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# ESTABLISHING A DEICTIC RELATIONAL REPERTOIRE IN YOUNG CHILDREN

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*Perspective-taking skills have been shown to be pivotal in a variety of social and interpersonal interactions. A better understanding of the process involved in building such a repertoire could be beneficial in a wide variety of language and social skills training programs. A relational frame theory approach to perspective taking involves a focus on deictic relations, such as I-You, Here-There, and Now-Then. The present study examined the effect of operant contingencies on deictic relational responding in 3 normally developing young (57 to 68 months old) children. In a multiple baseline across persons and tasks format, I-You, Here-There, and Now-Then deictic relational frames were successfully shaped as operant behavior. As the children acquired deictic relational frames at the Reversed and Double-Reversed levels, the children's performance on traditional perspective-taking measures generally increased.*

Key words: Relational Frame Theory, deictic relations, perspective taking, Theory of Mind

In typical development, children learn that they are seeing events in the here and now from their own perspective, that their current perspective is different from that of others who may also be present, and that their perspective and others' perspectives change due to a change in position or time. Perspective-taking skills of this kind, which are generally assessed using a "theory of mind" paradigm (Baron-Cohen, 2000; Howlin, Baron-Cohen, & Hadwin, 1999), are crucial to social and intellectual development. A child unable to understand the perspective of another cannot understand the motivation of characters in a story (Baron-Cohen, 2000), empathize with others (Baron-Cohen, 2005), or distinguish appearance from reality (Flavell, 2004). Children who do not develop perspective-taking skills cannot read social cues (Downs & Smith, 2004; Perner, 1988), have difficulty forming friendships and maintaining jobs (Klin, Schultz, & Cohen, 2000), and are deficient in self-control (Frith, 1992; Perner, 1991), among a long list of other problems.

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Cognitively oriented developmental researchers generally assume that perspective-taking skills emerge around 5 years of age (true and false belief) due to biological maturation (Baron-Cohen, 2005) and perhaps for that reason have developed few empirically validated technologies for training these skills. Behavior analysts generally view perspective taking as a learned repertoire (Barnes-Holmes, McHugh, & Barnes-Holmes, 2004; McHugh, Barnes-Holmes, & Barnes-Holmes, 2004). In a global sense, this idea is supported by the growing body of research showing that perspective-taking skills are influenced by environmental factors, such as the presence of siblings (e.g., Cassidy, Fineberg, Brown, & Perkins, 2005), family size (e.g., Jenkins & Astington, 1996), the relative age and gender of siblings (e.g., Ruffman, Perner, Naito, Parkin, & Clements, 1998), and the quality of sibling and maternal conversations about perspective taking (e.g., Foote & Homes-Lonergan, 2003; Peterson & Slaughter, 2003; Ruffman, Slade, & Crowe, 2002).

The experimental analysis of perspective-taking skills in behavior analysis has focused particularly on verbal relations that must be seen from a specific point of view in order to be used coherently, such as *left-right, up-down, I-you, here-there*, or *now-then*. These relations are "deictic" in the sense that they can be modeled/demonstrated but are not defined by formal properties of the related events per se; rather, they are relative to the point of view of an individual, often the speaker. For example the statement "John is to the left of the barn behind the tractor" requires that the listener assume the speaker's reference point to make meaning of "left" and "behind."

Relational frame theorists have long claimed that deictic relations are central to perspective taking and an important aspect of sense of self (Barnes-Holmes, Hayes, & Dymond, 2001). In empirical work, research has largely focused in particular on the interpersonal, spatial, and temporal relations of I-You, Here-There, and Now-Then (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2001; McHugh et al., 2004). Skills with these relations are commonly assessed by their speed and accuracy under contextual conditions of increasing complexity in which relations are tested in Simple form, or are Reversed and Double-Reversed (e.g., McHugh et al., 2004). An example of a Simple I-You deictic relation is "I have a cup and you have a pencil. What do I have? What do you have?" An example of a Reversed relation is "I have a cup and you have a pencil. If I were you and you were me, what would I have? What would you have?" Double-Reversed relations combine Reversals of two deictic relations (Triple Reversals, which are rarely tested, do so with three, and even more Reversals are theoretically possible, for example, "Now I have a cup and you have a pencil. Yesterday I had a box and you had a glass. If I were you and you were me, and yesterday were today and today were yesterday, what would I have now? What would you have now?")

Research has shown that deictic relations assessed across the developmental period in this way become more accurate in middle childhood (McHugh et al., 2004), particularly in Reversed and Double-Reversed trials, and that these skills are key to understanding (a) deception (McHugh, Barnes-Holmes, Barnes-Holmes, Stewart, & Dymond, 2007) and (b) that others can have false beliefs (McHugh, Barnes-Holmes, Barnes-Holmes, & Stewart, 2006; McHugh, Barnes-Holmes, Barnes-Holmes, Whelan, & Stewart, 2007). Furthermore, as expected theoretically, deictic relations have been shown to be weak in certain clinical populations, including children diagnosed with

Asperger's syndrome (Rehfeldt, Dillen, Ziomek, & Kowalchuk, 2007) and adults with an inability to experience pleasure from social interactions, or "social anhedonia" (Villatte, Monestès, McHugh, Freixa i Baqué, & Loas, 2008, 2010a, 2010b).

The data showing that deictic relations can be trained are more limited. Rehfeldt et al. (2007) found increases across interpersonal, spatial, and temporal deictic relations after presenting two typically developing children already in middle childhood (male 9 yrs 2 mo; female 10 yrs 4 mo) with multiple exemplar training focused on the three complexity levels. This study used children well above the age at which perspective-taking ability is said to appear, however, and it is important to assess whether this approach is viable with younger children. Finally, given the applied importance of perspective-taking skills and the correlational evidence relating deictic responding to theory-of-mind tasks (e.g., McHugh et al., 2004; McHugh, Barnes-Holmes, Barnes-Holmes, & Stewart, 2006), assessing the relation of training in deictic frames in younger children to performances on perspective-taking tasks is worthwhile.

## Method

### Participants and Settings

**Abu.** Abu was a typically developing male (5 yrs 2 mo), attending morning kindergarten at a charter school with grades preschool through 9th grade. An only child, he lived with both parents, who worked full-time. Abu was receiving individualized speech services approximately 2 h per week during the course of the study. His academic performance was reported by his teachers to be within the appropriate range (kindergarten).

Sessions were conducted four to five times per week in a room at the school. The room measured 3 m × 3 m and was equipped with a desk, table, and two chairs. A one-way window was used for observation. A video camera was placed on the desk approximately 3 m from the child during all sessions.

**Ariel.** Ariel was a typically developing female (4 yrs 9 mo) living at home with her mother and older brother (6 yrs). She attended a public elementary school in a general education classroom.

Sessions were conducted in a program room (4 m × 5 m) in a university setting. The room was equipped with a computer desk with a computer and printer and a long table (3 m) with six chairs. Sessions were conducted in the morning each day of the week. A video camera was approximately 3 m away from the child on the computer desk.

**Aladdin.** Aladdin was a typically developing male (5 yrs 8 mo). Aladdin lived at home with both parents and a younger brother (4 yrs 3 mo) diagnosed with PDD-NOS. Aladdin attended elementary school in a general education classroom. Parents reported academic performance at grade level with no special services or academic difficulties.

Sessions were conducted at his home in a room measuring 4 m × 4 m containing a bed, dresser, and bookcase. A video camera was placed on a bookshelf approximately 3 m away from the child and angled to capture both the trainer and the child from the child's right side.

## Interobserver Reliability and Treatment Integrity

All sessions were videotaped and scored by a trained observer. A random sample of sessions across all phases for each child was selected to compute interobserver agreement (IOA) and treatment integrity. IOA was evaluated on 33% of sessions across all phases for each child. Interobserver agreement was calculated by dividing the total agreements by the total agreements + disagreements. The percentage agreement was 90% across all children and across all phases in this study.

Treatment integrity was evaluated on 33% of all sessions across all phases for each child. The observer would score a + on each trial that the trainer was observed to (a) gain attention prior to the trial, (b) accurately read the scenario, and (c) consequate appropriately. The percentage agreement for treatment integrity in this study was 93%. The most prominent error by trainers was failure to gain attention prior to starting the trial.

## Design

The design of the study was a within-participant multiple-probe design across levels of relational complexity that evaluated correct responding to questions of various scenarios. There were three levels of relational complexity involved in this study: Simple relations, Reversed relations, and Double-Reversed relations. Participants would advance to more complex scenarios as their performance permitted (mastery was met). In addition, a between-participants multiple-probe design (concurrent) was implemented across two of the three children involved in the study.

## Procedure

**Preference assessment.** Preference assessment interviews were conducted to identify highly preferred stimuli for use as reinforcers. A multiple stimulus without replacement (MSWO) preference assessment (DeLeon & Iwata, 1996) was conducted during the initial session with each child. Items in the preference assessments included a variety of edible and tangible items identified by the parent and the child through interview. The top five items chosen by the child were utilized during the training.

To ensure that the items used contingently during training were, in fact, the most preferred (and thus potentially most reinforcing), similar MSWO assessments were conducted at the beginning of each session and upon observation of any item that was not consumed/interacted with following delivery of the item. These brief assessments included two differences from the DeLeon and Iwata (1996) method: First, the number of stimuli included was decreased to three to four items, and, second, only a single array was presented during these brief assessments. These brief assessments were conducted throughout the study to ensure that preferred stimuli were utilized in the training procedure.

**Relational protocol.** ***Deictic relations.*** The protocol used in the current study consisted of the shortened perspective-taking protocol employed in the developmental profile of perspective taking reported in McHugh et al. (2004) using the three deictic relations of I-You, Here-There, and Now-Then. The protocol consisted of 62 relational scenarios that targeted responding in accordance with these three perspective-taking frames across three levels

of complexity (Simple, Reversed, and Double-Reversed). Each of the specific statements was presented by the researcher and was read from an index-sized card. The correct answer was in parentheses and was printed at 20% grayscale to minimize the chances that the participant was able to see it. Several examples of the scenarios follow, to provide an understanding of what was presented to the participants. A listing of all items included in this study can be found in McHugh et al. (2004, pp. 121–126).

Each of the three relations (I-You, Here-There, Now-Then) was included in the scenarios variously at each different level of complexity (see below for a description of the complexity levels). For instance, the simplest presentation would include one relation: "I have a red ball and you have a blue ball." Making this more complex, it is possible to add in an additional relation, such as time: "Yesterday I had a red ball; today you have a blue ball." Questions based on these two examples would include, for the former, "What ball do you have? What ball do I have?" and, for the latter, "What ball did I have yesterday? What ball do you have today?" Additionally, a contextual cue could be added that affects one or both of the relations. For instance, "If yesterday was today and today was yesterday, and if I were you and you were me, what ball would I have today? What ball did I have yesterday?" The general structure of interactions in this protocol centers on the delivery of scenarios as above but with variations in which relations are involved, which stimuli/events are referenced, and, finally, which contextual cues are utilized. The inclusion of contextual cues provides the various levels of complexity that are required to build out flexibility in relational responding.

***Complexity levels.*** The inclusion of complexity levels is meant to build flexibility in relational responding and perspective taking by requiring the child to respond in an "as if" manner. *Flexibility* in this context is defined as responding to stimulus relations coherently given varying contextual cues. The three levels of complexity correspond to whether the answers provided in the scenario involve responding to the scenario as presented or, given a contextual cue, require a Reversal or Double Reversal of the relations. For instance, if the scenario is "Today I play soccer, and tomorrow you will play Frisbee," a Simple trial would provide questions asking "What did I play today?" and "What will you play tomorrow?" A Reversed trial would include a contextual cue that indicates that one of the two relations involved is reversed. For instance, the statement "If I were you and you were me" would be provided following the scenario but prior to the questions being presented. This contextual cue would subsequently require the child to respond "as if I am you." The cue "If today were tomorrow and tomorrow were today" requires responding "as if time has been changed." Reversal of both cues (in a Double-Reversed trial) requires the child to respond "as if I am you" and "as if today is tomorrow and tomorrow is today."

## Relational Testing and Training

The scenarios utilized in this study were incorporated from McHugh et al. (2004) and were used in all phases of this study (preinstructional, instructional, and postinstructional). While the relations involved in the items remained constant throughout phases, the stimuli/events employed in the scenarios in the instructional phase were changed when presenting the scenario in the postinstructional probes. This was an attempt to assess

generalization to other stimuli/events, and to reduce the probability that the participants would simply respond as they did on the same trials in the instructional phase.

**Preinstructional probes.** All preinstructional probes (baseline) involved a random presentation of the three deictic relational frames across all three complexity levels. A total of 18 trials (6 per complexity level) were included. The testing procedure was conducted without feedback and in the absence of reinforcement. Because the design employed in this study was a multiple-probe baseline design across levels of complexity, baseline testing sessions were conducted throughout on complexity levels that were not yet involved in training.

**Postinstructional probes.** Probes were conducted following acquisition of all relations at each level of complexity. These procedures mirrored the preinstructional testing procedures, with the single difference that only relational skills that were acquired up to the point when the postinstructional probe was conducted were included in that probe. For example, after responding at 80% or better on deictic relations at the Simple level, a postinstructional probe was conducted involving only those relations at the Simple level. Next, upon responding at 80% or better during training on deictic relations at the Reversed level, a postinstructional probe was conducted that involved only those relations at the Simple and Reversed levels. Mastery criterion was set at 80% or better across all relations and complexity levels (that were acquired to that point).

**Relational training.** All training sessions included 12 trials of the deictic frames at the respective complexity level randomly presented to the child. Exceptions to this occurred with Abu and Ariel, for whom it was necessary to work on one specific deictic frame, or to alternate (by session) between training on two deictic relations (e.g., Here-There and Now-Then), due to poor performance on the specific relations. A trial consisted of the presentation of a scenario followed by a contextual cue (except at the Simple level). This was followed by posing two questions to the child as described above. Reinforcement or corrective feedback was delivered following the second response only, regardless of whether the first response was correct or incorrect.

Responses to these 12 trials produced either reinforcement (social, edible, tangible) as identified in the MSWO procedure or corrective feedback ("No, I'm sorry, I would be in the blue chair"). On some occasions, two trial blocks would be conducted each day with a break in between. Mastery criterion during the training phase for all relational frames was 80%.

During training, the protocol included mixed trials involving the three deictic relations at a particular complexity level. Specifically, the training protocol was divided into the three levels of relational complexity (Simple, Reversed, and Double-Reversed relations), within which trials took two forms: First, each session would involve 12 trials inclusive of the three relations (4 I-You, 4 Here-There, 4 Now-Then). Second, at any point that it became clear the child was struggling with one of the deictic relational frames (performing at chance levels or worse), massed trials would be presented of this frame (e.g., 12 trials of only Now-Then) and recombined with the other deictic relational frames as the child acquired the appropriate relational response. One exception included Ariel, whose performance did not improve prior to mixing all deictic relations at the Reversed level (see Figure 2).

**Programmed consequences.** Each trial in the relational testing and training protocol included two questions (e.g., "Where am I sitting? Where are you sitting?"). A correct response required that the child answer *both* questions correctly. If the child indicated a choice by means of an alternative response (e.g., by pointing), the experimenter immediately prompted the child with a statement such as, "Please tell me what your answer is." After answering the first question, participants were not given feedback; the next question was asked immediately. Feedback only followed the child's answer to the second question in a given trial. A correct response to the trial (i.e., answering both questions correctly) resulted in the delivery of social praise and access to an identified reinforcer.

It should be noted that Ariel and Aladdin were placed on a token system following several initial sessions, in an attempt to make the procedure more efficient and to reduce the intertrial interval. Both children were familiar with the process involved in a token system, and the earn rate remained on an FR1 schedule while the exchange rate was equated to FR1 access to the backups. For example, if the reinforcement schedule provided an edible for every correct response, the tokens earned during the session would be exchanged following the session for the same amount of edibles.

## Perspective-Taking Tests

To evaluate the potential emergence of perspective taking due to acquisition of the deictic relations, traditional theory of mind tasks were conducted during the first session, and following mastery probes of all deictic frames at the Reversed and Double-Reversed levels for each participant. The perspective-taking tasks employed in the current study were adapted from Howlin et al. (1999) and are summarized below.

**Level 3: Seeing leads to knowing.** Tests for the third level of perspective taking are based on the principle that only through experiencing something (in this case, seeing) does one gain knowledge of the event. Performance on this test is evaluated by utilizing a doll as the target "person," and includes placing items in known containers and asking the child what both she/he and the doll will think is in the container. The correct response to each trial required that the child state that neither she or he nor the doll knew what was inside the box when they did not see, and both did know what was inside the box when they did see.

**Level 4: Predicting actions on the basis of a person's knowledge.** The fourth level of perspective taking is based on the principles that people can have true beliefs due to prior experience and that knowledge of a person's belief can help you to predict his or her actions. Utilizing toys placed on the table and a doll as the target "person," the child was asked a series of questions regarding the perspective of the doll, for example, "Where does the doll think the car is? Why does the doll think it is beside the plane/boat? Where will the doll go to get the car? Why will the doll go to the plane/boat?" The correct response to each trial required the child to state that the doll would go to the location in which the doll had originally seen the car, and not to the location in which the child saw the car.

**Level 5: Predicting actions on the basis of a person's false belief.** The fifth level of perspective taking is based on the principle that people may have false beliefs about an event previously experienced and that knowledge

of a person's false belief can help you to predict their actions. False-belief tasks were separated into two tests: "unexpected transfer" and "unexpected contents," both of which involved questions of another person's perspective of an experienced event that involved a change unknown to the person. That is, when an item is moved without the knowledge of the other person, that person has a false belief about where to find the item. An example would be going to the drawer where you left your phone charger, only to find that it has been moved by your wife.

Children who are unable to predict false beliefs in others would be expected to attribute knowing to the other person, though that other person was not present to see/experience what actually changed. Rather, the child would indicate that the doll/action figure would look in the original spot for the item—knowledge attributable only to the child and experimenter. For more on these tests, see Howlin et al. (1999).

## Results

### Aladdin

Baseline scores for Aladdin were evaluated in the first session and yielded the following aggregate data: Simple, 66% (4/6); Reversed, 50% (3/6); and Double-Reversed, 0% (0/6). Training on Simple relations started with Session 2 and continued for five sessions (see Figure 1). Both I-You and Here-There relations were quickly acquired by Aladdin; however, Now-Then relations were difficult to acquire, with performance steadily increasing between 50% and 100% (see Figure 1). A postinstructional probe was conducted and resulted in 100% performance on all three Simple deictic relations. During the training for Simple relations, a baseline probe showed Reversed performance levels at 17% (1/6) and Double-Reversed at 33% (2/6) and included increased accuracy with I-You/Here-There Double Reversals.

Training at the Reversed level of complexity then commenced over two sessions. When the aggregate performance met criteria for 80% correct responding, interpersonal and spatial relational responding was at 100% and temporal relations at 75% correct. A postinstructional probe was conducted that resulted in 75% correct responding on Simple and Reversed levels. The following day, a second postinstructional probe was conducted and resulted in 100% correct responding on Simple and Reversed relations.

A final preinstructional probe showed Double-Reversed (I-You/Here-There and Here-There/Now-Then) at 0% accuracy. Training on these two combined relations over two sessions resulted in increased accurate responding from 83% to 100% and 33% to 66%, respectively. When the aggregate was above the 80% mastery criterion, a postinstructional probe was conducted and Aladdin responded at 83% on all three levels of complexity.

Perspective-taking probes were conducted on three occasions (see Table 1). Evaluation of Levels 4 (true belief) and 5 (false belief) were compared. On the first perspective-taking probe, Aladdin performed at 33% (1/3) on Level 4 and 50% (3/6) on Level 5. Following acquisition of Simple deictic relations, a second perspective-taking probe was conducted, with performance improving slightly to 66% correct on Level 5. Level 4, however, decreased to 0% correct responding. A final Theory of Mind (ToM) probe

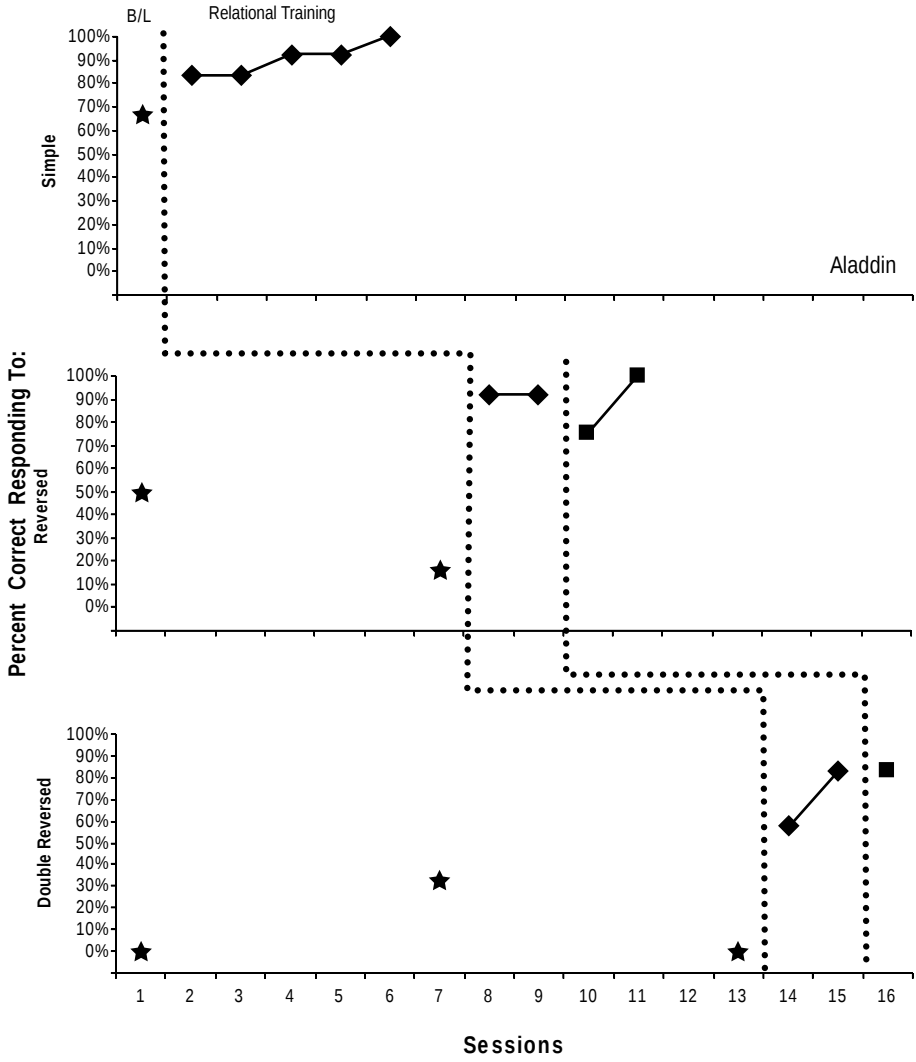


*Figure 1*. Aladdin's performance across levels of complexity. Each data point is an aggregate of correct performance on all three deictic relational frames. The star data points are preinstructional probes (baseline), and the squares are postinstructional probes (for mastery).

was conducted following the postinstructional mastery probe performance. Aladdin's performance on both levels of ToM was 100%.

Finally, errors were tracked by condition (baseline or training), by relation (I-You, Here-There, and Now-Then), and by complexity level (Simple, Reversed, Double-Reversed). Errors increased as complexity level increased; more errors were shown on spatial than interpersonal relations, and more on temporal than spatial.

Table 1
*Participant Performance on Theory of Mind Tests for Levels 3, 4, and 5*

| | Aladdin | | | | Ariel | | | | Abu | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Level | | | | Level | | | | Level | | | |
| ToM Test | 3 | 4 | 5 | Total | 3 | 4 | 5 | Total | 3 | 4 | 5 | Total |
| Pre-Test | 66% (4/6) | 33% (1/3) | 50% (3/6) | 55% (8/15) | 50% (3/6) | 100% (3/3) | 0% (0/6) | 40% (6/15) | 0% (0/6) | 0% (3/3) | 0% (0/6) | 0% (0/15) |
| After Reversal | 66% (4/6) | 0% (0/3) | 66% (4/6) | 55% (8/15) | 66% (4/6) | 33% (1/3) | 0% (0/6) | 33% (5/15) | 0% (3/6) | 0% (0/3) | 0% (0/6) | 0% (0/15) |
| 2nd After Reversal | ___ | ___ | ___ | ___ | ___ | ___ | ___ | ___ | 33% (2/6) | 66% (2/3) | 50% (3/6) | 47% (7/15) |
| Post-Test (after Double Reversal) | 100% (6/6) | 100% (3/3) | 100% (6/6) | 100% (15/15) | 50% (3/6) | 66% (2/3) | 50% (3/6) | 55% (8/15) | ___ | ___ | ___ | ___ |

## Ariel

As seen in Figure 2, baseline performance for Ariel was assessed and yielded the following aggregate data: Simple, 50% (6/6); Reversed, 66% (4/6); and Double-Reversed, 0% (0/6). Training on Simple relations started with Session 2 and continued for two sessions. All relations were quickly acquired, and mastery for Simple relations was met in Session 3 with all deictic relations at 100% (12/12). Training was shifted to the Reversed relations.

Performance through two sessions showed strong responding to interpersonal and spatial relations and weak responding to temporal relations. Due to this weak responding, subsequent training focused on temporal relations for eight sessions. A slow and variable increase in accurate responding was observed over the eight sessions. However, Sessions 12 and 13 showed slight declines in accuracy. To better focus on the relational nature of the task, the three relations were again combined in a trial block. Ariel responded at 100% (12/12) accuracy under these conditions; subsequently, a postinstructional probe (unreinforced) was conducted to further assess her ability to relationally respond on all relations at the Simple and Reversed levels. Accuracy for this probe was 66% (9/12). The following day, a second postinstructional probe was conducted with performance at 92% (11/12).

Following recombination of the deictic relations (Session 14), a baseline probe was conducted at the Double-Reversed level. Ariel responded at 17% (1/6) accuracy on this probe. Training resulted in large changes in accuracy across three sessions. In the third session (Session 19) she met mastery criteria, and a postreinforcement probe was conducted the following day that included relations at all three levels of complexity. Ariel responded at 88% correct on this final probe.

Finally, perspective-taking probes were conducted on three occasions (see Table 1). Evaluation of Levels 4 (true belief) and 5 (false belief) were

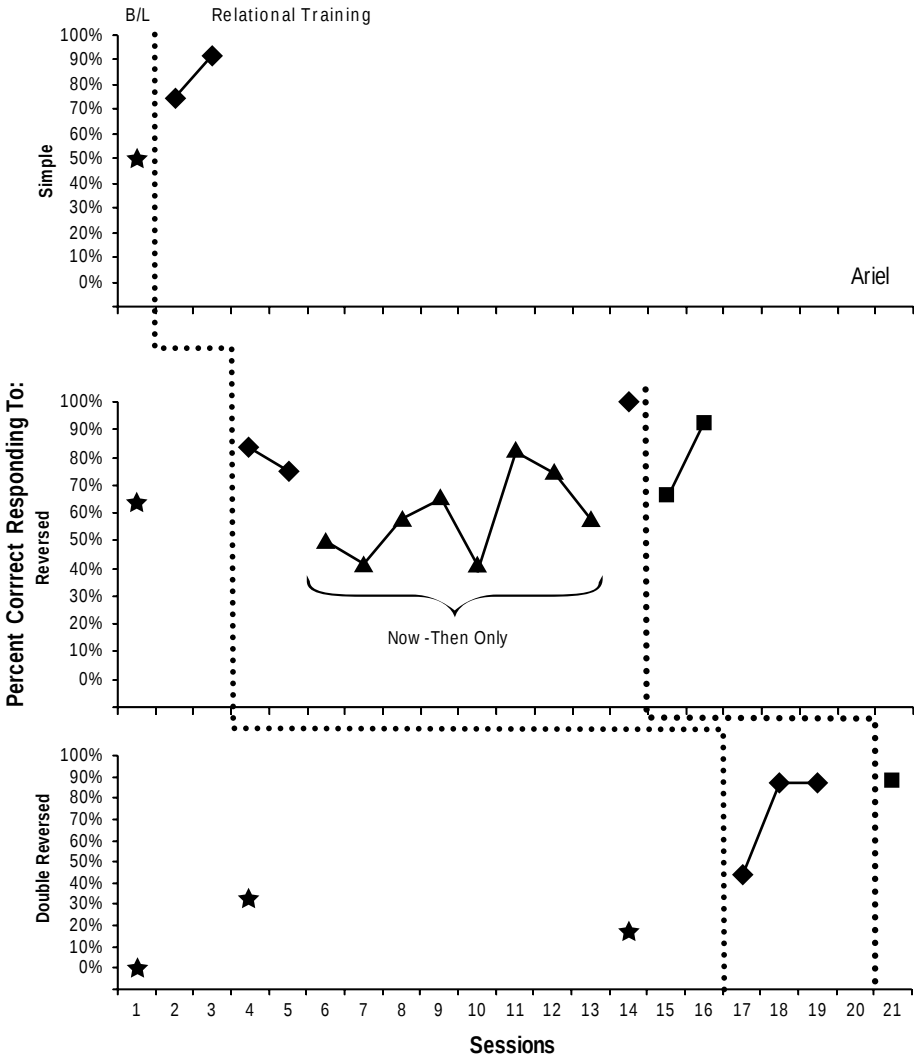


*Figure 2*. Ariel's performance across levels of complexity. Each data point is an aggregate of correct performance on all three deictic relational frames. The star data points are preinstructional probes (baseline), and the squares are postinstructional probes (for mastery).

compared. On the first perspective-taking probe, Ariel performed at 100% (3/3) and 0% (0/6) on Levels 4 and 5, respectively. A second ToM probe was conducted on Session 15 and showed a decrease in Level 4 to 33% (1/3). Level 5 performance was 0% (0/6). The final ToM probe was conducted during Session 21; the day after that, Ariel met mastery for all levels of complexity. Her performance was 66% (2/3) and 50% (3/6) on Levels 4 and 5, respectively.

However, as will be discussed later, her performance on this final perspective-taking test was confounded, to some extent, as she was engaging

in imaginative play, which may have affected her responding. During the test she stated that the toy figures that were used in the perspective-taking tests were "superheroes" who had the ability to see through the table, or through a door. Such imaginative play involves a relatively advanced understanding of another's perspective-taking ability, but due to the nature of the test questions, this imaginative play led to responses that had to be counted as incorrect.

Errors were tracked by condition (baseline or training), by relation (I-You, Here-There, and Now-Then), and by complexity level (Simple, Reversed, Double-Reversed). As would be expected, errors increased as complexity level increased. As with Aladdin, Ariel responded with more errors on spatial (Here-There) than interpersonal (I-You) relations and with more errors on temporal (Now-Then) rather than spatial relations. The exception to this can be seen in the number of errors on the Reversed relations (all errors are temporal), where there are significantly more errors than the other levels of complexity. This may have been related to the number of sessions devoted exclusively to the training of temporal relations at the Reversed level.

## Abu

As is seen in Figure 3, baseline scores for Abu were evaluated across three sessions and yielded the following aggregate data: Simple, 66% (12/18); Reversed, 50% (9/18); and Double-Reversed, 17% (3/18). Training on Simple relations started with Session 4 and continued for 15 sessions. Both I-You and Here-There relations were quickly acquired; however, Now-Then relations were difficult to acquire, with performance variable between 0% and 100% (see Figure 3 for individual relations). Although performance was variable, a postinstructional probe was conducted and resulted in 100% performance on all three deictic relations at the Simple level.

During the training for Simple relations, two baseline probes were conducted for both Reversed and Double-Reversed relations. Reversed performance was at 85% and then 33% just prior to intervention on the Reversed relations. Double-Reversals continued at 17% and then increased to 66%. It is possible that this increase occurred because responses to questions at the Simple and Double-Reversed levels are similar.

During training at the Reversed level of complexity, performance slowly increased for all deictic relations at this level (6 trial blocks); however, acquisition for both Here-There and Now-Then relations was variable, resulting in those relations being targeted directly (e.g., separated out and mass trials presented). Here-There relations were trained across 4 trial blocks of 12 trials each. Now-Then relations were trained across 5 trial blocks of 12 trials each. With performance improved on both deictic relations, a mastery test was performed whereby all deictic relations (at the Simple and Reversed levels) were again combined. Performance on this test was 50%, so a return to training on the Simple level occurred once again. A baseline probe showed poor performance of the temporal relations at the Simple level; therefore, training started with these relations en masse. Across five sessions, temporal relations were acquired and randomly rotated across the other two deictic relations, resulting in 100% performance during the fifth session.

Following reacquisition of Simple deictic relations, a baseline preinstructional probe of Reversed deictic relations was conducted. Performance on

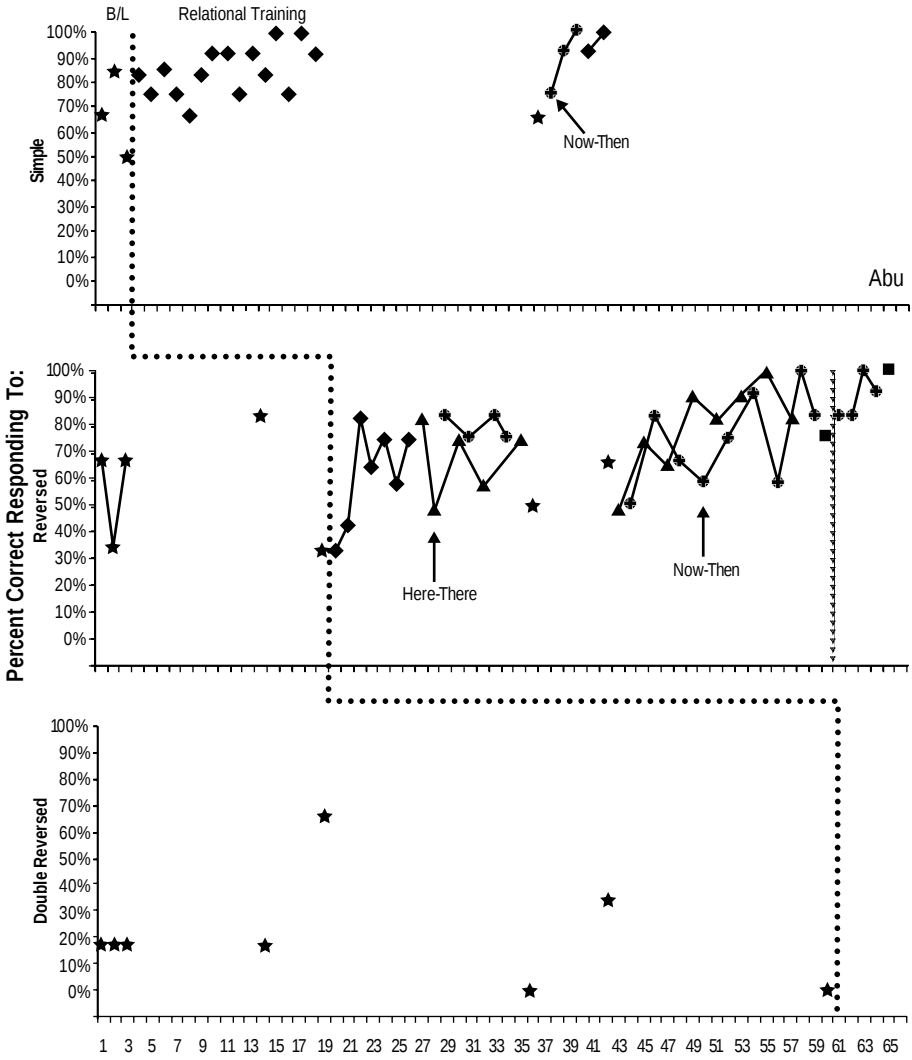


*Figure 3*. Abu's performance across levels of complexity. Each data point is an aggregate of correct performance on all three deictic relational frames. The star data points are preinstructional probes (baseline), and the squares are postinstructional probes (for mastery).

this probe was 66% (4/12), and training began with mass trials of Here-There and Now-Then (12 trials each for each session). Gradual increases in performance for each of the two deictic relations were seen across eight Here-There sessions and nine Now-Then sessions. A subsequent postinstructional probe involving all three deictic relations across the Simple and Reversed levels resulted in 75% performance. As performance on I-You and Here-There relations was excellent, training commenced on Now-Then relations for four sessions. Following these sessions, a second postinstructional probe was conducted and resulted in Abu performing at 100%.

It is worthwhile to review specifics of Abu's performance. Abu had considerable difficulty in learning both spatial and temporal relations at both the Simple and Reversed levels of complexity. Initially, his performance on the Simple deictic relational frames was hampered by slow and variable acquisition of temporal frames. For instance, a typical trial would involve the following:

"Yesterday I played Frisbee and today I played soccer."

"What did I play now? What did I play then?"

As no relational frame was Reversed, the answers are seemingly obvious. However, with this difficulty present in the first five sessions, a change was made: "Yesterday" and "today" were substituted for "then" and "now," respectively. This change in stimuli resulted in a much improved performance on temporal relations, but far from mastery.

When mastery was achieved at the Simple level, performance on temporal relations was high but still variable. The change previously described was utilized in the Reversed training as well, but to limited effect, as performance on both spatial and temporal Reversals was poor. A change at Session 25 resulted in improvements in responding on the temporal frames. The change involved decreasing the temporal frame from yesterday-today to a much shorter time span. The trainer would perform an action, wait for a minute, and then while performing a second action present the trial. For instance:

"A few minutes ago I was bouncing a ball. Now I am coloring."

"What was I doing a few minutes ago? What am I doing now?"

This was seemingly helpful, in that he was able to respond correctly on temporal frames approximately 25% of the time. A reinforced test was conducted (Session 36) that included all three deictic frames to evaluate performance in a random rotation context. Abu's performance on this test was weak. He responded correctly to I-You frames at 100%, Here-There frames at 50%, and Now-Then frames at 0%.

A return to training temporal frames at the Simple level was conducted, as it was assumed that the poor performance resulted from a lack of ability at the most basic level of this relational frame. The shorter temporal frame described previously was used here. Five sessions were conducted in which responding on temporal frames increased quickly, and a subsequent mastery probe resulted in 100% correct responding across all three deictic frames.

A baseline probe involving Reversed and Double-Reversed trials was conducted to evaluate any effects of the second training on Simple deictic relations. Effects were seen on Reversed temporal frames, in that Abu responded 100% correct during this baseline to those as well as the personal deictic frames. However, correct responding on spatial frames was 0%. Performance on Double-Reversed relations remained low. Most notably, accuracy on I-You/Here-There Double Reversals increased from 0% on Session 37 (first day of return to Simple relations) to 66% following acquisition of deictic relations at the Simple level.

The second training on Reversed deictic relations involved alternating training between the spatial and temporal frames. Although the baseline performance in Session 42 was 100%, it was desirable to maintain that performance by including training sessions on temporal frames. Unfortunately, the accuracy on temporal frames continued to be weak and therefore it was necessary to continue training on both spatial and temporal frames. When it

was felt that performance was sufficient to test for mastery, a postinstructional probe was conducted. As Abu's performance was low on this probe, further training on temporal frames occurred for four more sessions. A final probe was conducted that resulted in 100% correct responding on unreinforced, unprompted trials with novel stimuli involved. It was not possible to continue on with Abu, due to the ending of the school year and resource availability in the school.

During training on the Simple and Reversed complexity levels, baselines were conducted intermittently on the Double-Reversed complexity relations. With a single exception (previously discussed), all baseline probes remained low throughout training on the other levels of complexity. Due to the extended duration of training for Abu, we were unable to engage him in the training phase at the Double-Reversed level because the school year ended and further training was not possible.

Finally, perspective-taking probes were conducted on three occasions. Evaluations of Levels 4 (true belief) and 5 (false belief) were compared. On the first perspective-taking probe, Abu performed at 0% across both levels. Following initial failure on the first postinstructional probe for the Simple and Reversed complexity levels, perspective taking was evaluated and showed a stable performance at Levels 4 and 5 of 0%. Following the final four sessions of Now-Then training and the subsequent postinstructional probe, Abu's perspective-taking performance at Levels 4 and 5 increased (66% [2/3] and 50% [3/6], respectively).

Errors were tracked by condition (baseline or training), by relation (I-You, Here-There, Now-Then), and by complexity level (Simple, Reversed, Double-Reversed). As would be expected, errors increased as complexity level increased. As with the other children, Abu responded with more errors on spatial (Here-There) than interpersonal (I-You) relations and with more errors on temporal (Now-Then) than spatial relations.

## Discussion

A small number of behavior analytic studies have attempted to measure perspective taking; however, only a handful have targeted changes in deictic relational deficits. The present study is the first to apply deictic relational training to preschool children (4–5 yrs old) in which deficits in perspective taking would be probable in those who are typically developing. All children showed clear increases in deictic framing that generalized across stimuli, suggesting the acquisition of an operant class. In addition, this study also included traditional Theory of Mind perspective-taking tests. All of the children showed some improvement on these tasks following improvements in deictic performance at the Reversed and Double-Reversed levels.

The present data strengthen a growing body of evidence that relational responding can be shaped as operant behavior (e.g., Berens & Hayes, 2007), and to a more limited data set suggesting that the shaping of deictic relations and flexibility of contextual control over these relational responses are both possible and productive.

The protocol used in this study provides a curriculum framework to utilize when working with individuals whose perspective-taking ability is weak or nonexistent. While normally developing populations may benefit from this type of intervention, those diagnosed with autism provide an example

of a group that may particularly benefit. Lack of perspective is prevalent and long lasting with these individuals (Baron-Cohen, 2000), even more so than with those diagnosed with Down syndrome, intellectual disability, and schizophrenia (Baron-Cohen, Tager-Flusberg, & Cohen, 2000).

This is the first study to evaluate a tabletop training procedure that includes the relational protocol described by McHugh et al. (2004), which is probably a more realistic protocol approach than a purely computerized one for many disabled populations. To date, only Rehfeldt et al. (2007) have included children with autism in a purely computerized approach. The children involved were very high functioning, and they were able to sit through a lengthy computer presentation of the various items from the relational protocol, but it seems unlikely that this would continue to hold for lower functioning children. As it was, the children in the present study had a fair bit of difficulty (especially Abu) with the presentation of so many trials in a day. If two sessions were conducted on the same day, the children were exposed to between 24 and 42 trials, which can stretch the limits of motivation. Thus, further technological refinements will likely be needed for use with disabled populations. It is possible that breaking the number of trials down, altering the scenarios and/or context of training, and including primes and prompts (such as visual aids) would mitigate motivational issues. A recent book-length treatment of this issue is an especially hopeful sign that behavior analysis is beginning to gird itself for that effort (Rehfeldt & Barnes-Holmes, 2009).

Regarding the general relation of deictic and perspective-taking abilities, an off-note in the present study is the weakness of Ariel's final perspective-taking probe, which would normally indicate a weak understanding of true and false belief. However, as was described in the results section, Ariel invented thoughts, beliefs, and predicted actions for various actors in the test. For example, she verbally described a removed toy actor's ability to see or hear through "magic powers." Due to the specific questions on the perspective-taking tasks, it was necessary to count her responses as incorrect when they did not correspond to the basic questions involved in the true- and false-belief tests. However, her use of the knowledge and intentions of others was notably more advanced in the final test than it was at baseline, and indeed that was reflected in the play responding itself, despite the fact that it could not be captured appropriately in the measure used.

Although this study supports the idea that relational responding is operant behavior and as such is sensitive to environmental consequences and contextual features, it is important to consider potential threats to internal validity. The most important variable to consider in a study such as this is maturation. In the mainstream psychology literature, perspective taking is primarily conceived of as a cognitive process that develops relatively independently of environmental stimulation, and thus it is important to control for maturation as best as possible. The multiple-probe design used in this study does so by showing reliable changes in the level and trend of the data following an intervention at one level of complexity, while showing no change, little change, or trending in the opposite direction of the other behaviors/relations of interest (Reversed and Double-Reversed relations). Given that probe data for Reversed and Double-Reversed relations do not show an intervention effect, another comparison between data series

is possible when the intervention is applied to each subsequent level of complexity. If the data again respond to the application of the intervention, then there is strong support for functional control. These same concepts can be applied to the multiple probe across participants; and Aladdin and Ariel were trained concurrently and thus permit the same kind of comparisons across children.

A concern of the protocol itself involves the use of paired question probes in which the participant's correct response to the first question could set the occasion for a correct response to the second question by serving as a discriminative stimulus. Control over the second response needs to be focused on the scenario and contextual cues themselves, and paired question probes of this kind should probably be avoided in future research, perhaps by separating questions so that discriminative effects are unlikely.

It is possible that a test/retest effect (Kazdin, 2003) was observed in some areas. This may have been particularly so with the perspective-taking probes because they were similar and no stability of measurement could be determined due to their relatively low frequency. The stimuli involved in the tests varied during each administration, but the vignettes were similar across all tests, which could increase this effect. Future studies should consider the effect of test–retest effects on the Theory of Mind measures collected.

Another potential limitation of this study pertains to the mastery criteria used for the relations at each complexity level. The use of an 80% mastery criterion across all three deictic relations in this study may not be adequate to show fluency of relational responding. Support of this is evident in the first postinstructional probes for each of the children at the Reversed level. When not receiving social praise and/or other reinforcement signaling a correct response, the children engaged in variable responding. It may be desirable for future research to evaluate other preparations to train the deictic relations, such as fluency building or relational games.

One advantage of this study over previous studies on deictic relational responding was the inclusion of random presentation of all deictic relations across all learned complexity levels. A potential confound to earlier RFT research in perspective taking is the use of massed trials during mastery probes. In these studies, mastery at each level of complexity was tested in the absence of reinforcement. It is possible that given a Double Reversal, the child would merely echo the initial statement. That is, when a Double Reversal is employed, the correct answer is a Simple statement of the scenario that was presented before the presentation of the contextual cues to reverse both relations. If confused, the child might simply have repeated the initial statement, which would result in correct responding.

Future research should continue to focus in a more detailed way on the relationship between the relational protocol and performance on traditional Theory of Mind tasks. Studies with larger populations that are matched by age, relational performance, and Theory of Mind performance would help to identify under what conditions learning is enhanced, as well as lend support to outcomes showing that advances in deictic relational responding consistently affect perspective taking, as measured through traditional Theory of Mind tasks. If this outcome can be further established, deictic relational responding would be seen as a necessary component of the repertoire needed for a child to infer the thoughts, beliefs, and intentions of another person. Knowledge of that kind would help explain the

environmentally focused findings in the cognitive literature. For example, it is known that having siblings who are close in age to the target child results in the target child's learning about perspective taking at an earlier age (Cassidy et al., 2005; Perner, Ruffman, & Leekam, 1994; Ruffman et al., 1998). From a behavioral point of view, the natural context may support natural training opportunities afforded by interpersonal interactions. In that context it may be noteworthy that the two children in this study who had siblings (Aladdin and Ariel) were able to acquire these skills much more quickly than Abu, who was an only child. Some of the present participants also had measurable levels of Theory of Mind skills at baseline; however, it will be important to show definitively in future research that deictic framing can lead to the development of such skills regardless of baseline levels.

It seems reasonable, given the evidence provided here as well as the other studies on deictic relational abilities, to conclude that learning flexible deictic relational frames may affect children's ability to engage in perspective taking. Perspective taking seems pivotal for the development of social skills and general intellectual abilities. Thus, it seems possible that training on deictic relational responding can help create a foundation for more widespread improvements in children's social and intellectual performance.

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