection on the generalization materials continued for all components during Component 1 training, however, doing so became too disruptive to the flow of training. Following mastery of Component 1, probes following mastery of each training component were conducted for all remaining components. No other participants received probes during training on Component 1. Following mastery of Component 1, his performance increased to 100% during the generalization assessment for that component and he failed all three perspective-taking tasks. During the second pre-training sessions for Components 2 through 6 his performance was 33% on Component 2, 67% on Component 3, and 0% on Components 4 through 6.

Training was introduced for Component 2 and Liam met mastery criterion after 16 sessions. Following mastery, his performance during the generalization assessment improved to 67% compared to 33% at pre-training. During assessment probes of other components, his maintenance performance of Component 1 remained stable at 100% and his pre-training performance for the other components improved to 100% for Component 3, and remained relatively stable for Components 4 through 6. He failed the Sally-Anne false location FB and Seeing-Knowing tasks, but passed the Smarties® false content FB task. Due to a 2-week break, the assessment probes for all components were repeated before training was introduced for the next component. Liam's performance on each component remained relatively stable, except for Component 2, which improved to 100%. He failed all three perspective-taking tasks despite having passed the Smarties® false content FB task during the previous assessment.

Given his performance for Component 3, training was not provided and it was initiated for Component 4 instead. Liam mastered Component 4 after seven training sessions. A probe of all components following mastery showed that maintenance performance accuracy remained stable for Components 1 through 3. Generalization performance remained at 0% for Component 4 and pre-training performance improved slightly on Component 5, while Component 6 remained at 0%. Liam failed all three perspective-taking tasks. Since generalization performance did not improve for Component 4, the component was re-taught and Liam re-mastered Component 4 after another seven training sessions. However, he still showed no improvement during two generalization assessments for Component 4, and he failed all three perspective-taking tasks. Component 4 was taught a third time and Liam met criterion after 10 training sessions. Following re-mastery of Component 4 for the third time, Liam's generalization assessment accuracy improved to 100%. A probe of all components following re-mastery showed that maintenance performance accuracy remained relatively stable for Components 1 through 3 as did pre-training performance on Components 5 and 6. He did not pass any of the perspective-taking tasks.

Liam mastered Component 5 after five teaching sessions. A probe of all components following mastery showed that maintenance performance for Components 1 through 3 remained stable, for Component 4 decreased to 33%, and pre-training performance remained at 0% for Component 6. Generalization performance improved to 67% for Component 5. He failed all three perspective-taking tasks.

Liam mastered Component 6 after 10 teaching sessions. Following mastery one generalization assessment was conducted and he performed at 33%. His maintenance performance increased for Component 2, remained stable for Components 3 and 4, and declined for Components 1 and 5. He did not pass any of the three perspective-taking assessments.

Since Liam did not pass the perspective-taking tasks and his Component 6 generalization performance only increased to 33% Component 6 was re-taught three times, however, Liam's generalization performance did not improve, his maintenance performance remained relatively stable on Components 1 through 5, and he did not pass any of the three perspective-taking assessments.

Since Liam did not pass the perspective-taking tasks and his Component 6 generalization performance showed no improvement, narrative response training was introduced. Liam mastered Component 6 after 31 training sessions with the narrative response training. During the generalization assessment, Liam's performance did not improve. His maintenance performance for Components 1, 2, and 5 was 100%, for Component 3 was 67%, and for Component 4 was 33%. He did not pass any perspective-taking tasks.

The questions that were introduced during narrative response training were systematically faded out and after eight training sessions Liam re-mastered Component 6. Two generalization sessions were conducted, however, his performance remained at 0%. Maintenance assessment accuracy remained at 100% on Component 1, remained relatively stable for Components 2 and 3, and declined for Components 4 and 5. He did not pass any of the perspective-taking tasks.

Additional generalization programming measures were implemented in which one of the three generalization sets was used for training Component 6 using the narrative response training procedures and no further maintenance data were collected on Components 1 through 5. Liam re-mastered Component 6 a third time in four sessions. His performance did not improve on the subsequent generalization session and he did not pass any of the perspective-taking tasks.

The second set of generalization materials were introduced for training. Liam re-mastered Component 6 a fourth time in two sessions. Generalization performance did not improve. The final set of generalization materials were introduced and the first sound of the narrative response prompt was provided during the initial part of each trial (e.g., when the object was placed into the first container in the doll's view Liam was prompted by the experimenter saying "sss" to prompt him to say "saw <container>" when placing the object in the container in the doll's view, "th", to prompt "thinks <container>" after placing the object in the container in the doll's view, and "mmm" to prompt "moved to <container>" after moving the object to the second location out of the doll's view). Prompts however, were not provided when the belief, reality, or memory questions were asked. Liam correctly answered all three of these questions on all three trials. He passed the Sally-Anne false location FB task, but failed the Smarties® false content FB and the Seeing-Knowing tasks.

The maintenance assessments were repeated 1 week and 1 month following the final mastery of Component 6 with the narrative response training. At the 1-week assessment, Liam responded correctly on 67% of Component 6 trials; he failed all three perspective-taking tasks. At the 1-month assessment, his maintenance performance declined to 0% and he did not pass any of the perspective-taking tasks.

Randy's generalization assessment results across the 6 components are presented in the first six graphs in Figure 3 and his generalization assessment results on the three perspective-taking tasks are shown in the bottom graph. Training using the training materials for each component is indicated in Figure 3 by an arrow and the number beside each arrow denotes the number of training sessions provided until 100% accuracy was reached. During the first session before training, Randy performed at 33% correct for Component 1, 0% for Component 2, 100% for Component 3, and 0% for Components 5 and 6. Component 4 was not taught to Randy given that Stephan and Liam passed Component 6 and generalized to some or all of the perspective-taking tasks despite accuracy on assessment probes for Component 4 declining to 0%.

Randy mastered Component 1 after five training sessions. Following mastery of Component 1, he performed at 100% during the generalization assessment for that component and he failed the Sally-Anne false location FB and Smarties® false content FB tasks, and passed the Seeing-Knowing task. The second pre-training session for Components 2 and 3 increased to 100% and his performance on Components 5 and 6 remained at 0%. Given his performance for Components 2 and 3, training was not provided for these components.

Randy met mastery criterion for Component 5 after 23 sessions. Following mastery of Component 5, he performed at 100% during the generalization assessment for that component. During assessment probes of the other components, his maintenance performance of Components 1, 2, and 3 was 100% and his pre-training performance for Component 6 was at 0%. He failed the Sally-Anne false location FB and Smarties® false content FB tasks and passed the Seeing-Knowing task.

Randy mastered Component 6 after eight sessions. Following mastery a generalization session was conducted and his performance remained at 0%. His maintenance performance on Components 1, 2, and 3 remained stable and on Component 4 declined to 67%. Randy did not pass the Sally-Anne false location FB or Smarties® false content FB tasks but passed the Seeing-Knowing task. Since generalization did not emerge following mastery of Component 6, the component was re-taught to mastery using one set of the generalization materials. Randy re-mastered Component 6 after two sessions. Generalization performance improved to 100% for Component 6 and given the stability of maintenance on Components 1 through 5 no further maintenance assessments were conducted. He failed the Sally-Anne false location FB and Smarties® false content FB tasks and passed the Seeing-Knowing task.

The generalization assessments were conducted again 1 week and 1 month following the final mastery of Component 6. At the 1-week and 1-month assessments, Randy responded correctly on 100% of Component 6 maintenance trials; he failed the Sally-Anne false location FB and Smarties® false content FB tasks, and passed the Seeing-Knowing task.

Ava's generalization assessment results across the six components are presented in the first six graphs in Figure 4 and her generalization assessment results on the three perspective-taking tasks are shown in the bottom graph. Training using the training materials for each component is indicated in Figure 4 by an arrow and the number beside each arrow denotes the number of training sessions provided until 100% accuracy was reached with the exception of Component 6 narrative response training due to Ava being withdrawn from the study by her parents. During the first session before training, Ava performed at 33% correct for Components 1 and 2, 67% for Component 3, and 0% for Components 4 through 6. She failed all three perspective-taking tasks.

Ava mastered Component 1 after seven training sessions. Following mastery of Component 1, her performance was 100% for that component during the generalization assessment. The second pre-training session for Component 2 increased to 100%, and remained relatively stable for Components 3 through 6. Ava failed all three perspective-taking tasks. Given her performance for Component 2, training was not provided for that component.

Ava met mastery criterion for Component 3 after four sessions. Following mastery, her performance during the generalization assessment improved to 100% for that component. During assessment probes of other components, her maintenance performance for Components 1 and 2 declined to 67%, and her pre-training performance for Components 4, 5, and 6 remained stable. She failed all three perspective-taking tasks.

Ava met mastery criterion for Component 4 after six sessions. Following mastery of Component 4, her performance increased to 67% during the generalization assessment for that component. During assessment probes of other components, her maintenance performance of Component 1 decreased to 33%, of Component 2 increased to 100%, and of Component 3 remained stable. Her pre-training performance of Components 5 and 6 remained at 0%. Ava did not pass any of the perspective-taking tasks. Since generalization increased to 67%, and not 100%, it was decided to continue teaching to promote further generalization. Following one teaching session during which Ava responded correctly to 100% of the trials, generalization was re-assessed and Ava performed at 100%. During assessment probes of other components, her maintenance performance of Components 1, 2, and 3 was 100%, and her pre-training performance for Components 5 and 6 remained stable at 0%. Ava failed all three perspective-taking tasks.

Ava met mastery criterion for Component 5 after 18 sessions. Her performance increased to 67% during the generalization assessment for that component. During assessment probes of other components, her maintenance of Components 1, 2, and 3 remained stable at 100%, Component 4 declined to 33%, and her pre-training performance for Component 6 remained at 0%. Ava did not pass any of the perspective-taking assessments. Ava met mastery for Component 6 after 19 sessions and her performance increased to 33% during the generalization assessment for that component. During assessment probes of other components, her maintenance of Components 1 through 5 remained stable. Ava did not pass any of the perspective-taking tasks.

Since Ava did not pass the perspective-taking tasks and her Component 6 performance during the generalization assessment showed only 33% improvement, Component 6 was re-taught and after six sessions, Ava re-mastered Component 6. Her performance on the subsequent generalization assessment returned to 0%. During assessment probes of other components her performance remained stable for Components 1, 2, 3, and 5, and her performance for Component 4 declined to 0%. Ava did not pass any of the perspective-taking tasks.

Since Ava did not pass any of the perspective-taking tasks and her performance on Component 6 following re-mastery declined, narrative response training was introduced. Ava did not master Component 6 with the narrative response training procedures as she was withdrawn from the study by her parents after 21 training sessions prior to mastering Component 6. During the last training session Ava responded correctly on five of the six trials. One final assessment probe of Component 6 was conducted with the consent of Ava and her parents. Her performance increased to 67% during the generalization assessment probe for that component. Ava did not pass any of the perspective-taking assessments, however, correctly responded to the belief question on the Sally-Anne task for the first time. No follow-up sessions were conducted.

Discussion

Of the 17 components that were trained (i.e., Stephan received training on four components, Liam on five, Randy on three, and Ava on five) improvements on the assessment probes following training were observed on 14 of the 17 components. Stephan improved on three of the four taught components, Liam improved on four of the five taught components, Randy improved on two of the three taught components, and

Ava improved on all five of the five taught components. Following the first occurrence of mastery of each trained component skill generalization performance increased by 54% overall. This was calculated by averaging the percentage obtained on all pre-training sessions immediately preceding training for all trained components across all participants and subtracting that from the average of the percentage obtained on the first generalization assessment session immediately following mastery for all trained components across all participants. Stephan improved by 59%, Liam improved by 40%, Randy improved by 56%, and Ava improved by 60%. With additional training to further promote generalization, performance increased by 72% overall from pre-training to generalization. Stephan improved by 59%, Liam improved by 74%, Randy improved by 89%, and Ava improved by 67%. Prior research has demonstrated improvements in performance on FB tasks following training on perspective-taking skills (i.e., Charlop-Christy & Daneshvar, 2003; LeBlanc et al., 2003; McGregor et al., 1998a; 1998b; Swettenham, 1996; Wellman et al., 2002). These six studies combined demonstrated some generalization to untrained variations of the trained tasks with 21 of the 50 participants.

The production of generalization to perspective-taking tasks observed in this study is consistent with the body of literature documenting generalization to untrained perspective-taking tasks that differ from the training task (i.e., distant transfer tasks) in children with autism. Pass performances on perspective-taking tasks following training were observed for three participants in this study. Specifically, Stephan passed all three perspective-taking tasks and Liam passed the Sally-Anne false location FB task following mastery of Component 6 under the narrative response training conditions. Randy passed the Seeing-Knowing task following mastery of Component 1, Liam passed the Smarties® false content FB task following mastery of Component 2, and Stephan passed the Seeing-Knowing task following mastery of Component 4. Three of the six studies (Charlop-Christy & Daneshvar, 2003; Leblanc et al., 2003; &McGregor et al., 1998a) produced generalization to the Smarties® false content FB task with a total of 13 of the 50 participants. Wellman et al. (2002) also demonstrated modest generalization to the Seeing-Knowing task with two participants passing the task during pre-testing and five participants passing after training. Stephan's generalization to other perspective-taking tasks that differed from the training tasks (i.e., distant transfer tasks) contributes to this limited body of research (e.g., Charlop-Christy & Daneshvar; LeBlanc et al.; Wellman et al. 2002).

The number of teaching sessions required to achieve mastery on the component skills varied greatly across participants, ranging from four to 80 sessions. Stephan required a total of 139 teaching sessions, Liam received 138 teaching sessions, Randy received 38 teaching sessions, and Ava received 81 teaching sessions. Moreover, the number of teaching sessions required to achieve mastery across components were inconsistent across participants. While Stephan and Ava appeared to require more sessions to achieve mastery as the complexity of the component skills increased, Liam's results showed the reverse, requiring more training sessions for Components 1 and 2 than for later components. In light of the variability in sessions required to achieve mastery, consideration should be given to alternative intervention approaches to decrease the number of teaching trials and sessions required to produce mastery. Given the prior success of video modelling to teach perspective-taking to children with ASDs (i.e., Charlop-Christy & Daneshvar, 2003; Leblanc et al., 2003) one possibility is to explore the addition of video modelling to teaching the component skills identified in the present study. Video equipment is generally economically feasible and portable, and can be operated with little instruction. For these reasons, video technology is the technology of choice for many clinicians and researchers (Goldsmith & LeBlanc, 2004). Charlop-Christy, Le, and Freeman (2000) conducted a comparison of video modelling and in vivo modelling for teaching children with autism. Their findings indicated that not only did video modelling produce faster acquisition of a variety of behaviours (i.e., expressive labelling, independent play, conversational speech, cooperative play, and social play) than in vivo modelling, it was also shown to be effective in promoting generalization. Geiger, LeBlanc, Dillon, and Bates (2010) however, also compared video and in vivo modelling for teaching children with autism and reported that their findings differed from those of Charlop-Christy et al., (2000). In Geiger et al. (2010) there was no consistent difference reported in the effectiveness of video over in vivo treatment. Two participants required the same number of trials to reach criterion in the two conditions, while the third participant performed slightly better in the in vivo modelling condition. The authors acknowledge that the discrepancy between their findings and those of Charlop-Christy et al. may be the result of participant or procedural differences and recommend that future research investigate the conditions under which in vivo and video modelling procedures are differentially effective.

Stephan’s results were most promising in that he generalized to all three perspective-taking tasks. What might account for Stephan’s performance relative to the other three participants? Stephan’s chronological age was similar to Randy's and Ava's and his verbal mental age was comparable to Liam's and Randy's (see Table 1). However, he scored much lower on the autism composite on the PDDBI than the other children, indicating that he had fewer overall challenges compared to the other participants related to the autism composite on the PDDBI. Future research is needed to explore the relation between the severity of autism symptoms and acquisition of perspective-taking skills.

Generalization to the perspective-taking tasks following mastery of Component 6 varied across participants. Following picture prompt training on Component 6 none of the participants generalized to the FB or Seeing-Knowing tasks, however, following mastery of Component 6 with the narrative response training procedures, two participants generalized to the FB and/or Seeing-Knowing tasks. Some instances of passing the perspective-taking tasks prior to mastering all six training components was observed, however, only Randy maintained his pass performance on the Seeing-Knowing task during subsequent administrations while Liam and Stephan did not maintain their pass performance on the Seeing-Knowing and Smarties® false content FB tasks respectively. Performance across participants varied during the 1-week and 1-month follow-up assessments.

Why did generalization not occur across all participants on all of the perspective-taking tasks? It is possible that a component in the task analysis may have been omitted. That is, Component 6, although designed to be similar but not identical to the Sally-Anne false location FB task, differed in a number of ways that extended beyond the task materials used for training. First, unlike the Sally-Anne false location FB task which is conducted with two dolls, Component 6 only had one doll. Second, rather than having the doll leave the room during the change of location event as is done in the Sally-Anne false location FB task, the doll remained in the room while the object location was changed behind a partition. Finally, although the narrative responses were successfully taught in the context of Component 6, it is possible that the narrative responses trained did not generalize to the context of the FB tasks (i.e., the narrative responses did not serve as effective prompts during the FB generalization assessments). That all three participants who received training on Component 4 were unable to maintain the skill, yet all were able to later master Component 6, with two participants passing one or more FB tasks, suggests that Component 4 may not be a necessary component within the task analysis. As such, future research might eliminate this component from training and consider adding training components involving two dolls and having one doll leave the setting. Lastly, it is possible that the absence of reinforcement during generalization assessments may have influenced responding. Specifically, the loss of Component 4 with Stephan, Liam, and Ava during the ongoing maintenance assessments of that skill would support this hypothesis as would the generalization and maintenance performance on Component 6 for Stephan and Ava, who showed an initial increase in their performance on the first generalization assessment following mastery of Component 6, and then went on to score 0% on the next generalization assessment.

During training, varying the names and features of dolls, size and colours of containers; the objects used on each trial; the order of the belief, reality, and memory questions; and the content of those questions across each training trial was not sufficient to produce generalization to untrained variations of the training task materials for Liam and Randy. Generalization occurred only after additional exemplars (Stokes & Baer,

1977) were taught for these two participants (i.e., tasks that were initially reserved for generalization probes).

A limitation of the present study is that measures of generalization to a natural setting were not conducted. Randy's mother reported, however, that following mastery of Component 1 (i.e., line of sight) Randy was observed to perform this skill at home and in his day care setting. Specifically, he reportedly asked his mother if she could see the IPod touch® he was holding, and then proceeded to approach her and use his finger to draw a line in the air between her eyes and the IPod touch® after which he said "Yes, you can." He also reportedly asked a peer in his day care class whether his peer could see the object that he was looking at, after which he proceeded to approach him and use his finger to draw a line in the air between his eyes and the object, and again indicated that yes the peer could see the object. Future research should incorporate generalization measures in the natural environment using the strategies outlined above. Strategies for promoting generalization to natural settings should also be systematically investigated in future research (Gould et al., 2011).

By adopting a behaviour analytic approach to analyzing and teaching perspective-taking to children with ASDs this study provides an alternative to the current body of research which focuses primarily on cognitive-based interpretations which offer little in the way of practical applications to teach perspective-taking skills to children within this population. To date, the most effective procedures for training and promoting generalization are based on behaviour analytic procedures (i.e., Charlop-Christy & Daneshvar, 2003; LeBlanc et al., 2003; McGregor et al., 1998a; 1998b; Swettenham, 1996; Wellman et al., 2002). The present study extends the limited research on teaching perspective-taking to children with ASDs.

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Appendix A

Training Materials

For Liam and Stephan
Dolls

Dolly: Orange hair, red dress, 10 cm tall
Arial: Blue hair, blue mermaid dress, 10 cm tall
Rosie: Blonde hair, white and pink dress, 25 cm tall
Ken: Brown hair, Purple sweater and grey pants, 25 cm tall
Diego: Brown hair, navy blue pants, teal blue shirt and beige vest, 15 cm tall
Jingles: Elf hat, green top and pants, red and white striped socks, 15 cm tall
Skipper: Blond hair, teal blue pants and a bright pink sweater, 20 cm tall

Objects

A camouflage green and beige coloured truck (7 cm x 5 cm)
A blue toy cell phone (8 cm x 12 cm)
A yellow rubber duck (10 cm x 10 cm)
A neon yellow eraser in the shape of a sandal (5 cm x 3 cm)
A blue plastic toy camera (10 cm x 5 cm)
A pair of pink baby sunglasses (10 cm x 5 cm)
A red Duplo® block (5 cm x 5 cm)

Containers

Red box (15 cm x 20 cm x 10 cm)
Spiderman® lunch box (20 cm x 15 cm x 10 cm)
Wooden box (15 cm x 20 cm x 10 cm)
Brown adult size toque
Beige adult size baseball cap
Blue Christmas stocking (50 cm long)
Red cookie tin with teddy bear picture on lid (25 cm in diameter x 10 cm deep)

For Ava and Randy
Dolls

Blueberry: Blue hair, blue dress, 20 cm tall
Paula: Purple hair, purple dress, 20 cm tall
Susie: Green hair, green dress, 20 cm tall
Bobbie: Pink hair, pink mermaid dress, 30 cm tall
Barbie: Blonde hair, blue pants and yellow shirt, 30 cm tall
Jane: White hat, white top and purple pants, 15 cm tall
Sarah: Blonde hair, blue dress, 20 cm tall

Objects

A gold coloured car (7 cm x 5 cm)
A red toy cell phone (8 cm x 12 cm)
A yellow rubber duck (10 cm x 10 cm)
Black Duplo® block (5 cm x 5 cm)
A blue plastic toy camera (10 cm x 5 cm)
A pair of pink baby sunglasses (10 cm x 5 cm)
A toy green mirror (10 cm x 5 cm)

Containers

Red box (15 cm x 20 cm x 10 cm)
Blue cardboard box with a coloured butterflies pattern (15 cm x 20 cm x 10 cm) with sliver latch
Wooden box (15 cm x 20 cm x 10 cm)
Brown adult size toque
Beige adult size baseball cap
Blue Christmas stocking
Blue cookie tin with gingerbread doll picture on lid (25 cm in diameter x 10 cm deep)

Generalization Materials

Dolls

Pete: Blonde short hair, red button down shirt, yellow knee length shorts, 30 cm tall
Lisa: Brown hair with two pigtails, purple dress, 10 cm tall
Jenna: Bald baby with white toque, white shirt, pink pants, 40 cm tall

Objects

A black train with red wheels (10 cm x 5 cm x 5 cm)
A red bug with white spots (10 cm x 5 cm)
A pink hair brush with picture of Snow White®, Cinderella® and Belle® (10 cm x 5 cm)
A white die with black dots
A green frog (10 cm x 5 cm)
A small tube of Colgate® toothpaste (10 cm x 5 cm)
A miniature Pepsi® bottle containing lip balm (8 cm x 5 cm)
A red, white, and blue baby size sock (15 cm x 8 cm)
A Dora® keychain in shape of yellow book (10 cm x 5 cm x 1 cm)

Containers

Purple plastic bag with Dora®, Boots®, and Backpack® on it (15 cm x 20 cm x 10 cm)
Black and white striped purse (30 cm x 20 cm x 10 cm)
Brown cardboard box with green, orange, and yellow dots (15 cm x 15 cm x 10 cm)

Appendix B

Script for Sally-Anne False Location False Belief Test

The experimenter places a box, a basket, and the two dolls in front of the child. The experimenter tells the following story, moving the dolls accordingly:

The experimenter points to each of the dolls says "This is Sally and Anne."
Naming question: Experimenter asks "Who are these?" (Correct Answer: Sally and Anne)

Experimenter says "Sally and Anne are good friends. One day they found a ball and decided to keep it in the basket." While delivering the script, the experimenter guides Sally through motions to place the ball in the basket in view of the child.
Prompt question 1: Experimenter asks "Where did Sally and Anne keep the ball?" (Correct Answer: Basket)

While guiding Anne through the motions the experimenter says "Excuse me. I need to go to the washroom." A second experimenter takes Anne out of the room. The experimenter guides Sally to take the ball from the basket and move it to the box.

Prompt question 2: Experimenter asks "Is Anne here?" (Correct Answer: No)

Prompt question 3: Experimenter asks "Did Anne see Sally hide the ball in the box?" (Correct Answer: No)

Prompt question 4: Experimenter asks "Does Anne know what Sally did?" (Correct Answer: No)

Second experimenter brings Anne back and while guiding Sally through the motions says, "I am going to get the ball."

Belief question: Experimenter says "Where does Sally think the ball is?" (Correct Answer: Basket)

Reality question: Experimenter says "Where is the ball really?" (Correct Answer: Box.)

Memory question: Experimenter says "Where did Sally and Anne put the ball before Anne left?" (Correct Answer: Basket)

Script for Smarties® False Content False Belief Test

After introducing an assistant (Jon) to the child, Jon leaves the room. The experimenter holds up a box of Smarties® and says the following: "Look, I have a box of something here."

Prompt question 1: Experimenter asks "What do you think is inside this box?" (Correct answer: Smarties®, candy, chocolate, or sweets.)

Experimenter opens the box to show the child what is inside. Experimenter says "Let's take a look. Oh! It's a pencil!"
Reality question: Experimenter asks "What is really inside this box?" (Correct answer: Pencil)

Prompt question 2: Experimenter asks "Is Jon here with us?" (Correct answer: No)

Prompt question 3: Experimenter asks "Does Jon know that there is a pencil inside this box?" (Correct answer: No)

Belief question: Experimenter asks "What does Jon think is inside the box?" (Correct answer: Smarties®, candy, chocolate, or sweets)

Memory question: Experimenter asks "Do you remember when I took the box out of my bag and asked you what was in it, what did you say?" (Correct answer: What the child said in Prompt Question 1)

Script for Seeing-Knowing Test

The experimenter places a box, and two dolls in front of, and facing, the child. The experimenter tells the following story, moving the dolls accordingly:

While pointing to the corresponding item or doll, the experimenter says "Look! I've got some boxes here. There is something inside each box. I am going to show the boxes to John and Fiona."

The experimenter makes one of the dolls pick up the closed box and says "John lifts the box up." The other doll is made to open the lid of the box and 'look' inside accompanied by the statement "Fiona opens the box and has a look".

The participant is then asked *"Who knows what is in the box? John or Fiona?"*

On each of the five trials the doll that looked, the order of looking versus lifting and the order in which the two dolls were mentioned in the question, were randomized. In these trials, measures were taken to ensure the subject could not see into the box when one of the dolls opened it. This meant that the subject remained ignorant of the contents of the box, and therefore had to answer the knowledge question purely on the basis of what could be ascribed to another character.

Note: Sally-Anne false location FB task script was adapted from Baron-Cohen, Leslie, and Frith (1986); the Smarties® false content FB task was adapted from Perner et al. (1989) and the Seeing-Knowing task script was adapted from Baron-Cohen and Goodhart (1994).

Appendix C

Script and training sequence for narrative response training of Component 6

Experimenter asks: *“Can <doll name> see the <container 1 name> and the <container 2 name>?*” (Correct answer: Yes)
Experimenter places object in the container indicated on the data sheet.

Experimenter asks the child *“Where did <doll’s name> see me put the <object name>?”*
Experimenter prompts Stephan, Ava, and Randy to say *“Saw <name of container>”*, prompt Liam to say *“He/She saw you put it in the <name of container>.”*

Experimenter asks child *“Where does <doll’s name> think the <object name> is?”*
Experimenter prompts Stephan, Ava, and Randy to say *“Thinks <name of container that object was placed in while doll was looking>”*, and prompts Liam to say *“He/She thinks it’s in the <name of container that object was placed in while doll was looking>.”*

Experimenter raises partition.

Experimenter asks child *“Can <doll’s name> see the <container 1 name> and the <container 2 name>”?* (Correct answer: No)
Experimenter asks child *“Did <doll’s name> see me put the <object name> in the <name of container that object was placed in while partition was lowered>?* (Correct answer: Yes)

Experimenter moves the object to the other container (i.e., the one that it was not placed in initially).
Experimenter prompts Stephan, Ava, and Randy to say *“moved to <name of container that objected was moved to while partition was raised*> and prompt Liam to say *“You moved it to the <name of container that object was moved to while partition was raised>.”*

The following three questions were asked in a randomized order across trials within each training session.

Belief Question: *“Where does <doll’s name> think the <object name> is?”*
(Correct answer Stephan, Ava, and Randy: Thinks <*name of container object was initially placed in while partition was lowered*> or saying the name of the container).
(Correct answer Liam: He thinks it’s in the <*name of container object was initially placed in while partition was lowered*> or saying name of correct container.)

Memory Question: “*Where did <doll’s name> see me put the <object name>?*
(Correct answer Stephan, Ava, and Randy: Saw <*name of container object was initially placed in*> or saying the name of the container.)
(Correct answer Liam: He saw you put it in the <*name of container object was initially placed in*> or saying name of correct container.)

Reality Question: *“Where is the <name of object>?”*

(Correct answer Stephan, Ava, and Randy: Moved to <*name of container that object was moved to while partition was raised*> or saying name of correct container).
(Correct answer Liam: You moved it to the <*name of container that object was moved to while partition was raised*> or saying name of correct container).

Appendix D

Baseline and Generalization Procedural Integrity Checklist

1. Task materials set up correctly prior to trial.
2. Correct instructions/question delivered.
3. Child thanked following response on trial, regardless of correctness of response.
4. Child asked to perform behaviour unrelated to the experimental materials.
5. Child given tangible and praise for performing behaviour before beginning next trial.

Training Procedural Integrity Checklist

1. Task materials set up correctly prior to trial.
2. Correct instructions/question delivered.
3. Correct prompt implemented (full prompt, partial prompt, picture prompt, or verbal prompt).
4. Praise and/or edible or tangible reward delivered, determined via pre-session preference assessment or child request, following correct target response.
5. Error correction procedure correctly implemented following incorrect response.

Table 1. *Participants' Characteristics.*

Participant	Chronological Age (Yrs-Months)	Diagnosis	PDDBI Autism Composite (T-score)	Verbal Mental Age or Age Equivalent (Months)
Stephan	5-07	PDDNOS	25	53
Liam	9-06	Autism	56	55
Randy	5-01	PDDNOS	44	55
Ava	5-10	ASD	67	46

Table 2. *Task Analysis of Perspective-Taking.*

Component	Nonverbal Cues	Verbal Cues	Correct Responses
1	A doll's eyes faced one of three objects (target object is randomized across trials) placed 25 cm in front of the doll.	"What is <dolls name> looking at?" or "Tell me what <doll's name> can see". The form of the question varied across trials.	Child named the object the doll was facing.
2	Same as 1 above except that a partition blocked the doll's view on some of the trials during the second question. Blocked and unblocked trials were randomized across trials over sessions to average 50%.	1. "What is <doll's name> looking at?" or a variation of this question as indicated in Component 1. 2. "Can <doll's name> see the <object's name>?" or "Is <doll's name> looking at the <object's name>?" or "Is <doll's name> able to see the <object's name>?"	1. Same as Component 1. 2. "Yes" when there was no partition or "No" when there was a partition.
3	Same as 1, but with only one object on table (instead of 3).	1. "What is <doll's name> looking at?" or a variation of this question as indicated	1. Same as Component 1.

Component	Nonverbal Cues	Verbal Cues	Correct Responses
		in Component 1. 2. “Can <doll’s name> see the <object’s name>?” or a variation of this question as indicated in Component 2. 3. “What does <doll’s name> think is on the table?” or “Tell me what <doll’s name> thinks is on the table”.	2. Same as Component 2. 3. Named object on table.
4	Same as 3, except that a partition was placed between the doll and the object *after* the doll saw the object. On half of the trials, the object was replaced with a second object behind the partition, out of the doll’s view (but within the child’s view). Trials on which the object changed were randomized	1. “What is <doll’s name> looking at?” or a variation of this question as indicated in Component 1. 2. “Can <doll’s name> see the <object’s name>?” or a variation of this question as indicated in Component 2. 3. “What does <doll’s name> think is on the table?”, or a variation of this	1. Same as Component 1. 2. Same as Component 2. 3. Named the object that was on table when

Component	Nonverbal Cues	Verbal Cues	Correct Responses
	across trials over sessions to average 50%.	question as indicated in Component 3.	partition was down (i.e., last object seen by doll).
5	Doll facing two opaque containers with lids. The partition remained lowered while the experimenter was placing the object in one of the containers on 50% of the trials and was raised, blocking the view of the doll, while the experimenter placed the object in one of the containers on the other 50% of the trials. The container in which the object was placed was selected randomly across trials.	1. “Can <doll’s name> see the <container’s name> and the <container’s name>?”; “Is <doll’s name> able to see the <container’s name> and the <container’s name>?” 2. “Did <doll’s name> see where I put the <object’s name>?”, “Was <doll’s name> able to see where the <object’s name> was put?” or “Could <doll’s name> see where the <object’s name> was hidden?” 3. “Where is the <object’s name>?”, “Tell me where	1. “Yes” 2. “Yes” if partition was down, “No” if partition was up while experimenter placed object in container. 3. Named the container

Component	Nonverbal Cues	Verbal Cues	Correct Responses
		the <object's name> is".	where the object was placed.
6	Doll facing two opaque containers with lids and the experimenter put an object in one of the containers while the partition was down. The container in which the object was placed was selected randomly across trials. A partition was raised *after* the object had been placed in the container. The location of the object was switched behind the partition, out of the doll's view, but in the child's view.	1. "Can <doll's name> see the <container's name> and the <container's name>?" or a variation of this question as indicated in Component 5. 2. "Did <doll's name> see where I put the <object's name>?" or a variation of this question as indicated in Component 5. 3. "Where does <doll's name> think the <object's name> is?", "Tell me where <doll's name> thinks the <object's name> is" or "Name the place where <doll's name> thinks the	1. Same as Component 5. 2. Yes. 3. Named the location where the object was placed.

Component	Nonverbal Cues	Verbal Cues	Correct Responses
		<object’s name> is.”	
		4. “Where did <doll’s name> see me put the <object’s name>?”, “Tell me where <doll’s name> saw me put the <object’s name>”.	4. Named the location where the object was placed while partition was down.
		5. “Where is the <object’s name>?”, “Tell me where the <object’s name> is.” (Note: The order of questions 3, 4, and 5 was randomized across trials).	5. Named or pointed to container that object was moved to.

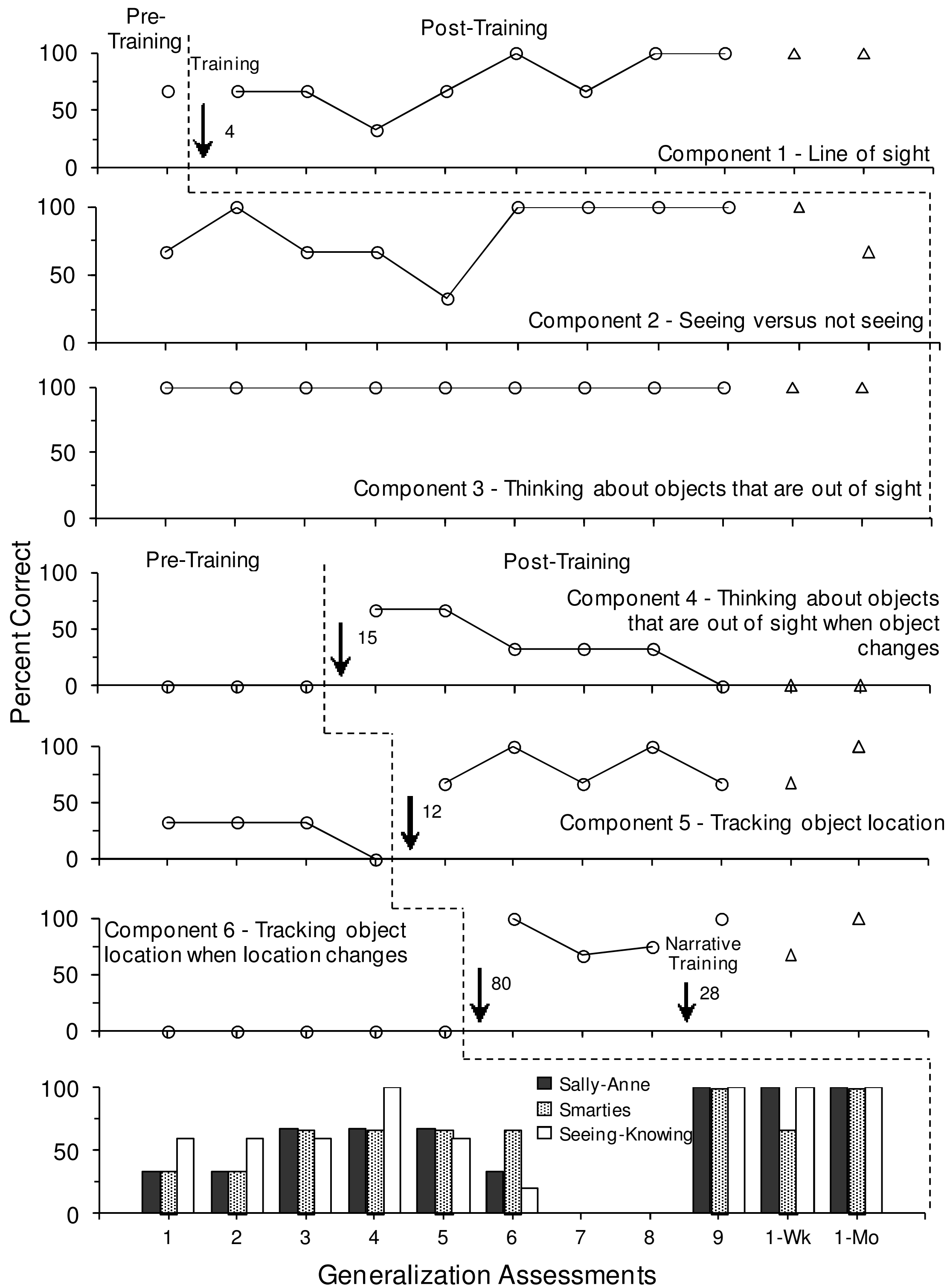

Figure 1. Stephan's generalization assessment results for each task component and the false-belief and Seeing-Knowing tasks (bottom graph). Each solid vertical arrow indicates training using the training materials for that component and the number next to each arrow indicates the number of training sessions delivered to reach mastery. The last two assessments are the 1-week and 1-month follow-ups.

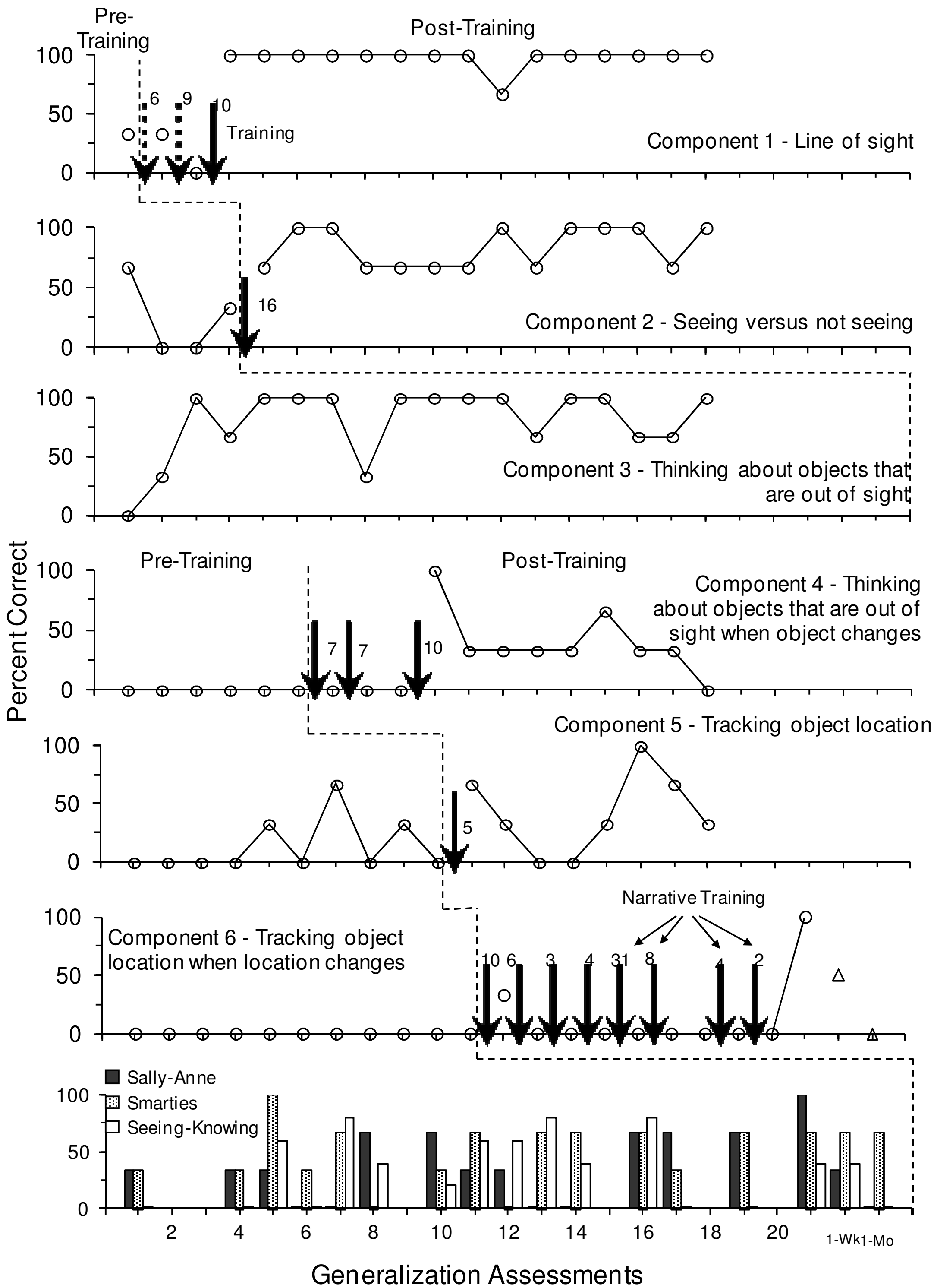

Figure 2. Liam's generalization assessment results for each task component and the false-belief and Seeing-Knowing tasks (bottom graph). Each solid vertical arrow indicates training using the training materials for that component and the number next to each arrow indicates the number of training sessions delivered to reach mastery. Vertical broken arrows indicate mastery criterion not met. The last two assessments are the 1-week and 1-month follow-ups.

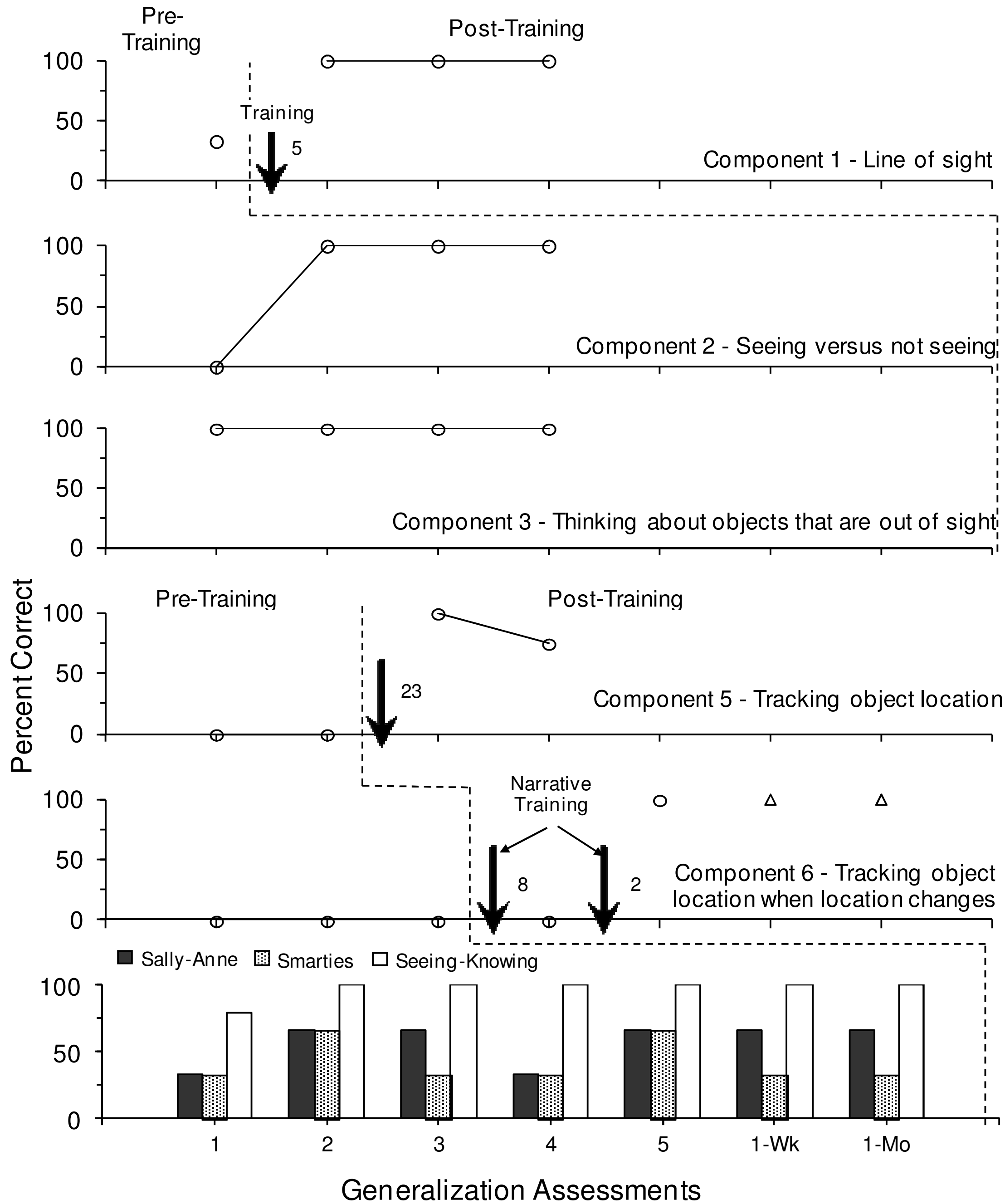

Figure 3. Randy's generalization assessment results for each task component (component 4 was not included for Randy) and the false-belief and Seeing-Knowing tasks (bottom graph). Each solid vertical arrow indicates training using the training materials for that component and the number next to each arrow indicates the number of training sessions delivered to reach mastery. The last two assessments are the 1-week and 1-month follow-ups.

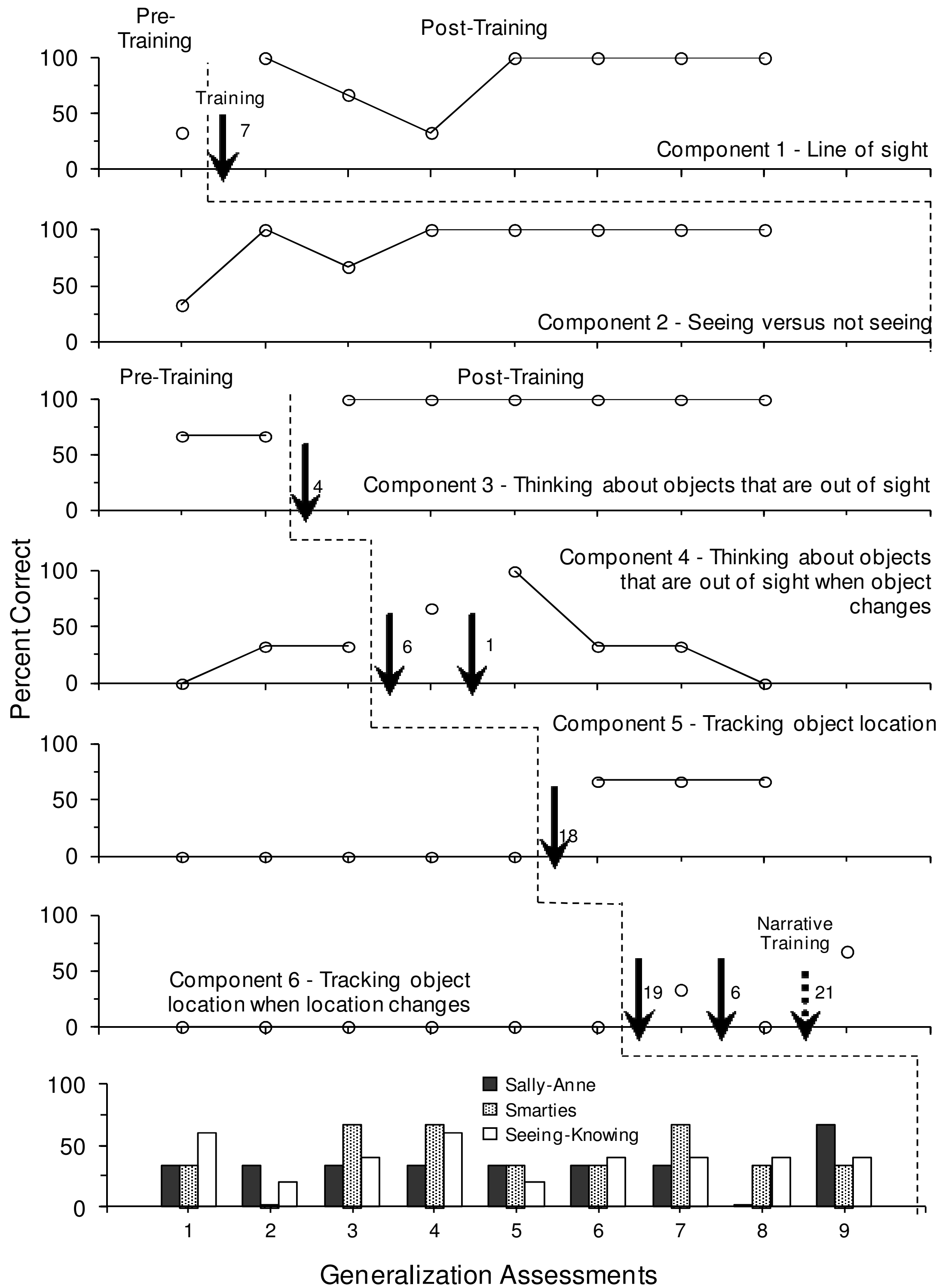

Figure 4. Ava's generalization assessment results for each task component and the false-belief and Seeing-Knowing tasks (bottom graph). Each solid vertical arrow indicates training using the training materials for that component and the number next to each arrow indicates the number of training sessions delivered to reach mastery. Veritcal broken arrow indicates mastery criterion not met. No follow-ups were conducted for Ava.