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Using Relational Frame Theory to Teach Prepositions to Children with Autism

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USING RELATIONAL FRAME THEORY TO TEACH PREPOSITIONS TO CHILDREN WITH AUTISM

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USING RELATIONAL FRAME THEORY TO TEACH PREPOSITIONS TO CHILDREN WITH AUTISM

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ABSTRACT

USING RELATIONAL FRAME THEORY TO TEACH PREPOSITIONS TO CHILDREN WITH AUTISM

By

Alexandra Helen Vacha

Children with autism often demonstrate deficits with the use of pragmatic language, including prepositions. Training methods such as direct instruction have been successfully used to train prepositions, but often do not demonstrate generalization of the skill, nor use of the skill when applied to arbitrary stimuli. The present study evaluated the efficacy of using a relational training method adapted from the PEAK-Transformation module to teach the non-arbitrary and arbitrary use of prepositions "close" and "far" to three children with autism. Participants 1 and 2 were able to demonstrate the non-arbitrary, receptive use of both close and far during training, while participant 3 was able to demonstrate and generalize the non-arbitrary use of close (far needed additional training). Additionally, the first participant demonstrated the arbitrary use of close and far following the implementation of arbitrary training, as well as demonstrated the ability to make combinatorially entailed relations between the arbitrary stimuli. The results from this study indicate that relational training as adapted from the PEAK-Transformation module is effective at training non-arbitrary and arbitrary applications of the prepositions close and far.

Keywords: relational training, prepositions, spatial, close and far, arbitrary, combinatorially entailed relations

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Introduction

As of 2016, Autism Spectrum Disorder (ASD) is increasing in prevalence; one in 54 children in the United States are diagnosed with ASD (Maenner et al., 2020). Diagnostic criteria as described in the DSM-5 for ASD include communication deficits, and often includes repetitive, perseverative, or otherwise inappropriate behaviors within different social contexts (American Psychiatric Association, 2013). Each of these can negatively affect interpersonal relationships among peers and other individuals. To address communication barriers, inappropriate behaviors, and teach adaptive behaviors to increase the quality of life for children with ASD, behavioral interventions are chosen as the form of treatment as a majority of evidence for best practices support these interventions (Anagnostou et al., 2014).

Among communication deficits with individuals with ASD, language deficits are often present with individuals who are lower-functioning. These generally include different pragmatic language deficits such as using correct words for the appropriate context, as well as exhibiting behaviors such as gestures or body language, around social or emotional aspects of language (Philofsky et al., 2007). One common deficit in pragmatic language is the use of prepositions. Prepositions are a necessary feature of communication as they describe the relationships such as temporal, or most often, spatial relations between an object and the other words of a sentence (Lindstromberg, 2010, pp. 15). For example, take the sentence ‘The ball is *in* the box.’ The word *in* allows us to know the location of the ball in relation to the box.

One reason individuals with the diagnosis struggle with this type of language may be due to problems with joint attention. Joint attention is one of the earliest signs of ASD and involves responding to multiple stimuli, usually a person and an object. Joint attention is similar to relational responding, further described below. This may support the use of programming based on Relational Frame Theory to effectively address teaching the skill of preposition use.

There have been some behavior analytic approaches to teaching prepositions to individuals with autism that have been successful. Using a multiple baseline across behaviors design, Hicks et al., (2015) examined the effect of direct instruction on expressive use and receptive responding of prepositions during probes and generalization, as well as whether correct preposition use was maintained following the intervention. The results of this study demonstrated that through the intervention, the individuals were able to learn and correctly use prepositions, and the results were maintained for 8 weeks after the intervention had ceased. During generalization, however, it was possible that individuals incidentally learned the correct responses due to instruction within a group setting.

Also using direct instruction, Hicks et al., (2016) taught prepositions to a small group of children with the deficit. An instruction was given, followed by a response, and the response was recorded on a data collection sheet. The targeted response was the correct use of the prepositions listed on the data sheet. Reinforcement was provided for all correct responses. Error Correction was provided during the testing phase of the intervention. When an incorrect response was provided, the correct answer was remodeled, and no reinforcement was given. While it was found that this method taught prepositions to individuals with this language deficit, it did not test for generalization nor did it provide direct teaching to an individual.

In another study, three students with moderate intellectual disabilities were participants involving “computer-based video self-modeling” as a form of multiple exemplar training used to train 3 pairs of prepositions (Mechling and Hunnicut, 2011). This study used a multiple probe design to test for generalization of positioning one's self and/or objects to the given preposition prior to and following the self-modeling training. The study demonstrated that the students were able to receptively select images in relation to the prepositions, but were unable to generalize at mastery level (80% accuracy) due to the lack of transfer of stimulus control to the novel examples. With only using 3 exemplars for each pair of prepositions, it is possible that the training of even more exemplars may be required to generalize to other stimuli.

Sailor and Taman (1972) studied the acquisition of preposition usage with three children with both autism and speech deficits. To teach the correct usage of in or on, two training conditions were used: one condition with what was referred to as ambiguous stimuli (i.e., the same stimuli for both in and on) and one condition with non-ambiguous stimuli (i.e., different stimuli for in and on). Two of the three participants began with the ambiguous condition while the third began with the non-ambiguous condition. Each of the participants went back and forth between the conditions so that they could experience each of them twice. The results demonstrated that correct usage of in and on occurred only under the non-ambiguous conditions, however starting training under the non-ambiguous demonstrated potential to increase correct responses under the ambiguous condition (Sailor & Taman, 1972). The correct usage under the non-ambiguous condition also may suggest positive results when utilizing multiple exemplar training to teach preposition usage through Relational Frame Theory.

While each of these studies above have successfully taught certain prepositions to individuals with autism, each of them had limitations relating to responding to others in a group setting, lack of generalization, and/or not using multiple exemplars. Having programs in which the individual is not responding within a group setting, as well as programming based in relational frame theory, which aids in generalization and utilizes multiple exemplar training, may be successful in addressing the listed limitations.

Relational Frame Theory

Relational frame theory (RFT) expanded upon stimulus equivalence theory founded by Murray Sidman (Hayes et al., 2001). In both stimulus equivalence theory and RFT, an individual can be directly taught relations and derive relations (i.e, make relations in which the individual has not been directly trained to make). For example, one can be taught to pick the image of a cat when shown the written word cat, and following this training if the individual selected the word cat when presented with the picture of a cat, selecting the word cat would be derived. Because prepositions include all different types of relationships between stimuli, relational frame theory is necessary to address them.

The above example with the stimulus class of cat demonstrates symmetry within stimulus equivalence theory. Through RFT, stimuli either are mutually (between two relations) or combinatorially entailed (between multiple relations), rather than being symmetrical: greater than entails less than, or less than entails greater than. For mutual entailment, this would be if B > A then A < B. For combinatorial entailment, it would be if A > B > C, then C < B < A. To use the example from before, if the ball is *in* the box, one would not also say the box is *in* the ball. Mutual entailment for this relation would be the box is *on* or *over* the ball.

Prepositions are an example of complex language. Relational frame theory says that we learn complex language by using multiple examples to directly train formal (non-arbitrary or physical properties) relations of stimuli (i.e., multiple exemplar training) and then derive similar relations to arbitrary stimuli (properties that aren't immediately apparent). This is called arbitrarily applicable relational responding (Hayes et al., 2001).

Prepositions are usually first taught directly in a receptive manner. Children are often instructed by their parents or others to place an object on a surface or to grab an object that is under, below, in, or on something. A child may also be told to go closer to or farther from an individual or object. For example, if a child and their parent are walking somewhere and there is a crowd, the parent might instruct the child to walk closer to them (the parent). Eventually, these same prepositions are used in an expressive manner and take on arbitrary features, which is seen when using metaphors, a prime example of arbitrarily applicable relational responding as well as an example of the use of pragmatic language.

Within metaphors are two key features: contextual relations (C_{rel}), which signify which frame we are using, and the contextual function (C_{func}), the function of the relation. An example of this would be the closeness of family relatives. They are not physically close, but close may describe the arbitrary distance between generations, or even the emotional distance between individuals. Close in this example would be the C_{rel}, signifying the spatial relational frame. The C_{func} would be applying the arbitrary function of close to the family member, because of the abstract concept of generational or emotional distance.

Along with the spatial frame, there are 7 other frames in which relations are made: coordination (same), opposition (opposite), distinction (different), comparison (quantitative, more than/less than), hierarchical (relation that only goes in one direction; professor>teachers assistant>student), temporal (time), conditionality and causality (if/then), and deictic (perspective taking: I-you, here-there, close-far, now-then).

When making these relations between stimuli, a process called the transformation of stimulus function occurs. This is when the function of stimuli change based on the relation of that stimulus to the other stimuli. So for example, If A is opposite of B and A is paired with a punisher, B may become a reinforcer. This reinforcing function was not transferred from another stimulus but rather transformed because A and B did not have the same function to start. Through this we are able to make all kinds of relations between arbitrary stimuli.

Relational frame theory has been used to train basic language skills, for example, 'WH' questions, as seen in a study by Daar et al. (2015), who used the Promoting Emergence of Advanced Knowledge (PEAK) Relational Training System to teach 'WH' questions to children with autism. This study was conducted in multiple phases, first using programs from the Equivalence module to teach sameness between community helpers, locations, and activities, then followed by a program from the Transformation module to teach word to noun-word associations. The results demonstrated that the participants were able to correctly answer the wh-questions only after training the wh-question word with the noun-words, which demonstrates derived relational responding due to no reinforcement or feedback being provided for the correct answers.

Something to consider is the relations for non-arbitrary or arbitrary stimuli are not always from a single frame. Deictic relations often occur with spatial and temporal relations. The spatial and deictic frames often accompany each other because the location of stimuli frequently depends on the location of the individual in relation to the particular stimuli. If two people were sitting in a room, an object may be close to one person but far from the other. If one person is asked which item is closer (or farther), their answers may be different. This is also the case for the temporal frame. For example, if holding a dual-sided picture card to an individual, what the person holding the card sees first will be different from what the other individual sees first, assuming that the two images are different.

For the reasons listed above, spatial and temporal relations are usually studied along with the deictic frame. Montoya-Rodriguez et al. (2017) conducted a literature review analyzing 26 empirical and 8 non-empirical studies from 2001 through 2015 utilizing interventions based around RFT to establish deictic repertoires. The studies examined range from the basic establishment of deictic relations for children with autism (or other developmental delays) using multiple exemplar training (e.g., Gilroy et al., 2015), to more complex studies involving the hierarchical frame and aspects of Acceptance and Commitment Therapy (ACT) to regulate one's own behavior with typically developing individuals (e.g., Luciano et al., 2011; Foody et al., 2013). Montoya-Rodriguez et al. (2017) found that there is an increasing number of empirical studies supporting the RFT approach to training deictic relations, however most studies are with typically-developing individuals leaving a need for studies addressing its application to atypically developing individuals.

Within the literature of using an RFT approach with atypically developing children are a number of studies utilizing procedures found in the PEAK Relational Training system, including Daar et al. (2015), mentioned above. This training system is geared toward individuals with autism, and the Transformation Module exclusively focuses on teaching the different relational frames described above (Dixon, 2016).

A number of studies have successfully demonstrated training relational frames with children with autism using the PEAK: Transformation module. Belisle et al. (2016) used programs from the PEAK Transformation module to examine the I-YOU deictic frame with children with autism. Conducted in multiple phases with intermittent probes for derived emergence, Belisle et al. (2016) trained and tested the regular I-YOU perspective, followed by the single reversal (e.g., if I were you and you were me). The results determined that the skill was supported as generalized operant behavior rather than stimulus generalization, as the stimuli were not formally similar, suggesting that this programming is effective in teaching this perspective taking skill.

Barron et al. (2018) evaluated the efficacy of relational training procedures from the for teaching single reversals of “here-there” and “then-later”, using programs from the PEAK Transformation module. Barron et al. (2018) first trained then-later and here-there, then single reversals (if then was later and later was then, etc.), and then tested for the transformation of stimulus function. This study found these relational training procedures to be effective in teaching children with autism these perspective taking skills, and supports the use of programming with the PEAK Transformation module.

Belisle et al. (2019) conducted two experiments evaluating procedures within the PEAK Transformation Module. The first experiment trained and tested bigger/smaller and faster/slower using different sets of 3 stimuli (each stimulus labeled either A, B, or C within the set), and probed throughout for the transformation of stimulus function. The results of this study demonstrated the untrained emergence of combinatorially entailed relations. The second experiment addressed a limitation in the first experiment, stimulus A was always bigger, and stimulus C was always smaller (or faster/slower depending on the skill taught), by using sets of 5 stimuli (labeled A, B, C, D, or E) for the same program. The results for this second experiment replicated those of the first, and the study overall demonstrated that establishing comparative relations with both 3 and 5 member classes using relational training can lead to untrained emergence of combinatorial entailed relations for children with autism.

The prepositions close and far take on spatial relations as well as deictic relations due to the perspective required for the response. Depending on where the speaker is in location to the object determines whether the object is close or far. If stating whether an object is close or far to another person, the speaker would have to take the perspective of said person. This is also the case for arbitrary stimuli, such as different buildings, cities, states, or countries. The purpose of the present study is to evaluate the efficacy of the procedures found in the PEAK: Transformation Module, which utilize relational frame theory, to teach the non-arbitrary and arbitrary use of prepositions close and far, and expand the literature of RFT with children with atypically developing individuals.

Methods

Participants and Setting

This study took place in a clinic at a university in the Midwestern United States. The study was conducted in a room within the clinic, which consisted of 3 stations of child appropriate tables and chairs for implementation of DTT. Participants included 3 children, each diagnosed with autism, and were recruited based on their enrollment in an ABA program due to deficits in language skills. Potential participants were evaluated as to whether or not they responded to arbitrary and non arbitrary closer and farther stimuli as described in baseline. Those individuals who scored 50% or less during baseline were included in the study. Participant 1 was a male, who began this study at age 4, and scored 107 out of the age normative criteria of 67 on the PEAK-Direct Training assessment. Participant 1 demonstrated the receptively identified nearly any object, however he did not demonstrate the ability to receptively identify prepositions. Participant 2 was also a male, and was 5 years old. Participant 2 scored 83 of the age normative criteria of 145 on the PEAK-Direct Training assessment, and had a similar receptive identification repertoire as participant 1 along with not demonstrating this skill with prepositions. Participant 3 was a 4 year old female who scored 65 of the age normative criteria of 67 for the PEAK-Direct Training assessment. Participant 3 also demonstrated the ability to receptively identify many objects, but not prepositions.

Stimuli

Non-arbitrary stimuli used for train trials consisted of 2 sets of images of common objects, measuring 7.5cm by 7.5cm. Each set included 2 pictures, examples can be found in

Table 1. Arbitrary stimuli used for train trials consisted of 2 sets of 3 images of United States of America geography states, with examples found in Table 2. Images of states were selected as arbitrary stimuli as they represent abstract spatial qualities (distance from the participant's location), and because they are common targets in general education settings. Additional sets of non-arbitrary and arbitrary stimuli were reserved for the event in which a participant was not demonstrating derived relations.

Experimental Design and Data Collection

A multiple baseline across treatments design with intermittent probing for derived relations was used for this study. Trials were run in blocks of 10, and data was collected using percentile correct. Correct responses are recorded as independent, otherwise responses are scored as incorrect, following the data sheet provided in the PEAK-Relational Training System. Probes were recorded similarly, either correct or incorrect, to track the emergence of derived combinatorially entailed relations with arbitrary stimuli. Interobserver agreement (IOA) was collected for 83.2% of trials and was calculated at 98.7% of agreement. by taking the sum of trials in which both observers recorded the same score, divided by the total number of trials and multiplied by 100 to get a percentage.

Procedure

General Procedures

All trials in this study were presented using DTT procedures in a matching to sample arrangement. The participant and technician sat facing each other. After gaining the participants attention, the C_{rel} (e.g., "which is closer" or "which is farther") and the sample stimuli was presented; the participant was then allowed 3 seconds to respond. If the participant responded independently, praise and reinforcement were provided. If no independent response occurred, prompts in the form of a gesture, partial and/or full verbal (in the event that the participant was able to tact the images) or physical prompt were provided, followed by reinforcement for the correct response. If the trials included prompting and feedback (e.g., reinforcement), they were referred to as train trials. Trials without prompting or reinforcement for the correct response were also utilized, and called test trials. The purpose of test trials was to evaluate for derived relations of the skill and for generalization of the repertoire.

In order to move through each phase, the mastery criteria for train trials across all phases included a score of 90 or greater across 2 trial blocks. The mastery criteria for test trial blocks in each phase is a score of 90 or greater on the trial block (only one test block is run on each tested relation unless otherwise specified). Participants were required to meet mastery criteria on the train trials prior to beginning test trials, and meet mastery criteria on the test trial blocks of phase 2 prior to moving onto phase 3.

Phase 1 Baseline

Baseline consisted of 3 trial blocks of test trials, tested across 3 sessions in order to establish the current level of skills in the repertoire. The first of the three trial blocks consisted of mass trials testing close (A-B, B-A), using pairs of images of common objects each placed close or far on the table from the participant. The second trial block also consisted of mass trials using another pair of images of common objects, testing far (A-B, B-A). The final trial block consisted of 1 set of three pictures of states, two of which would be placed on the table in front of the participant, and they would be tested on each relationship. First would be A-B, “which is closer?” Then B-C “which is closer,” followed by B-A “which is farther,” C-B “which is farther.” And finally, A-C is tested “which is closer” and C-A “which is farther.”

Phase 2: Non-Arbitrary Training of Closer & Farther

Participants were initially trained using set 1 and set 2 of common objects on close and far (A-B) independently. The stimuli were presented for all trials as they were in baseline, one closer or farther on the table from the participant. Once mastery criteria was met for each of them, the B-A relation was tested for each using the set of stimuli for the opposite relation (set 1 was used to test far, set 2 used to test close). If mastery was not met for either of these tests, training was reinstalled with the original sets of stimuli. If they were not passed a second or more times, additional sets of stimuli were used for further training, while the test stimuli remained consistent. Once mastery criteria was met for the B-A tests, a test of grand mixed review was conducted with each set, meaning a-b and b-a of both close and far were assessed all with set 1 and then all with set 2. If the participant failed the grand mixed review of set 1, training of a-b was reinstalled with the most recent train stimuli set. If the participants failed the grand mixed review with set 2, training of a-b was reinstalled utilizing additional common objects. Mastery criteria remained the same if the additional a-b training was required. Probes with arbitrary stimuli were conducted every 3 train trial blocks during this phase.

Phase 3: Arbitrary Training of Closer and Farther

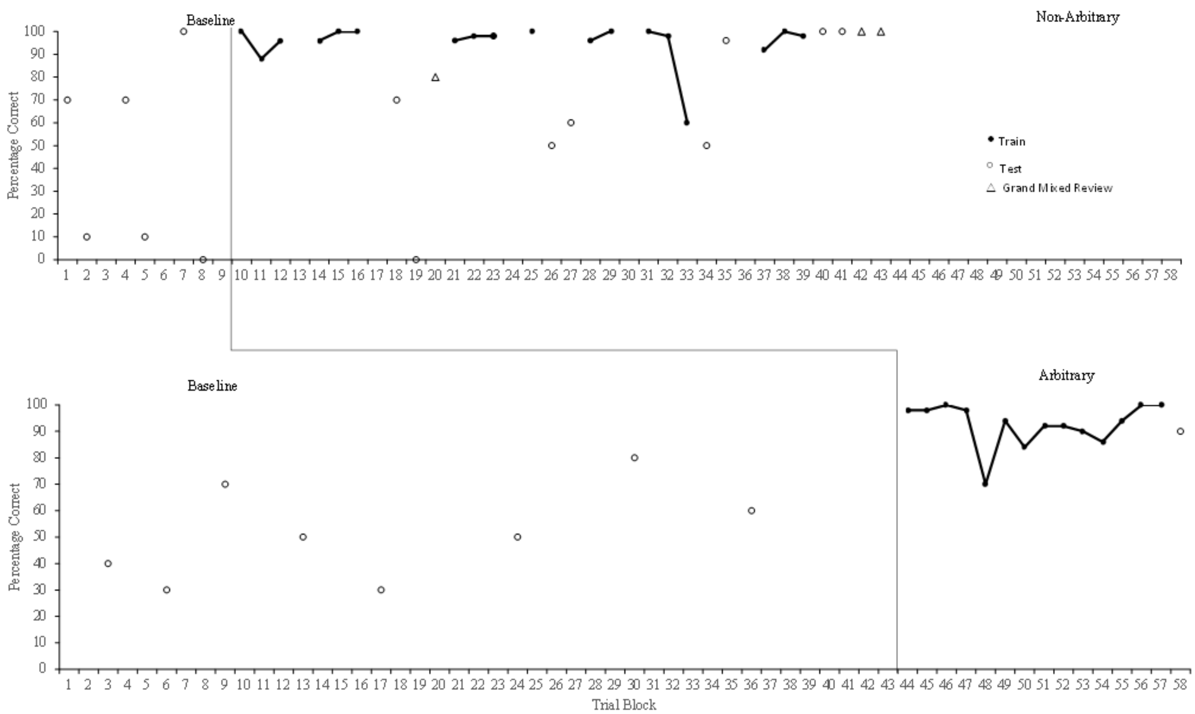
First, training was provided for the relation a-b and b-c with set 1 of states. This consisted of placing the a and b (or b and c) stimulus next to each other on the table, and presenting the C_{rel}, “which is closer.” When mastery criteria was met, test trials were conducted on the relations b-a, c-b, a-c, and c-a. For the test trials, the two respective stimuli were placed on the table next to each other, and the participant was asked the appropriate C_{rel} (“which is farther” or “which is closer). If the participant failed to demonstrate mastery of the derived combinatorially entailed relations, a second set of stimuli was utilized to train all relations. When all relations achieved mastery criteria from the second set of stimuli, the first set was used again and trained and tested as previously described.

Results

The results, as displayed in Figure 1, demonstrate the emergence of the spatial frames used to make relations between arbitrary stimuli for the first participant. During baseline, the first participant scored an average of 44.4%, but demonstrated a clear pattern of responding for each trial of selecting his most preferred images (e.g., when the spoon was present, he would select spoon for nearly all ten trials and pretend to eat from it). Following baseline, this participant required two additional exemplars during phase two prior to mastery of the test trial blocks. Scores for intermittent probing were variable, ranging from 30% to 80%, with an increasing trend. A single additional exemplar was trained for phase three, meaning all relations of the additional set were trained prior to the participant passing the test trials for the original set of stimuli. This participant was able to complete the program in 58 trial blocks.

Figure 1

Participant 1

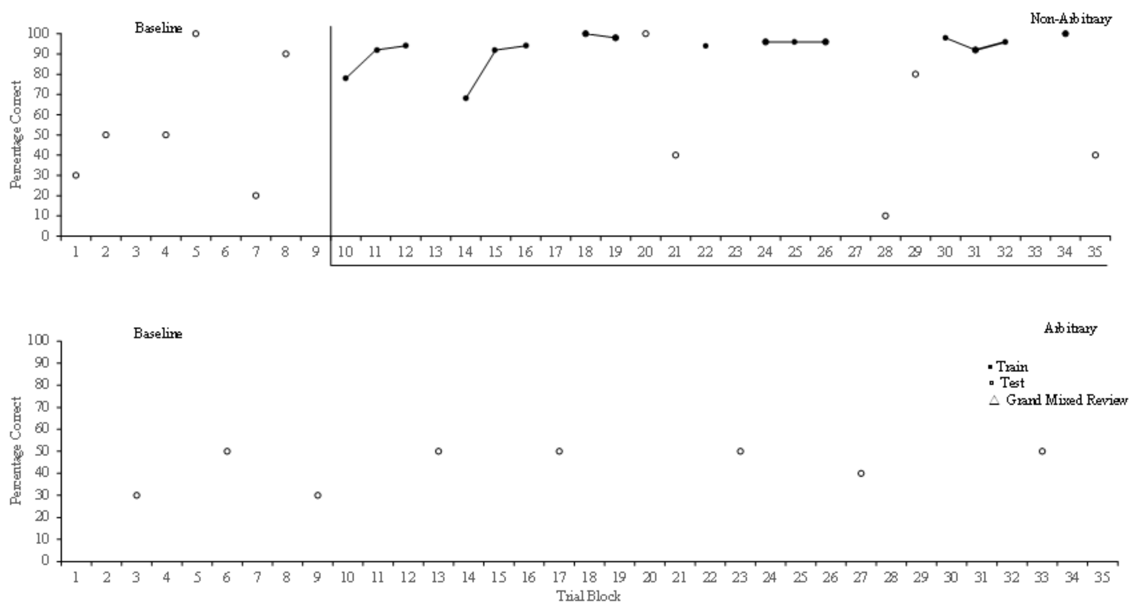


Note: This graph displays the percent of trials correct for train and test trial blocks of non-arbitrary close, non-arbitrary far, and arbitrary close and far relations for participant 1.

Participant 2 scored an average of 50% during baseline, and displayed a similar pattern in responding as participant 1, except he selected an image in his preferred position rather than a preferred image (i.e., he selected the closer image for every trial). For arbitrary trials during baseline, participant 2 scored consistently at a mid-level, between 30 and 50%, as displayed in Figure 2. For phase two, the participant reached mastery for train trials within 6 trial blocks, however he did not pass the test blocks. Additional training was implemented, and testing followed once mastery criteria was reached. This participant did not master test trials for phase two, indicating additional exemplars would have been needed for training. Scores were anticipated to progress similarly to participant 1, however it is possible participant 2 would have required additional exemplars that participant 1 did not need, in order to progress through the program.

Figure 2

Participant 2

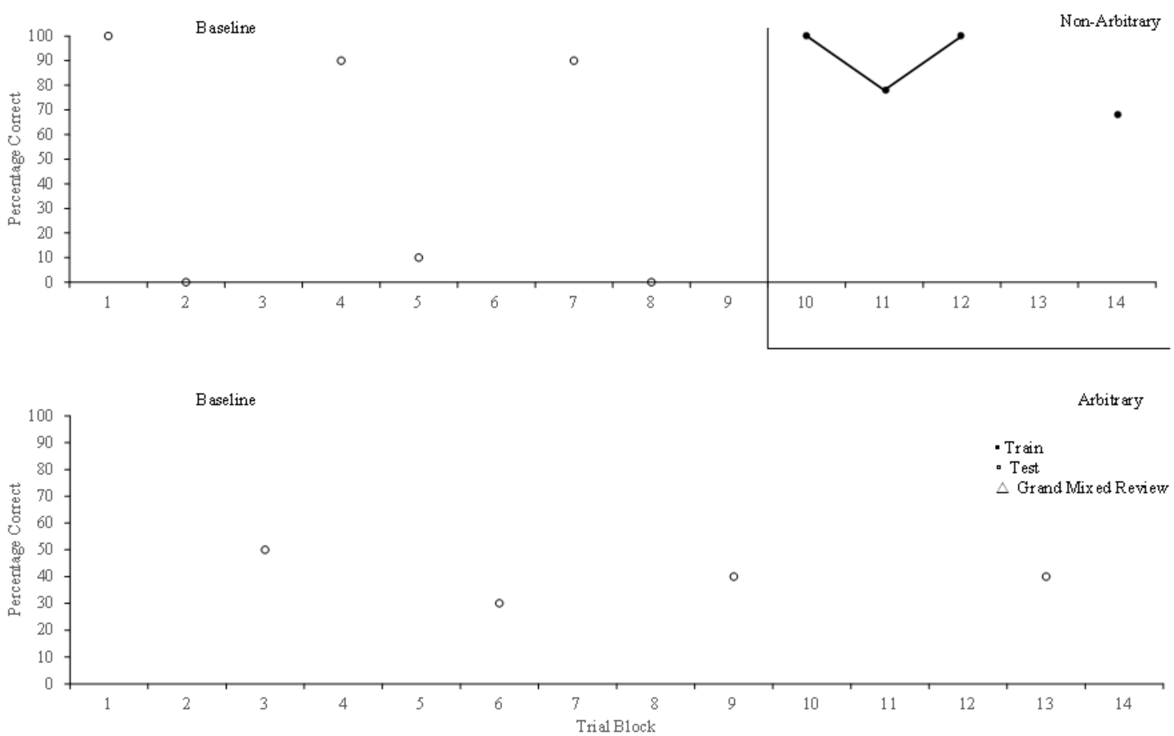


Note: This graph displays the percent of trials correct for train and test trial blocks of non-arbitrary close, non-arbitrary far, and arbitrary close and far relations for participant 2.

Participant 3 scored an average of 45% during baseline, and demonstrated a similar, yet opposite response pattern as participant 2 (i.e., she selected close for nearly every trial). As displayed in Figure 3, arbitrary trials scored at a mid level, ranging between 30 and 50%. Four trial blocks had been conducted for phase 2, and while this participant reached mastery criteria for close, additional trial blocks were needed to train far. Because this participant was still near the beginning of the program, it is unclear how many exemplars she may have needed before she passed the test trial blocks for both phase 2 and phase 3.

Figure 3

Participant 3



Note: This graph displays the percent of trials correct for train and test trial blocks of non-arbitrary close, non-arbitrary far, and arbitrary close and far relations for participant 3.

Discussion

Although two participants did not finish training in phase 1, the results of this study demonstrate that through training, children with autism are able to learn to non-arbitrarily receptively identify the prepositions “close” and “far”. Additionally, the non-arbitrary training of prepositions did not demonstrate changes in responding to arbitrary stimuli as observed through the intermittent probes. This indicates a connection needs to be made between them, which would occur by first training the C_{rel} with the non-arbitrary stimuli, then applying it to arbitrary stimuli through reinforcing correct responses. This established connection was demonstrated through participant 1. Following the presentation of the C_{rel}, correct responding to arbitrary stimuli was reinforced for an entire set of stimuli after originally failing to derive the additional relationships for the first set of stimuli. The participant was then able to combinatorially entail the additional relations untrained in the first set of stimuli.

The results of this study are limited in that while generalization was demonstrated in the non-arbitrary phase, in order to demonstrate over-arching generalization of deriving combinatorially entailed relations, at least one additional, novel set of states should have been introduced following mastery of the test trial block during the arbitrary phase. Additionally, this study only trained one pair of prepositions, which suggests these methods are effective at teaching “close” and “far,” but not necessarily other prepositions. During baseline, each of the participants demonstrated great variability in responding, particularly Participant 3, in that one trial block would score 100, then the next would score near 0 and continue. This could have been prevented by systematically randomizing the presentations of pictures so that 5 trials were presented with the correct answer on the right side, and 5 trials were presented on the left side, or similar.

Another limitation is that data collection was halted due to the clinic closing in response to the COVID-19 pandemic. During the implementation of this experiment, the clinic setting suspended direct services and thus further data could not be collected.

The present study addressed the limitations of Hicks et al. (2015, 2016), Mechling and Hunnicut (2011), and Sailor and Taman (1972) by using multiple exemplar training, individual training through DTT rather than group instruction, and demonstrated generalization of the non-arbitrary use of "close" and "far." This study also supported the findings of Daar et al. (2015), Belisle et al., (2016, 2019, in press), and Barron et al. (2018) in supporting the efficacy of relational training procedures within the PEAK-Transformation module.

Belisle et al., (2019, in press) suggested limitations of both experiments were that the participants were both able to demonstrate the non-arbitrary relations, make combinatorially entailed relations, and demonstrate non-arbitrary relations of the targets slower/faster, bigger/smaller prior to the start of the experiment. The present study addresses those limitations as it utilized children who have not demonstrated either of those skills, and although similar methods were utilized with different targets, suggests these procedures are effective at teaching these relational skills to a younger population with autism. However, the present study did not test for the transformation of stimulus function, which would have demonstrated relating non-arbitrary stimuli to arbitrary stimuli. As all three participants were between the ages of four and five, this testing for transformation of stimulus function would allow for researchers to state that individuals of this age group are able to develop and demonstrate this skill using the relational training procedures found in PEAK.

The arbitrary stimuli used within this study was selected as it has a use within real-world applications. Children who live in the United States of America will at some point during their early elementary school career learn about the states and about applying the prepositions close and far to them. This skill is especially useful as they get older for planning trips and determining which method of transportation to use. Although this study did not include many exemplars for the arbitrary phase, and only demonstrated the relationship between certain states and the current location of each of the participants, this particular skill can continue to be trained at home or within the school setting.

Future research would benefit from including additional prepositions to support the efficacy of these procedures toward any preposition. Although the participants were able to demonstrate the receptive use of "close" and "far," this study did not examine the effects of relational training procedures for training the expressive use of these prepositions. Future research should utilize relational training procedures that shift the receptive use of "close" and "far" to the expressive use, or utilize procedures to train the expressive use explicitly. Future research should also ensure additional stimuli are used in the arbitrary phase to demonstrate generalization of deriving combinatorially entailed relations, as well as test for the transfer of stimulus function while providing training on prepositions. Additionally, the arbitrary phase in the present study had all stimuli with the same function, meaning stimulus A was always the closest of the three, and stimulus C was always the farthest. In addition to providing additional stimuli for the arbitrary phase, it may be beneficial to train a set of stimuli where A is the farthest and C is the closest, to further demonstrate generalization.

In summary, children with autism frequently demonstrate delays with pragmatic language skills including the proper use of prepositions. The participants in the present study demonstrate the ability to learn how to non-arbitrarily receptively identify the prepositions close and far, and one participant demonstrated the ability to combinatorially entail relations between arbitrary stimuli following training to establish the connection of the C_{rel} between non-arbitrary and arbitrary stimuli. This study demonstrates that relational training methods as provided through the PEAK Transformation module of the PEAK Relational Training System continue to be supported as effective for teaching pragmatic language skills to individuals with autism.

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Appendix A

Table 1

Non-Arbitrary Stimuli Examples

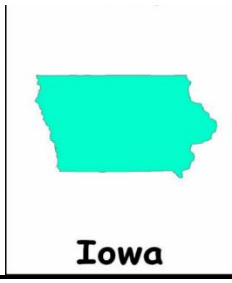
Close		Far	
Baseline Stimulus Set		Baseline Stimulus Set	
			
Stimulus Set 1		Stimulus Set 2	
			
Stimulus Set 3		Stimulus Set 4	
			
Stimulus Set 5		Stimulus Set 6	
			
Grand Mixed Review (Close and Far)			
			

Note: This table displays all of the non-arbitrary stimulus sets used for phase 1 and phase 2. The table displays an odd number of sets due to the single additional stimulus set for the second grand mixed review in phase 2.

Appendix B

Table 2

Arbitrary Stimuli Examples

A	B	C
Baseline and Probe Stimulus Set		
		
Stimulus Set 1		
		
Stimulus Set 2		
		

Note: This table displays all of the arbitrary stimulus sets used for phase 1 and phase 3. The columns labeled A, B, and C, are to designate the assigned position of the stimulus within the set. “A” indicates that the state is closest to the current location within the set, and “C” indicates that the state is the farthest from the current location within the set.

Appendix C

NORTHERN MICHIGAN UNIVERSITY

Graduate Studies and Research
Marquette, MI 49855-5301
906-227-2300
www.nmu.edu/graduatestudies/

Memorandum

TO: Alexandra Vacha
Psychological Sciences Department

CC: Jacob Daar

Sarah Dartt
Kendra Bloom
Callie Berg
Julianna Weir
Tiffanie Weeden
Victoria Mattson
Psychological Sciences Department

FROM: Dr. Lisa Schade Eckert
Dean of Graduate Education and Research

DATE: August 16, 2019

SUBJECT: IRB Proposal HS19-1055
"Using Relational Frame Theory to Teach Prepositions to Children with Autism"
IRB Approval Date: 8/16/2019
Expiration Date: 8/15/2020
Proposed Project Dates: 8/16/2019 – 8/15/2020

Your proposal "Using Relational Frame Theory to Teach Prepositions to Children with Autism" has been approved by the NMU Institutional Review Board. Include your proposal number (HS19-1055) on all research materials and on any correspondence regarding this project.

A. If a subject suffers an injury during research, or if there is an incident of non-compliance with IRB policies and procedures, you must take immediate action to assist the subject and notify the IRB chair (dereande@nmu.edu) and NMU's IRB administrator (leckert@nmu.edu) within 48 hours. Additionally, you must complete an Unanticipated Problem or Adverse Event Form for Research Involving Human Subjects

B. Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant.

C. If you find that modifications of investigators, methods, or procedures are necessary, you must submit a Project Modification Form for Research Involving Human Subjects before collecting data.

D. If you complete your project within 12 months from the date of your approval notification, you must submit a Project Completion Form for Research Involving Human Subjects. If you do not complete your project within 12 months from the date of your approval notification, you must submit a Project Renewal Form for Research Involving Human Subjects. You may apply for a one-year project renewal up to four times. Failure to submit a Project Completion Form or Project Renewal Form within 12 months from the date of your approval notification will result in a suspension of Human Subjects Research privileges for all investigators listed on the application until the form is submitted and approved.

All forms can be found at the NMU Grants and Research website:
http://www.nmu.edu/grantsandresearch/node/102

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Marquette, MI 49855-5301
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MEMORANDUM

TO:	Ally Vacha Psychological Science Department
CC:	Jacob Daar Psychological Science Department
DATE:	February 7, 2020
FROM:	Lisa Schade Eckert, Ph.D. Dean of Graduate Education and Research
RE:	Modification to HS19-1055 Original IRB Approval Date: 8/16/2019 Modification Approval Date: 2/7/2020 "Using Relational Frame Theory to Teach Prepositions to Children with Autism"

Your modification for the project "Using Relational Frame Theory to Teach Prepositions to Children with Autism" has been approved by the Northern Michigan University Institutional Review Board. Please include your proposal number (HS19-1055) on all research materials and on any correspondence regarding this project.

Any additional personnel changes or revisions to your approved research plan must be approved by the IRB prior to implementation. Unless specified otherwise, all previous requirements included in your original approval notice remain in effect.

If you have any questions, please contact the IRB at hsrr@nmu.edu.

NORTHERN MICHIGAN
UNIVERSITY

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Marquette, MI 49855-5301
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MEMORANDUM

TO: Alexandra Vacha
Jacob Daar
Psychological Sciences Department

CC: Sarah Dartt
Kendra Bloom
Callie Bergeron
Julianna Weir
Tiffanie Weeden
Victoria Mattson
Vanessa Buyarski
Amy Edwards
Breanna Henes
Saby Higueros
Danielle Keough
Hollie Koning
Gabrielle Nitti
Seth Pelkie
Jordan Porter
Lori Seguin
Carter Sperstad
Psychological Sciences Department

DATE: November 6, 2019

FROM: Lisa Schade Eckert, Ph.D.
Dean of Graduate Education and Research

RE: Modification to HS19-1055
Original IRB Approval Date: 8/16/2019
Expiration Date: 8/15/2020
Modification Approval Date: 11/6/2019
"Using Relational Frame Theory to Teach Prepositions to Children with Autism"

Your modification for the project "Using Relational Frame Theory to Teach Prepositions to Children with Autism" has been approved by the Northern Michigan University Institutional Review Board. Please include your proposal number (HS19-1055) on all research materials and on any correspondence regarding this project.