Establishing metaphorical reasoning in children with autism

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ABSTRACT

Researchers have shown that children with autism have difficulty with non-literal language, such as irony, sarcasm, deception, humor, and metaphors. To date, few studies have attempted to remediate these deficits, and no studies of which we are aware have attempted to teach children with autism to understand metaphors. Metaphorical reasoning consists of complex verbal behavior, involving relations of coordination, hierarchy, and distinction, at a minimum. The purpose of the current study was to evaluate multiple exemplar training for teaching children with autism to attend to relevant features of the context in which a metaphor is used and to engage in the required relational responding in order to respond correctly to metaphorical questions. Participants included three children, ages 5–7. Results suggest that multiple exemplar training is effective for teaching children with autism to understand metaphors. Furthermore, generalization to untrained metaphors was found for all participants.

Metaphorical language is a form of figurative speech that is characterized by the distribution and use of metaphors in everyday language. In linguistics, metaphors are defined as non-literal associations between concepts as a basis for comparison (Castillo, 1998). The complex structure of metaphors requires the ability to reason abstract interpretations of one term or topic comparatively to another term or topic in order to identify non-literal, symbolic similarities between the two. This type of abstract reasoning is important because the use of metaphorical language is pervasive in society and plays a significant role in communication. For example, it has been estimated that the average English-speaker uses over 3000 metaphors per week and potentially four metaphors per minute in everyday conversation (Garner, 2005). In addition, it has been suggested that it is more efficient to use metaphors in everyday language because metaphors can provide a shorthand method for defining the abstract through relating a familiar concept to an unfamiliar concept (Garner, 2005). Therefore, the ability to understand metaphors appears to be fundamental to language comprehension and communication and therefore, the inability to understand metaphors is likely to be detrimental to social functioning.

A considerable amount of research has shown that children with autism spectrum disorders (ASD) present deficits in figurative language, specifically with metaphorical language. Numerous studies have shown that children with autism perform more poorly than other populations, including children with intellectual disabilities, Down's syndrome, and ADHD and individuals with brain injury, on tasks involving metaphorical reasoning (Adachi et al., 2004; Baron-Cohen, Leslie, & Frith, 2007; Happé, 1994; Sabbagh, 1999). MacKay and Shaw (2004) discuss the varieties of figurative language with which children with autism have difficulty, including metaphor, irony, metonymy, rhetorical questions, understatements, hyperbole, and indirect requests. These deficits in figurative language comprehension could present significant challenges, considering the prevalence of figurative language in society.

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The majority of research on metaphorical language in individuals with ASD approaches the topic from a neurocognitive perspective, wherein deficits in metaphorical language are thought to be caused by dysfunction in underlying neurolinguistic mechanisms (Baron-Cohen, 2002; Gold & Faust, 2010). Since it is not yet possible to intervene at the level of these hypothetical neural mechanisms (nor will it likely ever be), it is perhaps not surprising that few or no studies have attempted to teach metaphorical language to children with ASD. In a study with typically-developing children, Białecka-Pikul (2010) attempted to teach metaphors to a total of 109 four and five-year-old children through direct and indirect cues and gestural and pictorial prompting. Training involved a metaphors test, which required the children to determine the solution of 15 metaphor tasks. Each task was structured in three series (A, B, and C) consisting of five metaphors each. In series A and B, the third task was always followed by either a direct or indirect cue. Direct cues involved direct formulation of the solution and verbal explanation. Indirect cues involved nonverbal, suggestive gestural and pictorial prompting. A correlational design was used to evaluate the performance of participants. The prompting strategies used were ineffective and that participants were ultimately unable to acquire an increased ability to understand metaphors.

A behavioral approach to the topic of metaphorical language may have much to recommend it; however, no previous behavioral empirical research of which we are aware has attempted to teach metaphorical language to individuals who do not already posses it in their repertoire. In addition, little behavioral conceptual work has been published on the topic, aside from a brief treatment by Skinner (1957) in his treatise, *Verbal Behavior*, and a few conceptual treatments in the Relational Frame Theory (RFT) literature (Stewart & Barnes-Holmes, 2001a,b). Space does not permit a full description of the RFT conceptual system, nor is it necessary here (see Hayes, Barnes-Holmes, & Roche, 2001; Rehfeldt & Barnes-Holmes, 2009 for volume–length treatments). For the current purposes, it should suffice to say that RFT treats relating, per se, as learned behavior. The various ways in which an individual can relate one thing to another are referred to as "relational frames." Furthermore, relating is conceptualized as generalized operant behavior, learned via a history of multiple exemplar training.

Three relational frames are particularly relevant to metaphorical language: coordination, hierarchy, and distinction (Stewart & Barnes-Holmes, 2001a). Relating in terms of coordination is the behavior of relating two or more stimuli as similar or the same. For example, one might relate the spoken word, "apple," and an actual apple as similar. Relating in terms of distinction is the behavior of relating one stimulus as different from another. For example, one might relate an apple as different from a rock. Relating in terms of hierarchy is the behavior of relating one stimulus to other stimuli that "belong to it." For example, the word "mammal" is related to the words, "dog," "dolphin," and "whale," in the sense that all three are examples of mammals. The concept that a thing or stimulus has "features" also involves hierarchical relating. For example, the stimulus, "apple," can be related to "fruit," "you can eat it," and "grows on trees," in the sense that all three are features of apples.

Relational frame theory analyses of metaphorical reasoning treat it as behavior that relates a variety of relations to one another, including coordination, distinction, and hierarchy. Metaphors involve calling a thing (referred to as the "target") something other than what it really is (referred to as the "vehicle"). For example, after eating a particularly sweet apple, one might say, "This apple is candy." According to the RFT analysis, the target and its properties are related in terms of hierarchy. To understand a metaphor, one first relates the target to its various properties (e.g., relating an apple to its various properties, one of which is sweetness). One must then relate the vehicle to its various properties (e.g., relating candy to its various properties, one of which is sweetness). Understanding the metaphor then amounts to identifying the property that is similar between the target and the vehicle. In this case, both the apple and candy are sweet, so the metaphor, "This apple is candy," means that the apple tastes particularly sweet.

Fig. 1 is a flowchart that depicts this same set of relations but with another metaphor. Consider the metaphorical story located at the top of the flowchart: "I once knew a boy who always wore yellow, he liked to stay up late at night, and he was really strong. If I said, he is a super hero, what would I mean by that?" The correct answer here would be "he is strong," located at the bottom of the flowchart. The various stimuli and the relating behaviors required for understanding the metaphor are depicted in between the question at the top and the answer at the bottom. In order to understand what the speaker means when he/she speaks the metaphor, "He is a superhero," the listener first relates the target to its properties, depicted on the left half of the flowchart. In doing so, the listener relates "he" in the story to "wears yellow," "stays up late," and "is strong" – the properties of "he" described in the story. The listener then relates the vehicle to its properties, depicted on the right side of the flowchart. In doing so, the listener relates "super hero" to the stimuli that he/she has learned in his/her learning history, – such as "wears a cape," "flies," and "is strong." Finally, in order to make sense of the metaphor, the listener relates the various properties of the target to the various properties of the vehicle, all of which are related in terms of distinction (i.e., they are different), except for "is strong," which is related in terms of coordination (i.e., "strong" is the same as "strong"); therefore, the metaphor means the person is strong.

Perhaps, the greatest strength of the RFT analysis of metaphorical language is its inherent practicality. RFT provides immediately testable implications regarding how metaphorical language can be taught to individuals who do not already demonstrate the ability to understand it. As with all other relating behavior, RFT posits that metaphorical reasoning should be teachable via multiple exemplar training. A significant amount of previous research has shown that multiple exemplar training can be effective for establishing a variety of generalized behavior changes in children with autism in areas of complex behavior, including working memory (Baltruschat et al., 2011), rule-governed behavior (Tarbox, Zuckerman, Bishop, Olive, & O'Hora, 2011), visual perspective taking (Gould, Tarbox, O'Hora, Noone, & Bergstrom, 2011), deriving symmetrical naming relations (Greer, Stolfi, Chavez-Brown, & Rivera-Valdez, 2005), and past-tense usage of verbs (Greer & Yuan, 2008). Despite the significant potential of a multiple exemplar training approach to improving metaphorical language

Question: "I once knew a boy who always wore yellow, he liked to stay up late at night, and he was really strong. If I said <u>he is a super hero</u>, what would I mean by that?"
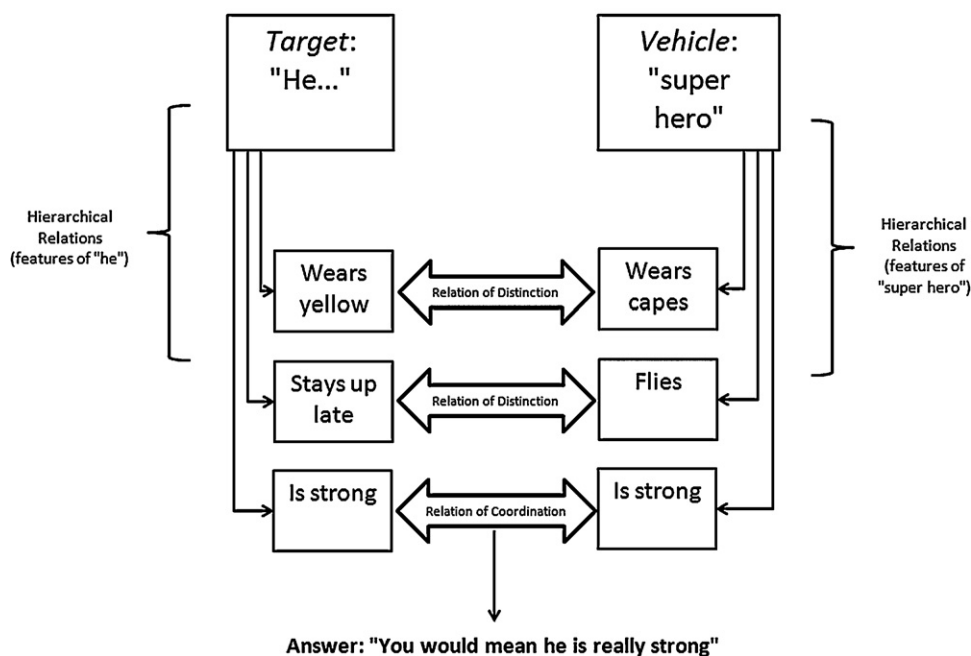

Answer: "You would mean he is really strong"

Fig. 1. Flowchart depicting the various stimuli and the various relational responses involved in understanding a sample metaphor. A story containing a metaphor is at the top of the page, the answer that demonstrates understanding is at the bottom, and the stimuli and their relations are in-between.

in children with ASD, no studies of which we are aware have attempted it. The purpose of the current study was to attempt to improve understanding of metaphorical speech in children with autism via multiple exemplar training.

1. Methods

1.1. Participants and setting

Three children participated in the study – Sheldon, Howard, and Raj. All participants had autism and were clients of a large-scale, home-based behavioral intervention provider. Sheldon and Raj were 5 years old, and Howard was 6 years old. Clinical supervisors and caregivers of all participants deemed metaphorical language an important target for clinical intervention. None of the participants had any previous training on metaphorical language. In order to be eligible, participants needed to have already mastered the following skills: (1) listening to and answering questions about short stories, (2) describing everyday objects by naming/identifying at least three of their features, and (3) discriminating between same and different. The majority of the sessions was conducted in their homes as a regular part of the participants' ongoing behavioral intervention sessions, with the exception of Raj, whose sessions were conducted in his home in his free time during after-school hours.

1.2. Materials

Materials included up to 10 stories in baseline and post-training and up to 44 stories in training. Stories for this study were created by the authors. Each story contained 2–10 sentences that depicted simple descriptions of people or events. Table 1 lists a sample of three stories used in baseline and post-training and three stories used in treatment (the remaining 48 stories are omitted for the sake of space but are available upon request). A visual aid was used in the *multiple exemplar training plus visual aid* condition. The visual aid was a laminated worksheet with two columns on which the participant was instructed to list the features of each item of the metaphor and draw a line connecting the shared feature.

1.3. Response measurement and interobserver agreement

During baseline and post-training sessions, data were collected on the percentage of correct responses to each untrained metaphor. A response was scored as correct if the child identified the shared feature of the target and the vehicle in the metaphor, (see description of stories below). Each session contained six metaphors. For training phases, data were collected

Table 1
Sample stories and metaphors from baseline/post-training and training.

Stories	Metaphors
Baseline/Post-training	
I walked to school once during the winter, and forgot to wear gloves. There was snow everywhere. I didn't see the big area of ice underneath all the snow and when I stepped on it, I slipped and fell.	1. The snow was a blanket. (Shared feature: covers) 2. My hands were icicles. (Shared feature: frozen) 3. The ice was a wet bar of soap. (Shared feature: slippery)
My friend's cat has black and white fur. It likes to sleep during the day but stays up late at night. The cat does not like to be picked up and if my friend tries, it runs away really fast.	1. The cat is an owl. (Shared feature: awake at night) 2. The cat is lightning (Shared feature: fast) 3. The cat is a zebra (Shared feature: black and white)
I am very scared of public speaking. When I get up on stage to talk in front of a lot of people my mouth gets dry, I can hear my heart pounding very loudly in my chest, and my voice becomes really shaky.	1. My voice was an earthquake. (Shared feature: shaky) 2. My heart was a hammer. (Shared feature: pounding) 3. My mouth was a desert. (Shared feature: dry)
Training	
I had the worst luck last night. I went to a restaurant for dinner and had to wait more than an hour for the waitress to bring my food to the table. The bread on the table was not fresh and I chipped my tooth when I took a bite of it. After that, when I took a taste of my soup, I burned my tongue.	1. My waitress was a snail. (Shared feature: slow) 2. The bread was cement. (Shared feature: hard) 3. The soup was fire. (Shared feature: hot)
I went on a really fast roller coaster ride right after I ate lunch which was a big mistake. I felt so sick afterwards that my face turned white. My friend was so sweet and took care of me the rest of the day.	1. The roller coaster was a shooting star. (Shared feature: fast) 2. After the ride, I was a ghost. (Shared feature: white) 3. My friend was sugar. (Shared feature: sweet)
Usually, when I get home at night my dog starts barking really loudly and starts jumping up and down because he is so happy to see me. I love sitting down and petting him because his fur is so soft and fluffy.	1. My dog's bark is a siren. (Shared feature: loud) 2. My dog is a kangaroo. (Shared feature: jumps up and down) 3. My dog's fur is cotton. (Shared feature: soft)

on the first-trial responses for each novel metaphor, and the percentage of correct responses to all remaining trials in that session.

A second independent observer scored videos from 32% of sessions in all phases. Trial-by-trial interobserver agreement (IOA) was calculated by dividing the number of agreements by the sum of agreements and disagreements and multiplying by 100. IOA was 100% for baseline and post-training sessions, and a mean of 97% for training sessions (range = 87–100%).

1.4. Experimental design and sequence

A multiple baseline across participants design was used to examine the effectiveness of the treatment. Generalization was assessed throughout by scoring participants' accuracy on the first trial of each novel exemplar in each session. In addition, none of the exemplars included in baseline and post-training were included in training. Therefore, all trials during post-training represented generalization to untrained stimuli.

1.5. Procedure

1.5.1. Baseline
During baseline sessions, the experimenter read a short story aloud to the child. The stories described the target, as well as three distinct features. An example of a story, the three features of the target, and three questions containing metaphors are below:

One of my coworkers brought a cake to work last week. The cake had fluffy frosting, and it smelled really good, but the cake was really hard on the inside.

1. If I say the cake was perfume, what do I mean? (Answer: The cake smelled really good.)
2. If I say the cake's frosting was a cloud, what do I mean? (Answer: The frosting was white and fluffy.)
3. If I say the cake was a rock, what do I mean? (Answer: The cake was hard.)

After the story was presented, the experimenter required an observing response by asking the participant to recount the story before the experimenter presented the three metaphor questions. The observing response was included to ensure that the participant had been attending to the story, and incorrect responding could not, therefore, be due merely to inadequate attention to the story. If the child answered any of the observing response questions incorrectly, the experimenter read the

story again. Once the child responded correctly to all observing response questions, the experimenter presented each metaphor question. The participant was not provided with any differential consequence for correct or incorrect responses to the questions. Specifically, the experimenter said, "Okay," with a neutral tone after the participant's response, regardless of whether it was correct. Each session included two short stories with three metaphors per story, for a total of six trials.

1.5.2. Multiple exemplar training

Each session during training consisted of four stories: two previously-trained stories and two novel stories (except for the first session which contained two novel stories because no previously-trained stories existed). During each training session, the experimenter read the story, asked the observing response questions, and then presented the metaphor questions. If the participant emitted a correct response (i.e., described the shared feature from the story to which the metaphor referred), the child received reinforcement in the form of specific praise (e.g., "That's right! They are both white and fluffy!"). If the child responded incorrectly to the metaphor question, the experimenter used leading questions to help the child talk through the hierarchical relations between the target and its features, the vehicle and its features, the relations of distinction between the dissimilar features, and then, finally, the relation of coordination between the one feature shared between the target and vehicle. If the child was not able to determine the shared feature through leading questions, the experimenter used an echoic prompt by stating the shared feature.

1.5.3. Multiple exemplar training plus visual aid

A visual aid was added to the multiple exemplar training procedure if a participant showed no progress across five consecutive training sessions, as determined via visual inspection of graphed data. The visual aid consisted of an 8.5" × 11" laminated white piece of paper divided into two columns. Participants were instructed to write the target (e.g., cake) at the top of one column and the vehicle (e.g., rock) at the top of the other column. Participants were then told to write a list of the features of each item in their respective columns. After listing the features, the participant was instructed to draw a connecting line between the matching features. The experimenter initially used verbal and gestural prompting to teach the participants how to use the visual aid. Howard had difficulty writing and reading the items on the list, so pictures were used instead of written words. The visual aid was only implemented on trials contingent upon an error on that trial. That is, trials in this condition always began unprompted and without the visual aid, thereby providing the participant the opportunity to respond independently. Training concluded after accuracy stabilized above 80% across three to four sessions.

1.5.4. Generalization probes

After the training criterion described above was met, a probe session was conducted, consisting of two completely novel stories (not included in baseline or training), with three metaphor questions per story, for a total of six trials. No differential consequences were provided for correct or incorrect responding on these probes. One additional generalization probe session was also conducted with novel metaphors at the end of the post-training phase.

1.5.5. Post-training

After a participant scored above 80% on a generalization probe session at the end of a training phase, the post-training phase was initiated. During post-training, all stories and questions from baseline were repeated, again without differential consequences for correct or incorrect responding.

2. Results

Fig. 2 depicts data for the three participants across all phases. Sheldon's accuracy during baseline was low ($m = 29\%$), and baseline was discontinued after two sessions (instead of three) due to human error. During the training phases, the percentage of correct responses to the first trial of each novel metaphor question (six per session) was graphed separately. Since each session included novel metaphors, and trials did not begin with prompting, these trials represented generalization to untrained metaphors. The objective of the study was to produce generalization to untrained metaphors; therefore, increasing trends in the data on first trials of novel metaphor questions were used as the primary indicator of the desired behavior change. Sheldon's responses on first trials of novel metaphors were variable during the first multiple exemplar training phase ($m = 33\%$). With the addition of the visual aid, his scores on first trials of novel metaphors immediately increased and remained above 67% ($m = 86\%$). Once scores stabilized above 80%, a novel probe without consequences was conducted in which he scored 83%, thereby concluding the training phase. When the baseline metaphors were repeated during post-training, Sheldon scored four out of six (67%) and 100% on the first and second post-training sessions, respectively. Sheldon scored 83% on his final generalization probe.

Howard scored 0% correct on all baseline sessions. When multiple exemplar training was initiated, Howard's accuracy on first-trial probes showed a gradual increase and then stabilized around 67% ($m = 42\%$), so the visual aid was implemented. With the visual aid, Howard's scores increased and stabilized at 83% ($m = 80\%$). Howard scored 83% on the novel generalization probe, which concluded his training. Howard's post-training score on the first session was low (33%), but his second and third session scores during post-training were 100% and 80%, respectively. Howard scored 83% on his final novel probe, concluding his participation in the study.
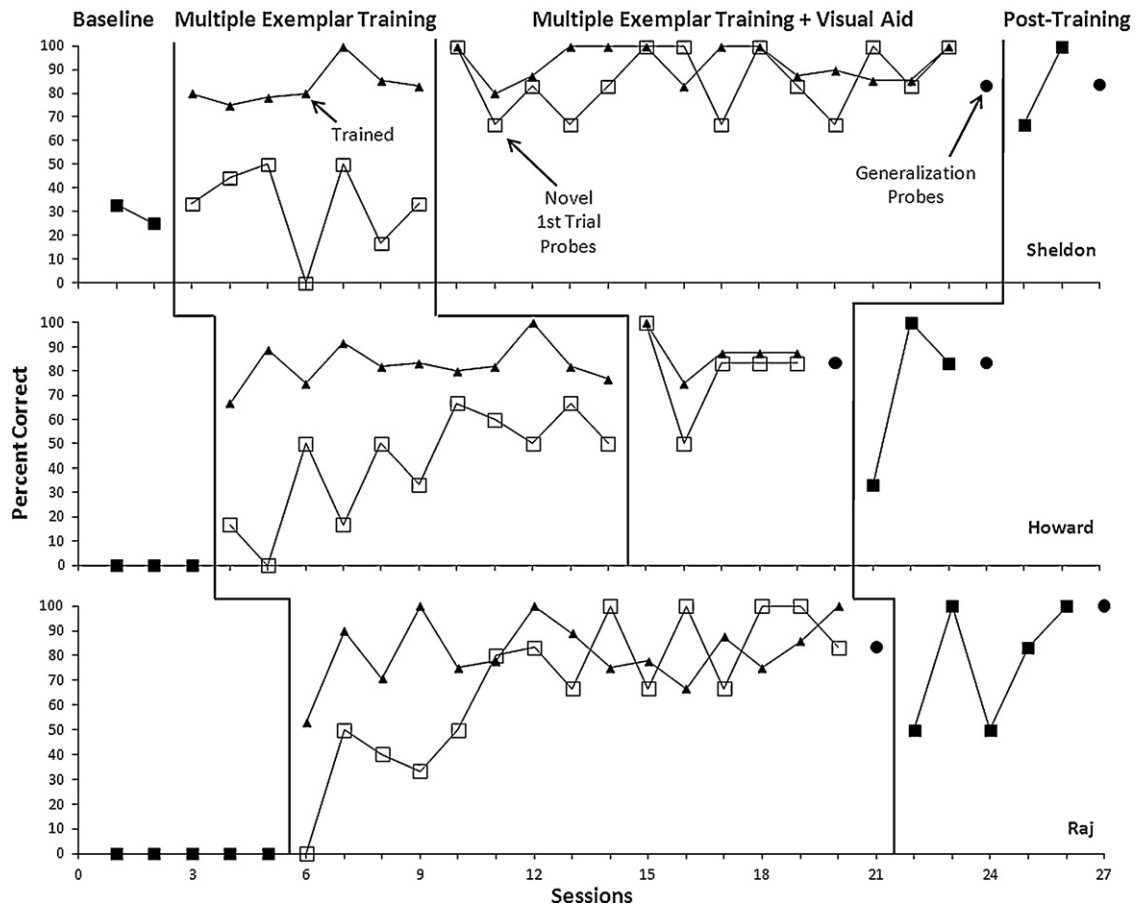
Fig. 2. The percentage of correct responses to metaphor questions across all phases of the experiment for all participants.

Raj's accuracy was 0% during all baseline sessions. When multiple exemplar training was initiated, Raj's scores on first-trial probes steadily increased and stabilized above 80% on training sessions and a novel probe. Raj was the only participant who did not require the visual aid. Similar to Sheldon and Howard, Raj's accuracy on his first session in post-training was low (50%). Raj scored above 80% on three out of five post-training sessions (including 100% on the final two sessions), concluding his participation in the study.

3. Discussion

The results of the current study suggest that the ability to understand metaphorical language is teachable to children with ASD. To acquire the skill, two participants required multiple exemplar training with a visual aid, and one participant required multiple exemplar training alone. All participants demonstrated generalization of the ability to understand metaphorical language to multiple untrained metaphors. Furthermore, accurate responding persisted after feedback was discontinued in the post-training phase.

The most important finding of the current study is likely generalization to untrained metaphors, thereby demonstrating a flexible, generally applicable skill, not merely rote memorization of particular metaphors. The metaphors contacted in baseline and post-training phases were never targeted during training; therefore, the improvement in accuracy on those metaphors from baseline to post-training is itself a demonstration of generalization. However, one could argue that performance could improve through mere exposure, so additional, completely novel metaphors (never before contacted in baseline or anywhere else) were probed at the end of training and at the end of post-training. All participants passed these probes with 83% correct responding or higher, again demonstrating robust generalization to untrained metaphors.

Two of three participants displayed generalized expressive metaphorical language during training and post-training sessions. That is, they began to create their own metaphors. No formal data were collected on this behavior, as the production of generalization to expressive language was not the goal of the study. Nevertheless, experimenters recorded anecdotal notes of these occurrences and found that Sheldon created his own novel metaphors during four sessions, and Raj did so during two

sessions. For example, Sheldon stated to the experimenter during one session, "Okay, I'm going to tell you a story. Today we learned about our five senses, and we ate watermelon. It tasted really good. What do I mean if I say the watermelon is a strawberry? The watermelon was red." The fact that two of three participants demonstrated the ability to create their own metaphors, even though this behavior was never prompted or reinforced, lends further evidence to the notion that the participants acquired the relational operants underlying metaphors, as opposed to having learned particular metaphors. Of course, future research should evaluate generalization of this sort with formal direct measurement and in the context of valid experimental designs that evaluate this effect directly.

The results of the study have positive implications for treating individuals with ASD in deficits of non-literal language. The ability to understand metaphors, in particular, is clinically important because metaphors are a common part of everyday language in our culture. If an individual with ASD responds to a metaphor spoken by someone else as though it were meant literally, he/she is likely to experience difficulty in his/her social and conversational interactions with others. Therefore, this study represents a first step in developing teaching procedures that may lead to increasingly effective social and conversational interactions for individuals with ASD. The current results also have more general implications for non-literal language. As discussed in the introduction, individuals with ASD have deficits in other types of non-literal language, such as sarcasm and analogy, among others. Although much further treatment research is needed into other areas of non-literal language, the results of the current study are encouraging. Specifically, there is no reason to assume that other areas of non-literal language would be more difficult to teach than metaphors, so further work in those areas is to be encouraged.

The results of the current study have implications for an RFT account of metaphorical language. The study was by no means intended to test an RFT analysis of metaphors. Rather, existing RFT analyses were used to interpret the type of behavior that participants would need to learn in order to understand metaphors, specifically, relating the target to its features (hierarchical relating), relating the vehicle to its features (also hierarchical relating), and then identifying which of those features is the same between the target and the vehicle (relating in terms of coordination). Furthermore, existing RFT analyses of metaphors suggest how these relating behaviors may be taught, that is, using multiple exemplar training. The success of the current procedure, then, provides initial evidence that the RFT analysis of metaphors may be useful for designing instructional programs for improving the understanding of metaphorical language in individuals who have difficulty with it.

One limitation of this study is that the relative difficulty of the many individual metaphors included in the study was not assessed or controlled. The data clearly suggest that some of the metaphors were more difficult for the participants than others, such as the metaphors probed in the first session of post-training, for which all participants displayed low accuracy. One possible variable that may affect the difficulty of a metaphor is whether it addresses topics that are familiar or unfamiliar to the participant. For example, one metaphor with which participants had difficulty referred to snow. Since all participants lived in Southern California, it is possible that they had never had any direct contact with snow, so that lack of familiarity may have increased the difficulty of the metaphor. A second possible variable that could affect the difficulty of a metaphor is whether the participants had prior experience with it in their learning history. The metaphors created for this study were intentionally unconventional in order to attempt to control for learning history (e.g., calling someone a banana because he wears yellow clothing is not common), but it was impossible to ensure a complete lack of previous contact with all of the metaphors included in the study. A third potential variable that may affect the difficulty of a metaphor is the saliency of the shared feature to which the metaphor refers. For example, calling someone a "tree trunk" could mean many things. The most salient features of a tree trunk are likely that it is large, heavy, and solid, so learning that the "tree trunk" metaphor means the person is big and strong might be relatively easy to learn. Much less salient features of tree trunks are that they grow slowly, they contain water, and they are covered with bark, so learning to call something a tree trunk if it grows slowly would likely be more difficult to learn, relatively speaking. In this study, no attempt was made to quantify the difficulty of the metaphors prior to beginning the study, so future research should attempt to analyze this variable and control it in some manner.

Perhaps, the most important limitation of the current study is that we did not assess if understanding metaphorical language generalized to everyday social interactions. Since the purpose of this study was to provide an initial test of whether understanding metaphors could be taught and whether generalization to untrained metaphors would be found, metaphorical reasoning was only measured in the context of a task that contained the minimum components that define the "cognitive" ability of understanding metaphors, which, in this case, was asking questions related to fictional stories. Of course, the ultimate point of any treatment research is to contribute to the eventual ability of practitioners to produce a clinically meaningful effect in the natural context of the person's everyday life. It is unknown if the skills established in the current study generalized to the participants' everyday lives, but the fact that generalization to the expressive production of novel metaphors was observed during sessions is encouraging.

In summary, this study used multiple exemplar training to teach children with autism metaphorical reasoning. Although research on metaphorical reasoning has suggested that this is a major deficit among children with autism, our results suggest that it is a skill that can be successfully remediated by teaching the child to identify and compare the features of the items in a metaphorical statement. These results are encouraging because they suggest that other deficits in non-literal language and other cognitive areas may be amenable to treatment through behavioral intervention.

Acknowledgement

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