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RESEARCH ARTICLE

A Systematic Replication of Teaching Children With Autism and Other Developmental Disabilities Correct Responding to False-Belief Tasks

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Abstract

Behavioral research has demonstrated that children with autism spectrum disorder can be taught to recognize the false beliefs of others using video modeling (e.g., Charlop-Christy & Daneshvar *Journal of Positive Behavior Interventions, 5*(1), 12–21, 2003; LeBlanc et al. *Journal of Applied Behavior Analysis, 36*(2), 253–257, 2003). The current study extended such research by teaching three children diagnosed with autism spectrum disorder and other developmental disabilities to respond appropriately to false-belief tasks using behavioral intervention strategies conducted in the natural environment with people in their enviornment. We used a nonconcurrent multiple-baseline across-participants design to evaluate the use of multiple-exemplar training, prompting, and reinforcement for training correct responses with two false-belief tasks: the hide-and-seek task and the M&Ms task. We also conducted a pre/posttest of an untrained false-belief task, the Sally-Anne task. All participants learned to pass the hide-and-seek task and the M&Ms task and improved on their performance on the Sally-Anne task during the posttest.

Keywords Autism · False belief · Perspective taking · Social language · Theory of mind

Perspective taking involves the ability to "put oneself in another's shoes." From a behavior-analytic standpoint, perspective taking likely comprises a complex repertoire of verbal and social behavior, consisting largely of responding verbally and otherwise to oneself, others, and the relation between oneself and others (Hayes et al., 2001). In addition, perspective taking involves identifying potential private events that others are experiencing, cued by overt stimuli and behaviors (LeBlanc et al., 2003). Although perspective taking is not easily understood behavior analytically and, perhaps not surprisingly, rarely addressed in the behavioral literature, it is nonetheless a critically important social repertoire. If one is not entirely convinced of this, one can simply imagine trying to be successful in a social, family, or work relationship, wherein one cannot identify or respond to others' emotions, intentions, thoughts, beliefs, or knowledge. Or, to switch perspectives, imagine choosing a friend or romantic partner who could not or would not respond to how you felt or what you thought. Put simply, identifying and responding to others' private events are foundational to successful social functioning for individuals who have complex verbal repertoires.

In cognitive and developmental branches of psychology, the false-belief task has been used as an assessment to identify whether children with autism spectrum disorder (ASD) are able to engage in perspective taking (Baron-Cohen et al., 1985). The classic test of false belief is the Sally-Anne task, wherein a girl named Sally places a marble in a basket and then leaves the room. While she is gone, Anne moves the marble to a box. When Sally returns to the room, participants are asked where Sally will look for her marble (Baron-Cohen et al., 1985). Children with ASD have been found to perform poorly on the Sally-Anne task, with 80% stating Sally would look in the box instead of the basket (Baron-Cohen et al., 1985).

Several studies from cognitive and developmental branches of psychology have attempted to teach children with ASD to pass false-belief tasks using procedures such as a computer-based presentation of the Sally-Anne task (Swettenham, 1996) and a picture-in-the-head strategy (i.e., training participants that thoughts are like pictures in one's head) using mannequins' heads (Swettenham et al., 1996), dolls (McGregor et al., 1998a, 1998b), and cardboard Sally-

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Anne figures (Wellman et al., 2002). Although these initial studies are encouraging and many of them predate any behavior-analytic attempt to teach these skills, they suffer from limitations. First, the results have been somewhat inconsistent, leading to some authors calling into question whether these skills can be genuinely taught or whether children are merely taught strategies to "hack out" solutions that are socially acceptable (Ozonoff & Miller, 1995). Second, the studies have generally used group designs and fixed protocol durations, rather than implementing and adjusting teaching protocols based on the effectiveness of the protocol for individual learners. Therefore, it is unknown how effective the procedures were for any individual learners or whether modification or extension of the procedures at the level of the individual participants could have made the procedures more consistently effective. Finally, because the intervention procedures were based on evolutionary-developmental theories of theory of mind, rather than on scientific principles of learning, it is not possible to troubleshoot or adjust them in any systematic way in order to make them more effective. A behavior-analytic approach to teaching perspective-taking skills may have the advantage of being conceptually systematic with basic principles of learning and motivation and therefore may be more likely to be effective and systematically modifiable when they are ineffective.

A small amount of research has demonstrated that children with ASD can be taught to identify the false beliefs of others using behavioral procedures (e.g., Charlop-Christy & Daneshvar, 2003; LeBlanc et al., 2003). Charlop-Christy and Daneshvar (2003) used a multiple-baseline across-participants and within-participants across-tasks design to evaluate the use of video modeling to teach participants to pass false-belief tasks. In this study, various false-belief tasks were trained using video modeling. An example of one of the tasks was a hide-and-seek task (similar to the Sally-Anne task) called the "pizza false-belief task." This task involves two people and one pizza box in a room. One person decides to leave the pizza for later and keeps the pizza boxin a cupboard, after which they leave the room. Then, the person still in the room moves the pizza box from the cupboard to the trash. When the person who initially left the pizza in the cupboard comes back into the room, the participant is asked where the person will look for the pizza box. The researchers used different stimuli in the pizza task and other untrained tasks in the study to measure generalization to untrained stimuli. Two of the three participants learned to pass all targeted tasks; however, the third participant was not able to pass two of five targeted tasks. Generalization to stimulus variations both within task and across tasks was observed for the two participants who successfully learned all the targeted tasks. Furthermore, the same two participants passed an untrained Sally-Anne posttest.

LeBlanc et al. (2003) used a multiple-baseline across-tasks design to evaluate the use of video modeling and reinforcement for training false-belief recognition to children with ASD. The video-modeling intervention included a hide-and-seek task (similar to the Sally-Anne task) and what is sometimes referred to as a "deceptive container task" (which they called the M&Ms task). They also included the Sally-Anne task as an untrained pretest and posttest. In addition, reinforcement in the form of preferred edibles or stickers was provided to participants after they answered questions correctly during training. To program for generalization across stimuli, the researchers included stimulus variations of both tasks. There were three variations of the hide-and-seek task and five for the M&Ms task. In the videos, an adult completed the task, giving the correct answer for the perspective-taking question. After seeing the adult in the video model a correct response, the researcher paused the video, asked the participant the same question, and reinforced a correct response. If the participant answered incorrectly, the experimenter replayed the video so that the participant could watch the modeled response again. Each task required three to eight views before the participant mastered the task. Results demonstrated all participants learned the targeted tasks and demonstrated generalization to stimulus variations of the tasks. Two of the three participants also passed an untrained Sally-Anne posttest.

Generalization to live people in the natural environment was not evaluated in the studies conducted by Charlop-Christy and Daneshvar (2003) and LeBlanc et al. (2003). The current study provides an extension of these two studies using a treatment package consisting of multiple-exemplar training, prompting, and reinforcement to teach children with ASD and other developmental disabilities (DDs) to respond appropriately to false-belief tasks directly in the natural environment with live people. Specifically, we wanted to identify whether this strategy would lead to generalization of the skill to untrained exemplars in the natural environment with people in their environment. Multiple-exemplar training involves presenting a variety of stimuli during instruction to promote generalization to untrained stimuli (Cooper et al., 2007) and has been found to be a successful procedure for obtaining generalization to untrained stimuli in other studies that have taught skills related to perspective taking (Najdowski et al., 2017; Najdowski et al., 2018; Persicke et al., 2013; Welsh et al., 2018).

Method

Participants and Settings

The participants in this study were three boys receiving intervention based on applied behavior analysis. Jayme, a 4-year-old boy diagnosed with ASD, was receiving 30–40 hr of behavioral intervention per week, and his sessions took place in a center-based program, at his preschool, and at his home. Bruce, an 8-year-old boy diagnosed with global developmental delay, and Tony, a 9-year-old boy diagnosed with ASD, were receiving 10–15 hr of behavioral intervention per week, and their sessions took place in various rooms of their homes, including the living room, kitchen, dining room, and their bedrooms. Each participant was performing within Level 3 of the Verbal Behavior Milestones Assessment and Placement Program (Sundberg, 2008) at the time of the study. All participants had listener repertoires and broad vocal–verbal repertoires, in that they were able to communicate in full sentences using nouns, verbs, adjectives, prepositions, pronouns, and negation. Each participant was able to identify their senses and identify what others could sense (e.g., "What can she see/hear/taste/smell/feel?"). They could also answer *wh–* questions, such as "where," and could recall events. They were not able to identify the false beliefs of others, which was determined by conducting a probe of both of the tasks in the study prior to conducting the pretest. One to two 30-min sessions were conducted 1–3 days per week.

Materials

The experimenters used three different false-belief tasks in this study, and several people were involved in conducting trials. Apart from the participant and experimenter, actors were also present. The actors were known to the participants: They included family members, behavior interventionists, and program supervisors. During a novel-person probe, however, the actors were people with whom the participant was unfamiliar, such as graduate students, interns, and different program supervisors and behavior interventionists whom the participant did not meet prior to those sessions.

Sally-Anne Task

The Sally-Anne task was probed at the following times throughout the study: (a) as a pretest, (b) after mastery of each trained task, and (c) after posttraining. A digital version of this task was administered as a cartoon on a computer. The scenario and questions asked were identical to the cartoon used by Baron-Cohen et al. (1985) with the exception that Sally had a basketball instead of a marble.

Hide-and-Seek Task

The hide-and-seek task (Chandler et al., 1989) involved four people in a room: the participant, one experimenter taking data, and two actors. While playing with a toy, Actor 1 put the toy in a location in the room (e.g., on the kitchen counter, in a box, on a coffee table, in a case) and left the room. Then, Actor 2 moved the toy from the location where it was placed to a different location (e.g., on the couch, on the floor, on the mantle). The participant was asked, "Where will [Actor 1] look for the [object] when s/he comes back?"

M&Ms Task

The M&Ms task (Perner et al., 1989) involved three people: the participant, the experimenter, and an actor. In this task, the experimenter showed the participant a labeled container (e.g., cereal box, candy box) and asked, "What do you think is in this box?" After the participant responded, the experimenter opened the box to reveal its contents (e.g., a labeled candy box filled with erasers) and asked, "What was really in the box?" After the participant responded, the experimenter closed the box and asked, "What will [Actor 1] think is in here?" Then, the experimenter instructed the participant to ask Actor 1 "What do you think is in here?" and after Actor 1 responded, the participant revealed the contents of the box.

Response Measurement and Interobserver Agreement

Participants' responses to questions associated with each task were recorded as correct or incorrect. The percentage of correct responses for each task was calculated by dividing the total number of correct responses by the total number of trials conducted.

Sally-Anne Task

After participants were shown the Sally-Anne cartoon, they were asked three questions. All three questions were from the Baron-Cohen et al. (1985) study. One of the questions, the "belief" question, served as the test question and dependent variable for the task. The other two questions were control questions used by Baron-Cohen et al. to test whether the participants had knowledge of the current location of the object and accurate recall of the previous location. During the test question ("Where will Sally look for her ball?"), a correct response was recorded when the participant said that Sally would look in the box, which was the location where Sally placed the ball before she left. An incorrect response was recorded if the participant said Sally would look for the ball in any other location or if the participant did not respond within 5 s. During the first control ("reality") question ("Where is the ball really?"), a correct response was recorded when the participant said that the ball was in the basket. An incorrect response was recorded if the participant said that the ball was in any other location or if the participant did not respond within 5 s. During the second control ("recall") question ("Where was the ball in the beginning?"), a correct response was recorded if the participant answered that the ball was in the box at the beginning. An incorrect response was recorded if the participant answered that the ball was in any other location in the beginning or if the participant did not respond within 5 s. Although responses for the control questions were recorded, only the data for the test ("belief") question were graphed.

Hide-and-Seek Task

When the participant was asked where Actor 1 would look for the object, a correct response was defined as the participant identifying that Actor 1 would look for the object in the location they left it within 5 s of being asked. An incorrect response was defined as the participant answering that Actor 1 would look for the toy in any other location or failing to respond within 5 s.

M&Ms Task

When the participant was asked what Actor 2 would think is in the box, a correct response was defined as the participant stating that Actor 2 would identify the item according to what was pictured on the front of the box (the label) within 5 s of being asked. An incorrect response was recorded when the participant gave any other answer or did not respond within 5 s.

Interobserver Agreement

Point-by-point interobserver agreement (IOA) was calculated on a trial-by-trial basis by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. IOA was collected for 76%, 44%, and 57% of sessions and equaled 97%, 100%, and 100% for Jayme, Bruce, and Tony, respectively.

Procedures

A nonconcurrent multiple-baseline across-participants design was employed to evaluate the effects of using multiple-exemplar training, prompting, and reinforcement to teach participants to respond appropriately to false-belief tasks in the natural environment.

Baseline

During baseline, participants observed actors carrying out the hide-and-seek and M&Ms tasks, and participants were asked the questions associated with each task as described earlier. No prompting, reinforcement, or feedback of any kind was provided. Each baseline session contained a total of 10 trials. Five trials of each of the tasks were presented semirandomly so that neither task was presented more than twice consecutively. A 30- to 60-s intertrial interval was used to allow the experimenter time to set up the stimuli for the next trial, which was done discreetly and out of the view of the participants. All of the stimuli used in baseline sessions were not used during training and were presented again during posttraining.

Training

General Procedures Each training session consisted of one trial block consisting of five trials. Prior to each session, an informal preference assessment was conducted by asking participants what they would like to earn. Independent correct responses resulted in immediate access to the participant's self-selected item for 30–60 s (time length depended on the length of consumption time required by the item/activity and the time needed to discreetly arrange the stimuli for the next trial). Incorrect responses resulted in an error-correction procedure consisting of the following least-to-most prompting hierarchy: (a) leading question, (b) gesture, and (c) full vocal model. That is, the same stimuli were immediately re-presented but with a leading question prompt provided. If the learner still responded incorrectly, the same stimuli were re-presented with the next prompt, and so on. All of the error-correction and prompt presentations were scored as one trial on the data sheet with the most intrusive prompt being scored as the prompt necessary for the participant to respond correctly to that trial's stimuli. Prompted correct responses resulted in praise only and a 30- to 60-s intertrial interval to discreetly arrange the next trial's stimuli. Multiple-exemplar training was implemented, wherein new stimuli were presented each trial contingent on the participant emitting a correct response. That is, once the participant responded correctly (independently or prompted) to a trial, the stimuli used in that trial were not presented again. The stimuli that changed included (a) the objects being moved in the hide-and-seek task, (b) the locations of the objects in the hide-and-seek task, (c) the containers used in the M&Ms task, and (d) the objects placed inside the containers for the M&Ms task.

Hide-and-Seek Task Two new adults (Actors 3 and 4), not used during baseline, acted out the scenarios during training of the hide-and-seek task. The general training procedures were implemented along with the following additions. Upon the participant's emission of an incorrect response, the initial question, "Where will [Actor 3] look for [object]?" was repeated and immediately followed by a leading question prompt, "Was [Actor 3] here to see where [Actor 4] moved the [object]?" If the participant responded incorrectly to the leading question, the experimenter repeated the initial question while pointing (gestural prompt) to where the object was placed before Actor 3 left the room. If the participant still did not respond correctly to the gestural prompt, the initial question was repeated and immediately followed by a full vocal model prompt, "[Actor 3] will look for the [object] in the [location]."

Once the participant was responding with at least 80% accuracy across two to three consecutive sessions, a novel-person probe was conducted. If the participant responded below 80% correct to the novel-person probe, the novel person was introduced into the hide-and-seek task until responding with 80% accuracy across two to three consecutive sessions was achieved. Then, a subsequent novel-person probe with an additional person was conducted. Once the participant responded with at least 80% accuracy during subsequent novel-person probes, a probe of the M&Ms task was conducted to identify whether generalization to the M&Ms task occurred or whether the task required training. If participants did not respond with at least 80% accuracy during the probe of the M&Ms task, this task was introduced into the training phase.

M&Ms Task Along with the following additions, the general training procedures were implemented with this task. The same prompting hierarchy used in the hide-and-seek task was implemented. An incorrect response resulted in repeating the initial question, "What will [Actor 1] think is in here?" and immediately providing a leading question prompt, "Was [Actor 1] here to see what was inside the box when I showed you?" If the participant responded incorrectly to the leading question, the same container and initial question were re-presented with a gestural prompt consisting of pointing to the picture on the box. If the participant responded incorrectly to the gestural prompt, the same container was re-presented with the initial question and immediately followed by a full vocal model prompt, "S/he will think [expected object] is in here."

Once the mastery criterion of at least 80% correct responding across two to three consecutive sessions was reached, a novel-person probe was conducted. If the participant passed the novel-person probe, he moved on to posttraining. It was planned that if the participant did not respond with at least 80% accuracy to the novel-person probe, that novel person would be introduced into training until the mastery criterion was again met. However, this was not required for any of the participants.

Variable-Ratio Three Reinforcement

After the participant achieved mastery of both of the tasks, a variable-ratio three (VR-3) reinforcement schedule was conducted in order to avoid responding being extinguished during posttraining, wherein no reinforcement was provided. As in the baseline phase, during each session, 5 trials of each task were presented semirandomly for a total of 10 trials.

Posttraining

During posttraining, the same actors and stimuli presented in baseline (and not used during training) to conduct the tasks were re-presented. This was done to identify whether generalization across untrained people and stimuli occurred. As in baseline, each posttraining session consisted of a total of 10 trials, with 5 trials of each task presented semirandomly. Posttraining was conducted until stable responding to each of the tasks was achieved.

Sally-Anne Task Probes

It was planned for the untrained digital cartoon version of the Sally-Anne task to be probed three times throughout the study: (a) as a pretest during baseline, (b) after participants met the mastery criterion for the hide-and-seek task, and (c) after posttraining. However, for Tony, the probe was mistakenly omitted after the hide-and-seek task was conducted, so it was conducted after the M&Ms task was mastered instead. The Sally-Anne task was conducted in order to identify whether (and if so, when) training in the M&Ms and hide-and-seek tasks would lead to correct responding on the untrained digital cartoon version of the Sally-Anne task. During each probe session, the Sally-Anne task was administered five times, and the following three questions were asked for a total of 15 trials: (a) "Where will Sally look for her ball?" ("belief" test question), (b) "Where is the ball really?" ("reality" control question), and (c) "Where was the ball in the beginning?" ("recall" control question). However, only the five trials consisting of the test question data were graphed (Table 1).

Results

Jayme

Jayme responded with 20% accuracy to the Sally-Anne pretest. In baseline, Jayme responded with 0%–40% accuracy during the hide-and-seek task and 0% accuracy during the M&Ms task. Upon the implementation of training for the hide-and-seek task, Jayme met the mastery criterion within three sessions. During the novel-person probe, Jayme responded with 100% accuracy. The experimenters also probed the Sally-Anne digital cartoon and the M&Ms task, during which Jayme responded with 0% accuracy to both tasks, indicating that the M&Ms task needed to be trained. During training for the M&Ms task, Jayme met the mastery criterion within two sessions and responded with 100% accuracy during the novel-person probe. During the VR-3 reinforcement phase, Jayme responded with 100% accuracy to both tasks. During posttraining, he responded between 80% and 100% correct for both tasks. Jayme responded with 80% accuracy to the Sally-Anne posttest.

Bruce

Bruce responded with 0% accuracy to the Sally-Anne pretest. During baseline, he responded between 0% and 20% accuracy

Table 1 Percentage of correct responses to Sally-Anne task questions

Participant	Test question: belief	Control question: reality	Control question: recall
Jayme			
Pretest	20	100	20
Posttest	80	60	80
Bruce			
Pretest	0	0	0
Posttest	80	60	80
Tony			
Pretest	0	100	0
Posttest	100	100	100

to the hide-and-seek task and between 0% and 40% accuracy to the M&Ms task. Upon the implementation of training for the hide-and-seek task, Bruce's responding met the mastery criterion within four sessions, and he responded with 100% accuracy during the novel-person probe. During the M&Ms probe, Bruce responded with 60% accuracy, so the task was trained. During a probe for the Sally-Anne cartoon, Bruce responded with 0% accuracy. During training for the M&Ms task, Bruce met the mastery criterion within three sessions and responded with 100% accuracy during the novel-person probe. During the VR-3 phase, he responded with 100% accuracy to the hide-and-seek task and 80% accuracy to the M&Ms task. During posttraining, Bruce continued to respond to the hide-and-seek task with 100% accuracy, and his responses for the M&Ms task were between 80% and 100% accurate. Bruce responded with 80% accuracy during the Sally-Anne posttest.

Tony

Tony responded with 0% accuracy to the Sally-Anne pretest. During baseline, he responded with 0% accuracy to the hide-and-seek task and with 0%–20% accuracy to the M&Ms task. During training for the hide-and-seek task, Tony met the mastery criterion within seven sessions. During the novel-person probe, he responded with 20% accuracy. Thus, the novel person was introduced into the training phase until Tony achieved the mastery criterion, at which point another novel-person probe was conducted. Tony responded with 100% accuracy to the second novel-person probe. At this point, a probe was also conducted for the M&Ms task, during which Tony responded with 20% accuracy, indicating that the skill needed to be trained. The M&Ms task was trained to the mastery criterion within three sessions. After the task was trained, Tony responded to both a novel-person probe and the Sally-Anne task probe with 100% accuracy. During the VR-3 reinforcement phase, Tony responded with 80%–100% accuracy to both tasks. Likewise, during posttraining, he responded with 100% accuracy during the hide-and-seek task, M&Ms task, and the Sally-Anne posttest.

Discussion

Overall, all three participants learned the targeted false-belief tasks using a treatment package consisting of multiple-exemplar training, prompting, and reinforcement conducted in the natural environment with live people. Furthermore, generalization to untrained exemplars, people, and the cartoon version of the Sally-Anne task was observed during posttraining. These results extend previous research by demonstrating that training these tasks using straightforward behavioral intervention strategies in the natural environment was effective. The components of the treatment package included ones similar to those of the training included in previous research, such as providing reinforcement for correct responses (LeBlanc et al., 2003) and using a pretest and posttest to observe generalization to the Sally-Anne task (Charlop-Christy & Daneshvar, 2003; LeBlanc et al., 2003). Perhaps the most important extension in the current study was the use of low-tech methods and live people. By not using video modeling, the current procedures may arguably require less effort and be more efficient than those used in previous research because they do not require clinicians to create or purchase videos.

An interesting aspect of the data for the first training block of the M&Ms task for Jayme and Tony is that each of these participants received 80% correct on their first M&Ms training session. These participants' responses could be explained by the error-correction procedure used in this study. When a participant emitted an incorrect response, the trial was presented again immediately with the least intrusive prompt. During data collection, instead of marking an incorrect response, and then marking the prompted response as a separate trial, the experimenter marked the prompt that produced the correct response on that trial within the training block. For example, because Jayme's first response was incorrect, the experimenter used a leading question prompt that produced a correct response. When taking data on the trial, the experimenter marked "LQ" for "leading question prompt" because that was the prompt that produced a correct response. The next trial then began with new stimuli. This error-correction procedure allowed the participant to immediately receive feedback on his response (Fig. 1).

Another intriguing aspect of the data is the responses to the Sally-Anne pretest control questions. These were included to mirror the procedure used in the false-belief task included in the study by Baron-Cohen et al. (1985). In that study, the researchers stated that the control questions were asked to test the participants' knowledge of reality and accuracy of recall. In the current study, the participants had varied responses to the control questions. Jayme and Tony answered the "reality" control question ("Where is the ball really?") with 100% accuracy, whereas Bruce responded with 0% accuracy. All participants responded with 0%–20% accuracy for the memory question ("Where was the ball in the beginning?"). The results of the control questions were different from those obtained by Baron-Cohen et al. in that the participants in their study responded correctly to the control questions. Although the participants in the current study had the prerequisite skill of answering "where" questions, recalling events, and sequencing (i.e., beginning, middle, end), none of them were able to accurately answer where the ball was previously located during the current study, and Bruce was not able to answer the "reality" control question. Yet all three participants were still able to acquire the skill of identifying where actors would look for items. Thus, it appears it may not be necessary for individuals to be able to answer the control questions in order to learn to identify false beliefs.

A major limitation of this study is that we taught a simple discrimination rather than a conditional discrimination. First, we taught participants to identify the original location of the

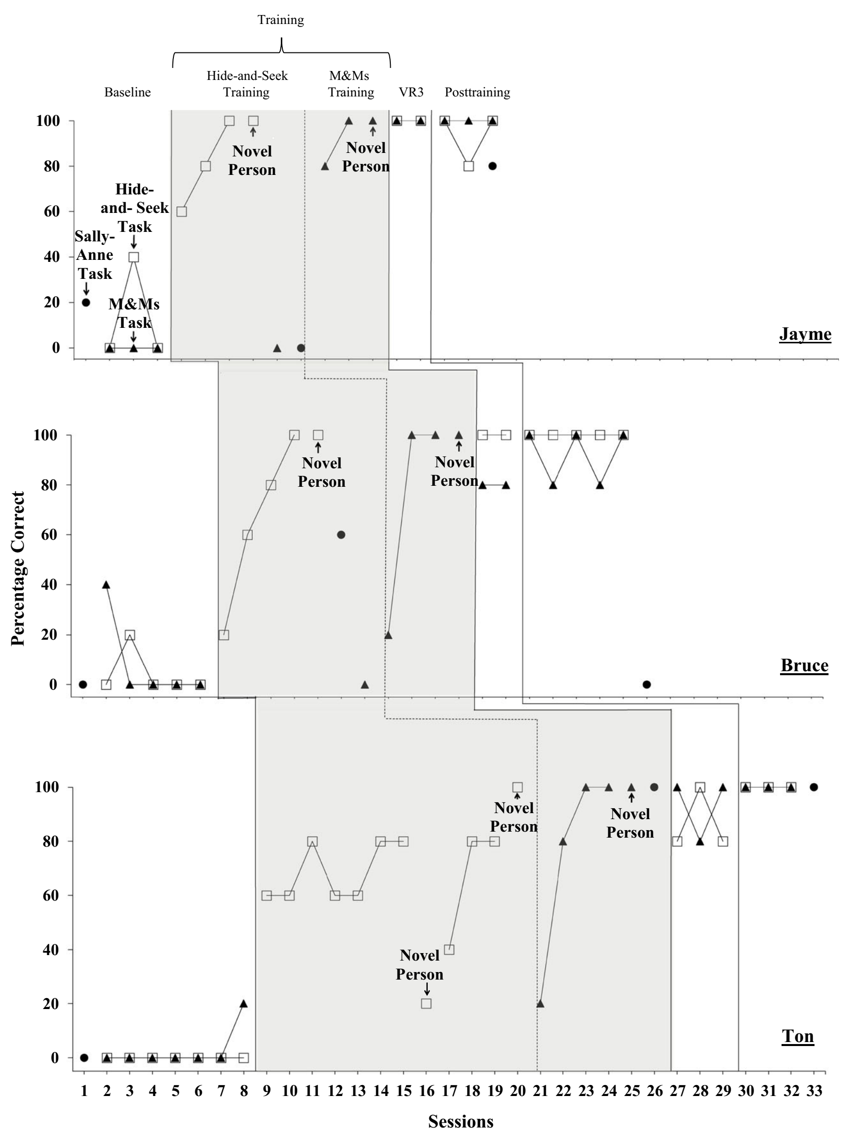

Figure 1 *Acquisition of Responses to False-Belief Tasks*
Note. Percentage correct on the Sally-Anne task (closed circles), hide-and-seek task (open squares), and M&Ms task (closed triangles) across baseline, training, training with a variable-ratio 3 (VR-3) reinforcement schedule, and posttraining.

stimulus in the hide-and-seek task, and subsequently, we taught them to name the outside of the container in the M&Ms task. In order to ensure that we actually taught participants to recognize false beliefs, we would need to have taught a conditional discrimination involving the identification of Sally's experience. That is, if she sees the marble get moved, she should look for it in the new location, but if she does not see it get moved, she should look for it in the original location. Future research could correct this limitation by including trials wherein Sally sees the object get moved or what is actually in the container. This limitation may also be potentially related to why training the hide-and-seek task did not produce correct responding in the M&Ms task.

Another limitation of this study is that the second Sally-Anne task probe was conducted at different times in the study. For Jayme and Bruce, the second probe of the Sally-Anne task was conducted after the novel-person probe of the hide-and-seek task. However, for Tony, the Sally-Anne task probe occurred after the novel-person probe of the M&Ms task. This discrepancy was due to experimenter error.

Behavior-analytic research on teaching perspective-taking skills in general, and identifying false beliefs in particular, is still in its infancy. Most of the research thus far, including this study, has identified a small number of skills and taught them in a controlled manner, as is often done in initial programs of research into behavioral repertoires that have not been subjected to substantial previous research. However, the question of whether or not it is clinically useful to teach identification of false beliefs is an important one. If you make the assumption that theory of mind is a neurological mechanism and that false-belief tests assess the presence or absence of that mechanism, then passing a false-belief task, per se, may be meaningful. However, from a behavior-analytic perspective, it is not useful to hypothesize an unobservable mechanism that we then attempt to assess. Instead, one might take a more pragmatic approach that starts with the assumption that perspective taking involves people interacting with their environment, ergo learned behavior. If one assumes that perspective-taking repertoires are large, complex, and emergent in nature, then one would not assume that any specific test or task would be representative of the larger repertoires that actually matter socially. In other words, false-belief tasks are not assumed to assess a perspective-taking repertoire; rather, they are assumed to be *one part*—one exemplar perhaps—of that larger repertoire. The question remains then: What is the connection between false-belief tasks and larger repertoires of perspective-taking behavior—both in terms of the initial acquisition of perspective-taking skills and in terms of the social use of those skills in everyday life? We believe most existing behavioral research, including the current study, has not yet addressed this question. These early studies have perhaps served the purpose of demonstrating that perspective taking is not merely a cognitive process; it involves skills that can be taught, but much more future research is needed.

Future research on perspective-taking skills, including detecting beliefs and false beliefs, should attempt to identify the separate and interlocking behavioral repertoires that compose one's overall perspective-taking ability. This may likely involve multiple different relational-framing repertoires, starting with deictic relating behavior (relations between "I" and "you"), and then progressing to combining deictic behavior with equivalence or coordinative relations (e.g., "You and I are the *same*"), distinction relations (e.g., "You and I are *different*"), comparative relations (e.g., "I am *bigger* than you"), temporal relations (e.g., "I get to go *before* you because I am younger"), causal relations (e.g., "I should give her a toy *because* it will make her happy"), spatial relations (e.g., "She was *over there*, so she didn't hear me, so she doesn't know"), and hierarchical or categorical relations (e.g., "You and I are *both humans* so we deserve to be treated equally"; Tarbox & Najdowski, 2014). Basic or bridge research could model how these complex repertoires are acquired in the laboratory, but, just as importantly, applied research could continue to isolate, teach, and assess for generalization within and across these multiple complex repertoires. And, ultimately, if behavioral research on teaching perspective-taking skills is to be truly applied, data must be collected that evaluate how teaching these repertoires affects a person's ability to function socially in their everyday life, not just when interacting with researchers.

Some specific examples of how learning to detect false beliefs might generalize to socially meaningful interactions for children include a variety of fun social situations that require it. For example, deception involves creating false beliefs in others. Playing a trick, bluffing during games, and keeping surprises and secrets are all forms of deception. When planning to deceive a person, we attempt to predict what behavior a person who holds the false belief will engage in. For example, when playing a trick by pointing and yelling "A spider!" a child may predict "She will look!" Or, when keeping a surprise birthday party a secret by saying just a small dinner with a few people is planned, one may predict "She will be so happy!" Or, when bluffing during a game, one may predict "She will think I have really good cards in my hand." Future research could also expand on teaching the identification of false beliefs of others as a component to other social skills programs with children with ASD. For example, when teaching a child to successfully tell a joke by holding the punchline until the very end, one might teach the learner that they are creating a false belief and to predict the listener's behavior ("He will laugh so hard!").

In summary, this study was successful in teaching children with ASD and other DDs the false-belief tasks that were targeted, and demonstration of generalization of this skill across people and stimuli was observed. Future research should examine how teaching this skill is connected to other important perspective-taking repertoires and how all of these are nested inside socially meaningful interactions in the everyday lives of children. Shifting greater attention to complex repertoires of perspective taking and social interaction has the potential to help the science of applied behavior analysis address a more comprehensive scope of social and verbal behavior.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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