EFFECTS OF CATEGORY AND EXEMPLAR TRAINING ON EMERGENT INTRAVERBAL RELATIONS

by

CHARLOTTE LYNN CARP

Bachelor of Science, 2004
Texas Christian University
Fort Worth, Texas

Submitted to the Graduate Faculty of the
College of Science and Engineering
Texas Christian University
in partial fulfillment of requirements
for the degree of

Master of Science

May 2010

ACKNOWLEDGEMENTS

My sincere thanks to the individuals whose support and guidance have helped me reach this milestone:

First and foremost, I thank God, and give Him all glory and praise.

To Dr. Anna Petursdottir, for your willingness to advise me through this project. I am blessed to have you as my mentor. I cannot thank you enough for your continued support, and for your commitment to me as my academic advisor.

To Dr. Gary Boehm, I am grateful for the support you provide and the confidence you help me find in myself.

To my committee members, Dr. David Cross and Dr. Mauricio Papini, whose expertise and guidance helped to shape this project.

To Dr. Einar Ingvarsson and Duy Lee, as well as all workers and friends at the Child Study Center, whose research advice and support has helped guide me, I cannot thank each of you enough.

To Derek Matthies and Jared Kronwitter for all of your hard work and insight.

To good friends and classmates (Crystal, Tiffany, Rachel, Tracy, Kristina, Dandy, Sean, Tami, Casey, and Cooper), for whose continual support, good humor, and advice I will be forever grateful.

Last, but certainly not least, this thesis is dedicated to my family and my cat Titan (☺), whom I love and cannot begin to thank enough. I would not be the woman I am without everybody's love and strength. Everybody's unconditional love, patience, and the difficult sacrifices each of you have endured made this possible.

TABLE OF CONTENTS

Acknowledgements…………………………………………………………………..……ii

List of Figures……………………………………………………………………………..v

List of Tables…………………………………………………………………………..….vi

I. Introduction…………………………………………………………...…...1

Intraverbal Behavior…………………………………………………3

Intraverbal Behavior and Stimulus Equivalence………………..……5

Conditional Discriminations………………………………….…...8

Purpose of the Present Study………………..……………………10

II. Methods

Participants and Setting……………………………………………..11

Stimuli………………………………………………...……….12

Measurement…………………………………………………..…14

Procedure………………………………………………..……….15

III. Results

Category Training……………………………………………………..21

Exemplar Training…………………………………………………….25

Analysis of Incorrect Responses to Probe Trials…………………...32

Trials to Criterion……………………………………………………...33

IV. Discussion

Overview of Results…………………………………………………..34

Category and Exemplar Training…………………………………..35

Effects of Repeated Training and Testing………………………….38

Additional Observations……………………………………………44

Future Research…………………………………………………….47

References…………………………………………………...……………..50

Vita

Abstract

LIST OF FIGURES

1. Results by Relation for Justin……………………………………..………..…22

2. Results by Relation for Matt…………………………………………..…....23

3. Results by Relation for Chris……………………………………………..…24

4. Summary of Results from Category Participants…………………………...26

5. Results by Relation for Nathan ………………………...……………..27

6. Results by Relation for Aaron…………………………………………………28

7. Results by Relation for Marcus………………………………………………..29

8. Summary of Results from Exemplar Participants……………………..……………31

LIST OF TABLES

1. Intraverbals Taught and Probed……………………………………………………….12

2. Category Intraverbals………………………………………………………………….13

3. Exemplar Intraverbals……………………………………………………………......13

4. Trials to Criterion……………………………………………………………………...32

EFFECTS OF CATEGORY AND EXEMPLAR TRAINING ON EMERGENT INTRAVERBAL RELATIONS

Section I. Introduction

Language is a powerful and unique tool that humans use to communicate and relay information to and from one another. According to Skinner's (1957) behavioral perspective, language or verbal behavior can be described in terms of stimulus control and reinforcement history by both a speaker and a listener. Skinner's basic assumption was that human verbal behavior is operant behavior that is controlled by specific antecedent and consequent stimuli. An antecedent stimulus precedes the target behavior (e.g., seeing a cat before emitting the verbal response "cat") and may function, for example, as a discriminative stimulus (S^D). A consequent stimulus occurs immediately after the target behavior (e.g., receiving praise for emitting the correct verbal response "cat" after seeing a cat), and may function, for example, as a positive reinforcer (Catania, 2007). Skinner (1957) classified verbal behavior into several types of verbal operants. A verbal operant consists of a verbal response and the antecedent and consequence stimuli to which it is functionally related. One operant is the mand, in which a state of deprivation or an aversive stimulus evokes a verbal response due to a history of response-specific reinforcement. The need for something to drink may evoke the vocal response "milk," which is reinforced by receiving milk. Another operant is the tact, in which a nonverbal stimulus evokes a verbal response due to a history of generalized or nonspecific reinforcement. Because a child has been praised in the past for emitting the response "dog" in the presence of a certain stimulus, the sight of a dog may evoke the verbal response "dog." Other verbal operants include echoic, textual, and intraverbal behavior, all of which are under discriminative control of a prior verbal stimulus. In echoic and textual behavior, there is point-to-point correspondence between stimulus and response. In the echoic relation, the antecedent stimulus is an auditory verbal stimulus that evokes a vocal response that produces the same sound pattern as the antecedent stimulus (e.g., saying "Good morning" in response to hearing someone else say "Good morning"). In the textual relation, a written verbal stimulus is the antecedent stimulus that evokes the same vocal verbal stimulus as the response (e.g., reading). Intraverbal behavior is also controlled by a prior verbal stimulus, but there is no point-to-point correspondence between the stimulus and the response. Intraverbal behavior incorporates the questions, sequences, conversations, etc. that make up verbal repertoires (e.g., saying "I'm doing well" in response to hearing someone else say "Good morning, how are you?").

Skinner's work has had a substantial influence on the fundamental ideas and techniques of behavior analysis. Recent decades have seen an increase in the volume of literature in this area of about three times compared to 1963 to 1988 (Sautter & LeBlanc, 2006). New theoretical extensions of Skinner's analysis have been proposed and have generated programs of basic and applied research attributing to this increase. Some examples of theoretical extensions are Relational Frame Theory, discussed in Hayes, Barnes-Holmes, and Roche (2001), and the Naming Hypothesis developed by Horne and Lowe (1996). These recent theoretical approaches emphasize the analysis of novel or emergent verbal behavior which is defined as verbal behavior that has not been previously reinforced. Emergent verbal behavior is an important extension of Skinner's work because, although Skinner proposed that verbal operants were established by social reinforcement, people often emit novel forms of verbal behavior without direct reinforcement. Skinner acknowledged this issue, and in *Verbal Behavior* assumed that known principles of behavior could account for the emergence of such novel behavior; however, he did not elaborate on the specific mechanisms that might be involved. The more recent theoretical extensions have brought attention to identifying the variables that may promote emergence of novel verbal behavior, and may be of considerable applied importance. The identification of these variables may aid in the design of language interventions that could be helpful to clients, including children with autism.

Intraverbal Behavior

Intraverbal behavior is a form of verbal behavior controlled by a verbal stimulus in which there is no point-to-point correspondence between the response and the stimulus (Skinner, 1957). Intraverbal behavior can go from the simple behavior of emitting chains of verbal stimuli and filling in words to simple phrases (e.g., saying the alphabet or saying "go" in the presence of "ready, set, …") to more complex questions and stating members of categories (e.g., "When are you coming home?", responding "towel, sunscreen, and toys" to "What are some things that you take to the beach?"; Axe, 2008). Typically developing children may develop their intraverbal repertoires due to their exposure to many different contexts in their verbal community, including conversations, songs, and stories (Axe, 2008). Furthermore, intraverbal behavior has been hypothesized to facilitate the acquisition of academic and social behavior. Therefore, some researchers suggest that early childhood education should focus attention on training intraverbal relations (Partington & Bailey, 1993; Sundberg & Michael, 2001).

There are three main categories of applied research that target establishing intraverbal relations. The first category includes studies that test procedures intended to establish intraverbals through direct reinforcement in children with developmental disabilities. Two procedures have typically been evaluated: (a) a trial-and-error intraverbal training that included reinforcement for correct responses and a time-out followed by an immediate prompt for incorrect responses and (b) an errorless discrimination procedure that used delayed prompting. Results showed that both procedures were sufficient to establish intraverbals, though emergence of novel intraverbals occurred less frequently in the errorless discrimination procedure (Braam & Poling, 1983; Luciano, 1986). To study echoic and textual verbal operants' effect on emergent intraverbal behavior, Finkel and Williams (2001) investigated the differential effects of transferring stimulus control from echoic and textual prompts to intraverbal behavior in a six-year-old boy with autism. Both prompting procedures were effective, but textual prompts resulted in faster rates of acquisition and improvement in full-sentence responses.

The second category of applied research consists of studies that evaluated the emergence of novel intraverbals as a function of establishing other verbal operants with young, typically developing children. Partington and Bailey (1993) examined the effects of tact training on the emergence of intraverbals. They found that tact training was not sufficient to establish intraverbal behavior, whereas direct intraverbal training was successful. Furthermore, other data indicate that listener training is not sufficient to facilitate the emergence of an intraverbal repertoire in the context of teaching categorization (Miguel, Petursdottir, & Carr, 2005; Petursdottir, Carr, Lechago, & Almason, 2008). However, one study by Petursdottir, Ólafsdóttir, & Aradóttir (2008) did show that both tact and listener training can produce greater effects on intraverbal responding with foreign-language vocabulary than prior research has shown using a less complex procedure involving one-on-one relations between stimuli and responses. Two children were given tact training (i.e., given a visual stimulus, the child was asked "What is this [animal or fruit] called in

Spanish?") and the other two were given listener training (i.e., the experimenter would place three visual stimuli on the table that were all animals or fruits, and the child was asked "Which [animal or fruit] is called [Spanish name]?"). When the intraverbal relation was tested, the two children showed that both types of training had an effect on the children's intraverbal repertoire; however, the emergent intraverbal relations were not necessarily bidirectional. In general, the limited emergence of intraverbals observed in these studies with typically developing children has been attributed to functional independence of verbal operants in early childhood (Partington & Bailey, 1993). The results suggest that preschool-age children often fail to acquire intraverbal behavior that is not directly trained.

Intraverbal Behavior and Stimulus Equivalence

A third category of research on intraverbals has investigated the effects of training specific intraverbal relations on the emergence of other intraverbal relations. The purpose of these studies has been to apply methods used in research on stimulus equivalence to the emergence of novel intraverbal behavior. A basic phenomenon in stimulus equivalence research is that if one teaches a typically developing human a few stimulus-stimulus relations, other non-taught stimulus relations termed *symmetry* and *transitivity* typically emerge without reinforcement (e.g., Sidman, 1994). For example, after learning that stimulus A is related to stimulus B and stimulus B relates to stimulus C, a person typically relates B to A and C to B (i.e., symmetry) as well as A to C and C to A (i.e., transitivity). Stimulus equivalence research, in general, is concerned with identifying variables that lead to emergence of novel stimulus control.

In stimulus equivalence research, the training and testing of stimulus-stimulus relations are typically conducted in match-to-sample format. However, three studies have investigated the effects of substituting vocal or typed intraverbal responses for match-to-sample responses in a stimulus equivalence paradigm. The emergence of novel symmetrical or transitive intraverbals requires not only novel stimulus control but may also involve novel responses or stimulus-response reversals. Polson and Parsons (2000) taught college students French-to-English or English-to-French relations by having them type English words in the presence of a textual stimulus on a screen that was the corresponding French word (A-B training), or vice versa (B-A training). They then tested B-A intraverbals if A-B intraverbals had been trained, and A-B intraverbals if B-A had been trained. They found that accuracy was greater when the reversal test involved the participants typing the English words. Therefore, when typed responses were substituted for match-to-sample responses, symmetry was dependent upon the direction of the trained relation. The researchers proposed that greater prior familiarity with the spelling of the English than the French words might be responsible; i.e., that familiarity with the intraverbal response facilitated symmetry. A second study conducted by Pérez-González, García-Asenjo, Williams, and Carnerero (2007) employed two children with pervasive developmental disorder (PDD) as participants. Both children were trained to respond intraverbally to questions such as "Name the opposite of hot" (A-B) and tested on the reverse intraverbal relation "Name the opposite of cold" (B-A). The training of A-B intraverbals was not sufficient by itself for B-A intraverbals to emerge. However, after some B-A relations were trained directly, other untrained B-A relations began to emerge. This study thus identified the training of multiple exemplars as another variable that might influence symmetry involving intraverbal relations.

Recently, a study by Pérez-González, Herszlikowicz, and Williams (2008) extended this research to the emergence of transitivity-like relations involving intraverbals. Two types of intraverbals were taught using Spanish countries, cities, and parks. The first intraverbal taught was the A-B Country-City intraverbal. The antecedent stimuli consisted of either (a) “Name the city of Argentina” with the correct response being “Buenos Aires” or (b) “Name the city of Uruguay”, to which the correct response was “Montevideo.” The second type of intraverbal taught was the B-C City-Park intraverbal. The antecedent stimuli consisted of (a) “Name the park of Buenos Aires”, to which the correct response was “el Botánico” or (b) “Name the park of Montevideo”, to which the correct response was “el Lecoc”. The emergence of novel intraverbals (B-A, C-B, A-C, and C-A) was tested after the A-B and B-C intraverbals had been trained. Only one out of the five children tested showed all the emergent intraverbals. In Experiment 2, Pérez-González et al. (2008) evaluated the effects of additional training conditions on the emergence of novel intraverbals. Each child was exposed to both category training and exemplar training along with the baseline A-B and B-C training. During category training, the antecedent stimuli were “What is ____ (“Argentina”, “Buenos Aires”, “El Botánico”, “Uruguay”, “Montevideo”, or “Lecoc”) and correct responses would consist of saying “country”, “city”, or “park” depending on the antecedent stimulus. During exemplar training, the antecedent stimuli were “Name a country (city or park)” to which a correct response would be “Argentina” or “Uruguay.” The next trial consisted of the antecedent stimulus “Name another country (city or park)” to which the correct response would be the other country. They found that all of the children demonstrated the B-A, C-B, A-C, and C-A intraverbals after being exposed to both category and exemplar training. A third experiment assessed whether novel country, city, and park relations would be acquired more rapidly across successive stimulus sets. Participants from Experiment 2 were exposed to both category and exemplar training with the novel stimuli as well as A-B

Country-City and B-C City-Park training. They showed that, in all four participants, the novel intraverbals emerged with successively fewer probes and errors.

Conditional Discriminations

In the Pérez-González et al. (2008) study, conditional discriminations were required in the tested intraverbals. A conditional discrimination is defined as a discrimination in which reinforcement of responding to a stimulus depends on (is conditional on) other stimuli (Catania, 2007). Catania (2007) offers the following example in which there is a food-deprived pigeon in a chamber with a lamp above a key. The available stimuli are triangles or circles on red or green backgrounds. When the lamp is on, pecks in the presence of triangles are reinforced; however, when the lamp is off, pecks in the presence of red are reinforced. Under these circumstances, when the lamp is on, the pigeon comes to peck triangles, but not circles, without regard to color. When the lamp is off, the pigeon comes to peck red keys, but not green, without regard to form. In other words, the form or color becomes the S^D and the conditional stimulus becomes the lamp. Whether the pigeon discriminates between form or color is conditional on whether the lamp is on or off.

Match-to-sample procedures, such as those commonly used in stimulus-equivalence research, involve the training of conditional discriminations. The participant is first shown a sample stimulus, and then asked to select another stimulus from a number of arranged stimuli. This task involves a conditional discrimination because the comparison selection that will be reinforced depends on the sample (Catania, 2007). In stimulus equivalence, for example, an A-B relation is taught in a match-to-sample procedure in which A is the sample stimulus and B is the correct comparison.

It has been argued that research on conditional discriminations must be integrated into research on teaching verbal operants as probabilities of verbal responses that vary with the presence of conditional and discriminative stimuli (Axe, 2008). In the intraverbal repertoire, a simple discrimination is when a person responds to only one verbal stimulus, for example, says “you’re welcome” after somebody has said “thank you.” The control of the verbal stimulus “thank you” over the verbal response “you’re welcome” is not dependent or conditional upon other stimuli. In a conditional discrimination, the response must come under control of two or more verbal stimuli. For example, if a person is asked, “What color is an apple?” a correct response is “red”. However, if the speaker is under control of only one part of the utterance (e.g., “apple” or “color”), then he has not made a conditional discrimination and, therefore may not give the correct response. He may say “fruit” (if responding to “apple”) or he may say “blue” (if responding to “color”). In conditional discriminations, a correct response is dependent on knowing that “color” is the conditional stimuli and “apple” is the S^D, or vice versa. Therefore, one verbal stimulus alters the evocative effect of the second verbal stimulus, and they collectively evoke an intraverbal response (Axe, 2008). To date, most research on intraverbals has focused on training simple discriminations, and only two studies (Braam and Poling, 1983; Pérez-González et al., 2008) have investigated conditional discriminations.

In the Pérez-González et al. (2008) study, the initial A-B and B-C training required participants only to make simple discriminations. For example, in A-B training, the questions were “Name the city of Argentina” and “Name the city of Uruguay.” The child only needed to discriminate between “Argentina” and “Uruguay” to respond correctly on each trial. A similar simple discrimination was required in B-C training. The questions were “Name the park of Buenos Aires" and "Name the park of Montevideo." The child only needed to discriminate between "Buenos Aires" and "Montevideo" to respond correctly on each trial. In the testing phase, the participant needed to make a conditional discrimination. For example, in the A-C relation, the antecedent stimulus was "Name the park of Argentina." Therefore, the conditional stimulus would be "park" and the S^D would be "Argentina." This is different from the trained B-C relation because the S^D is now a country and not a city. Furthermore, during training, the child was never required to discriminate "park" from "city." As a result, the child might continue responding to "Argentina" by saying "Buenos Aires." The relations involved in this task may therefore be more complicated than the simple training A-B, B-C, and testing of B-A, C-B, A-C, C-A relations proposed by Pérez-González et al. (2008). A more accurate description might be training XA-B and YB-C and testing the emergence of ZB-A, XC-B, ZC-A, and YA-C (X is the verbal stimulus "city," Y is the verbal stimulus "park," and Z is the verbal stimulus "country," and all three are constant, whereas A, B, and C vary across stimulus classes). Category name and exemplar training may have been effective because they addressed control by the X, Y, and Z stimuli over the B, C, and A responses, respectively, providing the foundation for conditional stimulus control over the emergent intraverbals.

Purpose of the Present Study

The present study was intended to extend the findings of the Pérez-González et al. (2008) study, and separate the effects of category and exemplar training to examine whether only one type of training might be sufficient to establish untrained intraverbals. Participants were first exposed to A-B and B-C training. After the training, category or exemplar training was conducted. One difference (besides the separation of category and exemplar training and some minor methodological differences) between the Pérez-González et al. (2008) study and the present study was the stimuli for the taught and probed intraverbals. The Pérez-González et al. (2008) study used Spanish speaking children; therefore, the antecedent stimuli were in Spanish and the Countries, Cities, and Parks were Spanish named places. The present study used English speaking children; therefore, the antecedent stimuli were in English, and consisted of States, Cities, and Parks from the United States. It was predicted that if one training condition was sufficient for the emergence of novel intraverbal relations, it would be exemplar training. Exemplar training may establish control by the verbal stimuli X (city), Y (park), and Z (country) over all responses that needed to be made during testing; therefore, the responses trained during exemplar training were the same as correct responses during the testing sessions. Category training might not be sufficient because the verbal stimuli X, Y, and Z would be responses in category training but stimuli during testing trials. Therefore, on test trials, the child would need to reverse the trained intraverbal relations to be able to respond correctly. Because of this, the child might not as easily acquire the conditional stimulus control necessary for novel intraverbals to emerge.

Section II. Methods

Participants and Setting

With their parents' permission, six children without any known developmental delays participated in the study. Four of the children (i.e., Justin, Matt, Nathan, and Aaron) were 6 years old at the time they entered the study, and two of the children (i.e., Chris and Marcus) were 7 years old at the time they entered the study. All children spoke English as their native language. Depending on the participant, sessions took place in either an empty preschool classroom or an empty elementary school library where the experimenter and child sat beside each other at a table. Sessions lasted approximately 20 to 30 min and were conducted up to 4 times a week. Children were rewarded by earning tokens on a token board. After a child filled up the token board, the experimenter rewarded the child with 5 minutes of play time.

Stimuli

Taught intraverbals. Four basic intraverbals were taught. Two intraverbals were A-B State-City relations and two intraverbals were B-C City-Park relations (see Table 1). For example, in the A-B intraverbal relations, one of the antecedent stimuli was "Name a city in Florida" and the correct response was "Branford"; in the B-C intraverbal, one of the antecedent stimuli was "Name a park in Branford" and the correct response was "Troy Springs." The other two A-B and B-C intraverbals were comparable, but they referred to "Utah," "Midway," and "Deer Creek."

Probed intraverbals. Eight additional intraverbals resulted from different combinations of the stimuli from the taught intraverbals (see Table 1). These novel intraverbals are termed B-A, C-B, A-C, and C-A relations.

Table 1
Intraverbals Taught and Probed

	Antecedent Stimuli	Correct Response
Teaching A–B State–City		
Name a city in [A1]	**[A1] Florida**	**[B1] Branford**
Name a city in [A2]	**[A2] Utah**	**[B2] Midway**
Teaching B-C City-Park		
Name a park in [B1]	**[B1] Branford**	**[C1] Troy Springs**
Name a park in [B2]	**[B2] Midway**	**[C2] Deer Creek**
Probing B-A City-State		
Name a state that [B1] is in	[B1] Branford	[A1] Florida
Name a state that [B2] is in	[B2] Midway	[A2] Utah
Probing C-B Park-City		
Name a city that [C1] is in	[C1] Troy Springs	[B1] Branford
Name a city that [C2] is in	[C2] Deer Creek	[B2] Midway

Probing A-C State-Park		
Name a park in [A1]	[A1] Florida	[C1] Troy Springs
Name a park in [A2]	[A2] Utah	[C2] Deer Creek
Probing C-A Park-State		
Name a state that [C1] is in	[C1] Troy Springs	[A1] Florida
Name a state that [C2] is in	[C2] Deer Creek	[A2] Utah

Categories. The category intraverbals were six intraverbals (see Table 2) in which the verbal antecedent stimuli were "What is …" followed by "Florida," "Branford," "Troy Springs," "Utah," "Midway," or "Deer Creek." The correct responses were "A state," "A city," or "A park." For example, the child was asked "What is Florida?" in which the correct answer was "A state."

Table 2
Category Intraverbals

	Antecedent Stimuli	Correct Response
Categories		
	What is Florida?	A State
	What is Utah?	A State
	What is Branford?	A City
	What is Midway?	A City
	What is Troy Springs?	A Park
	What is Deer Creek?	A Park

Exemplars. There were six exemplar intraverbals (see Table 3). The verbal antecedent stimulus was "Name a …", followed by "state," "city," or "park." A correct response was defined as one of the two state, city, or park exemplars used in the A-B and B-C relations. For example, the experimenter would say, "Name a state," to which a correct response would be either (a) "Florida" or (b) "Utah." On the next trial the experimenter would say, "Name another state," to which the remaining state would be the only correct response (e.g., if the child said "Utah" in the first trial then the only correct answer in the second trial would be "Florida").

Table 3
Exemplar Intraverbals

	Antecedent Stimuli	Correct Response
Exemplars		
	Name a state.	Florida
	Name a state.	Utah
	Name a city.	Branford
	Name a city.	Midway
	Name a park.	Troy Springs
	Name a park.	Deer Creek

Measurement

Dependent variable and scoring. The primary dependent variable was the number of correct intraverbal responses emitted during intraverbal probes. During testing, the experimenter recorded all responses on paper data sheets. The first response that the child made was the one that was recorded. A response was scored as correct if the child emitted the target vocalization within 10 seconds of the verbal stimulus. A response was scored incorrect if the child emitted a vocalization that was not the target vocalization, or if the child did not respond within 10 seconds of the verbal stimulus. The data were collected in a similar manner during training, except that the child had to respond within 5 seconds of the verbal stimulus.

Interobserver agreement. A second observer independently recorded data from at least 25% of all A-B and B-C, category, and exemplar training sessions and 100% of the intraverbal probes. For each training trial, point-by-point agreement was evaluated in which either an agreement or a disagreement between the two observers was scored. An agreement was defined as both observers recording a correct response or both observers recording an incorrect response. Point-by-point agreement was calculated by dividing the number of agreements by the sum of agreements and disagreements and then converting this ratio into a percentage. Mean agreement for A-B and B-C, category, and exemplar training was 100 % for Justin, 100 % for Matt, 100% for Chris, 94.45 % for Nathan, 99.64 % for Aaron, and 100 % for Marcus.

For the intraverbal probes, interobserver agreement was calculated using point-by-point agreement in the same manner as for training sessions. Mean agreement for intraverbal probes was 100 % for Justin, 100 % for Matt, 99.17% for Chris, 100 % for Nathan, 100 % for Aaron, and 100 % for Marcus.

Procedure

Experimental design. A non-concurrent multiple baseline design across subjects was used to evaluate the effects of category training for three participants and exemplar training for three participants. First, 2 pre-training probe sessions (each probe session consisted of the 12 intraverbal relations) were conducted to ensure that the child did not already know the intraverbal relations at the beginning of the study (if a participant had provided correct responses in the pre-training probes, then new verbal stimuli would have been be selected for that participant). Second, the baseline A-B State-City and B-C City-Park intraverbals were taught and 4 probe sessions were conducted. If participants did not pass the probes for the trained A-B and B-C relation, the baseline training and probes were repeated. Third, participants received either category or exemplar training. Category training or exemplar training was staggered across the A-B and B-C baselines. Two children were scheduled to receive category or exemplar training immediately following probes after A-B and B-C training, whereas two of the remaining children were scheduled to receive one additional round of A-B and B-C training followed by 4 additional probe sessions, and the remaining two children were scheduled to receive two additional rounds of A-B and B-C training followed by 4 additional probe sessions. This was done to control for the amount of training and testing, as well as for learning outside the experiment. If novel intraverbals emerged to criterion before the scheduled baseline training was completed, no further training was conducted. Finally, after the child received category or exemplar training, 4 probe sessions were conducted again. The acquisition criterion for each probed relation was 2 out of 2 correct responses on 2 out of the 4 probe sessions. If novel intraverbals did not emerge after either category or exemplar training, then the alternate training was conducted (e.g., if a participant received category training and it was not sufficient for novel intraverbals to emerge than exemplar training would be conducted and followed by probes, and vice versa), followed by intraverbal probes.

Probes of the 12 intraverbals. All 12 intraverbals shown in Table 1 were presented in a random sequence each session. The 12 intraverbals were probed a minimum of 4 times, except during pre-training probe sessions in which the intraverbals were probed a minimum of 2 times. The experimenter gave the following instructions to the child during intraverbal probe sessions: “I am not going to tell you whether your responses are right or wrong, but when we are done, you will get a bunch of tokens. You should try to respond correctly though, because you will get even more tokens for correct answers at the end.” All probes were given with the experimenter sitting behind the child to minimize the effects of experimental cueing. The experimenter did not present any consequence for an incorrect or a correct response on these trials, and the next question was given immediately following a response or if no response was made within 10 s after the verbal stimulus had been presented.

Teaching A-B State-City. State-City intraverbals were taught in three phases. In Phase 1, the first two trials contained an immediate prompt. The experimenter said, “Name a city in Florida” [A1] followed by the correct answer “Branford” [B1]. The next two trials contained a 2- s prompt delay, and the remaining trials contained a 5-s prompt delay. The child was praised and awarded a token for each correct response; however, if the child made an incorrect response, the experimenter prompted the child by modeling the correct response and no token was given. The child moved onto phase 2 when 3 correct consecutive responses were made with no prompt. Phase 2 was identical to Phase 1, except the antecedent stimulus was “Name a city in Utah” [A2] with the correct response being “Midway”[B2]. The child moved onto phase 3 when 3 correct consecutive responses were made with no prompt. In Phase 3, the two questions from phases 1 and 2 were randomly intermixed. Each trial contained a 5-s prompt delay. Phase 3 continued until the child made 6 consecutive correct responses with no prompts. If the child underwent 16 consecutive trials in which no more than 8 correct responses were emitted, then Phase 1 and Phase 2 were repeated.

Teaching B-C City-Park. The City-Park intraverbals were taught exactly as the State-City intraverbals were taught. The only difference was the stimuli: (a) “Name a park in Branford” [B1], to which the correct response was “Troy Springs” [C1] and (b) “Name a park in Midway” [B2], to which the correct response was “Deer Creek” [C2].

Teaching A-B State-City and B-C City-Park mixed. In this condition, the experimenter presented blocks of four trials in which the four A-B State-City and B-C City-Park intraverbals were randomly intermixed. The child had to complete two conditions: (a) an FR1 schedule and (b) a correction-only condition. During FR1, the child was praised and awarded a token for each correct response. If the child emitted an incorrect response, the experimenter prompted the child with the correct response, using a 5-s prompt delay, and no token was given. To move on to the correction-only condition, the child had to make correct consecutive responses in 3 blocks with no prompts. If the child underwent 8 consecutive blocks in which (a) there was no upward trend and (b) the average number of correct responses per block was 3 or less, then the participant repeated phase 3 of both A-B and B-C relations. During the correction-only condition, the child received no praise for correct answers but was prompted with the correct response if an incorrect response was made. The child received a number of tokens after a block, but the number and delivery of tokens was not contingent on performance. To meet the criteria in the correction control condition, the child had to make correct consecutive responses in 3 consecutive blocks. If the child underwent 8 consecutive blocks in which (a) there was no upward trend and (b) the average number of correct responses per block was 3 or less, then the participant went back to the FR1 condition.

Teaching categories. Categories were taught in five phases. In Phase 1, two stimuli were randomly intermixed. The stimuli consisted of (a) “What is Utah?” to which the correct response was “A state,” and (b) “What is Branford?” to which the correct response was “A city.” The child was praised and awarded a token for each correct response. If the child made an incorrect response, the experimenter prompted the child by modeling the correct response, using a 5-s prompt delay, and no token was given. After the child emitted 6 consecutive correct responses with no prompt, Phase 2 commenced. Phase 2 was identical to Phase 1 except that the stimuli consisted of (a) “What is Deer Creek?” to which the correct response was “A park,” and (b) “What is Florida?” to which the correct response was “A state.” In Phase 3, the four intraverbals that were taught in Phases 1 and 2 were randomly intermixed.

The child was praised and awarded a token for each correct response; however, if the child emitted an incorrect response, the experimenter prompted the child with the correct response, using a 5-s prompt delay, and no token was given. After the child emitted 12 consecutive correct responses with no prompt the experimenter moved to Phase 4. If the child underwent 16 consecutive trials in which no more than 8 correct responses were emitted, then Phase 1 and Phase 2 were repeated. Phase 4 was identical to Phase 1 except that the stimuli consisted of (a) "What is Midway?" with the correct response being "A city" and (b) "What is Troy Springs?" with the correct response being "A park." In Phase 5, the six intraverbal relations taught in Phases 1, 2, and 4 were presented in blocks. One block consisted of six trials that included each of the six intraverbals randomly intermixed. The child had to meet the criteria in (a) an FR1 schedule and (b) a correction-only condition. The procedure for the FR1 and correction-only conditions was the same as in the A-B and B-C mixed training except for the criterion to return to previous phases. If the child underwent 8 consecutive blocks in which (a) there was no upward trend and (b) the average number of correct responses per block was 5 or less, then the child returned to the previous condition (i.e., if the child was in the correction-only condition) or to Phase 1 (i.e., if the child was in the FR1 condition).

Teaching Exemplars. In exemplar training, there were two correct responses to each question presented; therefore, each verbal antecedent stimulus was presented for two consecutive trials. On the first trial any response with either exemplar was correct, and on the second trial the remaining exemplar was correct. Exemplars were taught in five phases. In Phase 1, the verbal stimuli were either "Name a state" or "Name another state." Each trial contained a 5-s prompt delay. The child was praised and awarded a token for each correct response; however, if the child emitted an incorrect response, the experimenter prompted the child with the correct response and no token was given. To move on to Phase 2, the child had to response correctly to six consecutive trials. Phase 2 was identical to Phase 1 except the verbal stimuli were either “Name a city” or “Name another city.” In Phase 3, pairs of trials with the stimuli from Phases 1 and 2 were intermixed. This phase continued until the child emitted 12 consecutive correct responses. If the child underwent 16 consecutive trials in which no more than 8 correct responses were emitted, then Phase 1 and Phase 2 were repeated. Phase 4 was identical to Phase 1 except the verbal stimuli were either “Name a park” or “Name another park.” Phase 5 was similar to Phase 3, except pairs of trials with the three stimuli from Phases 1, 2, and 4 were presented in blocks. One block consisted of two contiguous presentations of each of the three stimuli, and thus required the child to make each of the six possible responses. The child had to meet the criteria in (a) an FR1 condition and (b) a correction-only condition. The procedure for the FR1 and correction control conditions were the same as in the A-B and B-C mixed training except for the criterion to return to previous phases. If the child underwent 8 consecutive blocks in which (a) there was no upward trend and (b) the average number of correct responses per block was 5 or less, then the the previous condition (i.e., if the child was in the correction-only condition) or to Phase 1 (i.e., if the child was in the FR1 condition).

A-B State-City and B-C City-Park Maintenance. During category and exemplar training, the experimenter presented one block per session of the four trained A-B and B-C relations. This was done to ensure that the participant maintained the trained relations. All maintenance blocks were conducted using the correction-only procedure. If the participant demonstrated correct responding on all four trials of the maintenance block, then the participant proceeded with category or exemplar training. If one or more incorrect responses were made on a maintenance block, then the participant went back to the correction-only phase of A-B and B-C mixed training. The participant was required to meet the criteria of the correction-only condition before proceeding with category or exemplar training.

Section III. Results

Category Training

Figures 1, 2, and 3 contain the individual data of the probe trials for each relation. No participant responded correctly on any pre-training trials in baseline. Following A-B and B-C training, all three participants passed the test of the trained A-B and B-C relations, but none demonstrated the emergence of all four novel relations to criterion. For Justin, the only relation that emerged following A-B and B-C training was the C-B relation. Justin was exposed to only one round of A-B and B-C training before category training was administered, whereas Matt and Chris were exposed to two rounds. For Matt, no relations emerged following the first or second round of A-B and B-C training. For Chris, all four novel intraverbals emerged following the first round of A-B and B-C training; however, some inconsistent responding occurred for the transitive relations, and criterion was not met. Following the second round of A-B and B-C training, all relations emerged and criterion was met. Following category training, neither Justin nor Matt demonstrated the emergence of all eight novel intraverbals. For Justin, the C-B relation was maintained and the A-C relation emerged. For Matt, no relations emerged following category training. Following exemplar training, Justin demonstrated the emergence of all novel relations; however, none of the novel relations emerged for Matt.

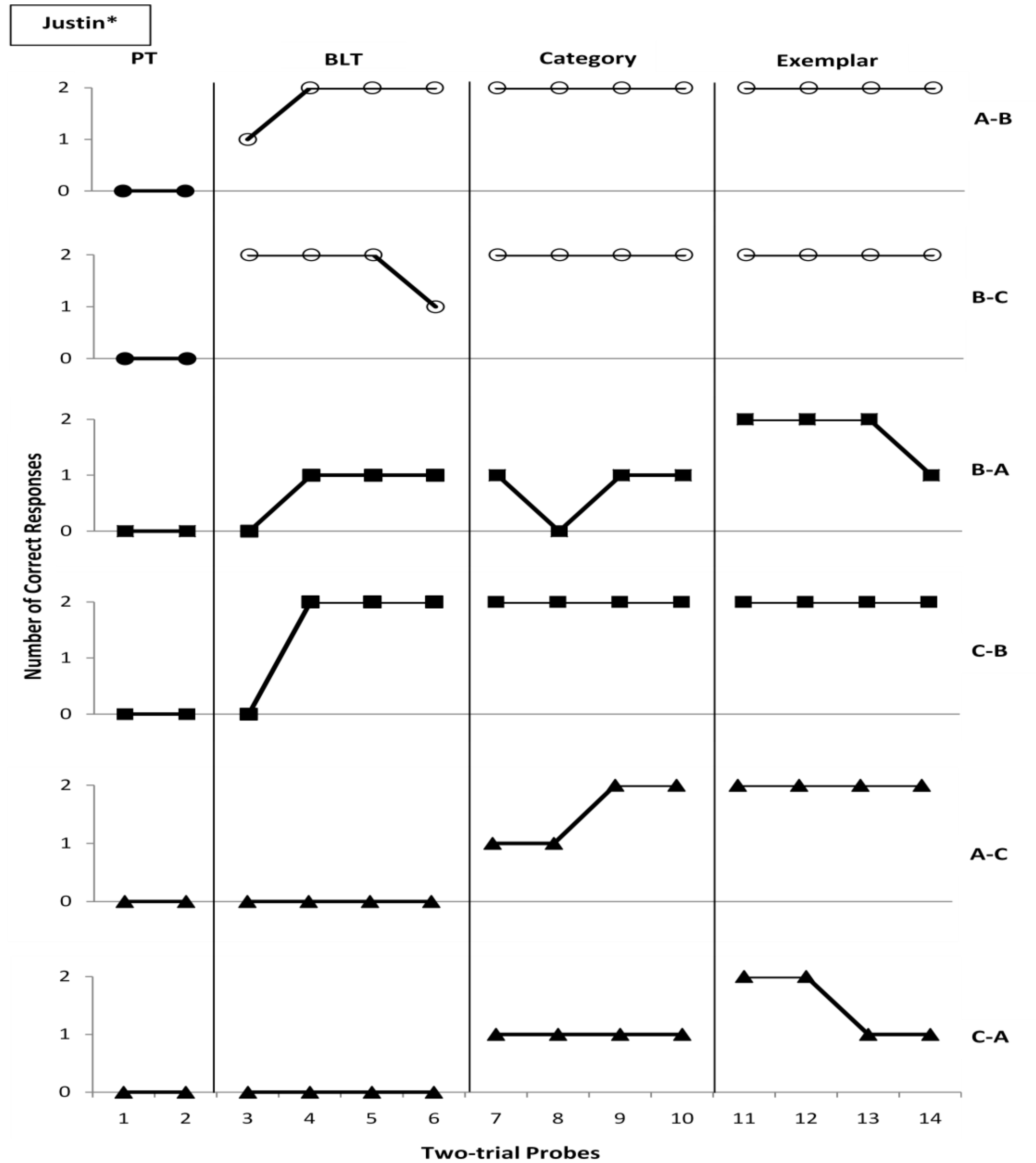

Figure 1. Correct responses to the probe of the 12 intraverbals for Justin. The "*" indicates that all novel relations emerged. Filled data points represent data of intraverbals that were not taught. Open data points represent data of intraverbals after being taught (A-B and B-C). Circles represent baseline relations, squares represent symmetric relations, and triangles represent transitive relations. "PT" indicates pre-training data, "BLT" indicates data following baseline training (i.e., A-B and B-C training), and the numbers beside "BLT" (e.g., 2 and 3) indicate additional rounds of baseline training. "Category" indicates category training, and "Exemplar" indicates exemplar training. One probe block consisted of 12-trials, and represents one column of data points. Teaching data are not presented in the figure. Solid lines represent when the participant was first exposed to a certain training (i.e., baseline, exemplar, or category).

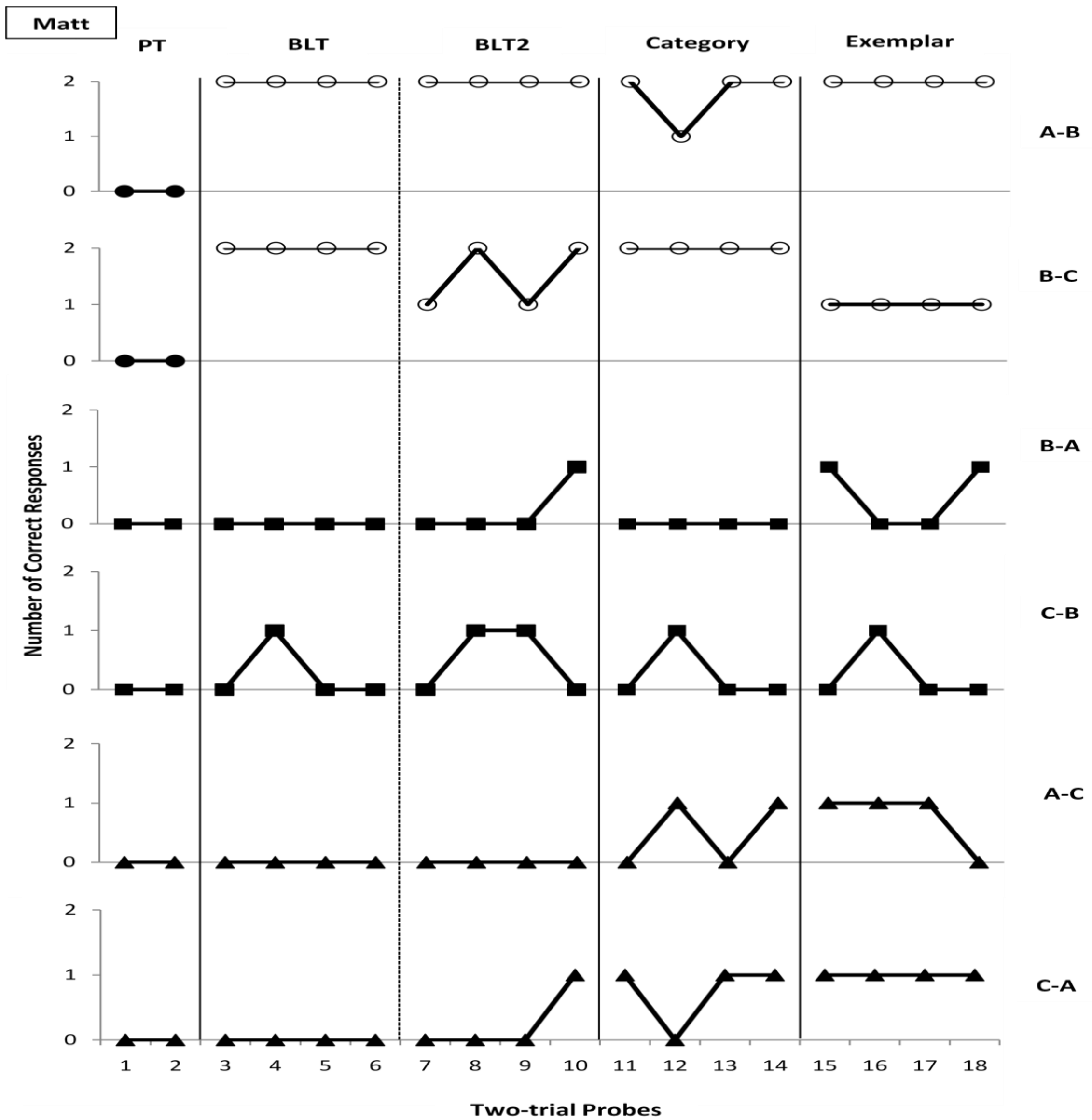

Figure 2. Correct responses to the probe of the 12 intraverbals for Matt. Filled data points represent data of intraverbals that were not taught. Open data points represent data of intraverbals after being taught (A-B and B-C). Circles represent baseline relations, squares represent symmetric relations, and triangles represent transitive relations. "PT" indicates pre-training data, "BLT" indicates data following baseline training (i.e., A-B and B-C training), and the numbers beside "BLT" (e.g., 2 and 3) indicate additional rounds of baseline training. "Category" indicates category training, and "Exemplar" indicates exemplar training. One probe block consisted of 12-trials, and represents one column of data points. Teaching data are not presented in the figure. Solid lines represent when the participant was first exposed to a certain training (i.e., baseline, exemplar, or category), and dotted lines represent additional training.

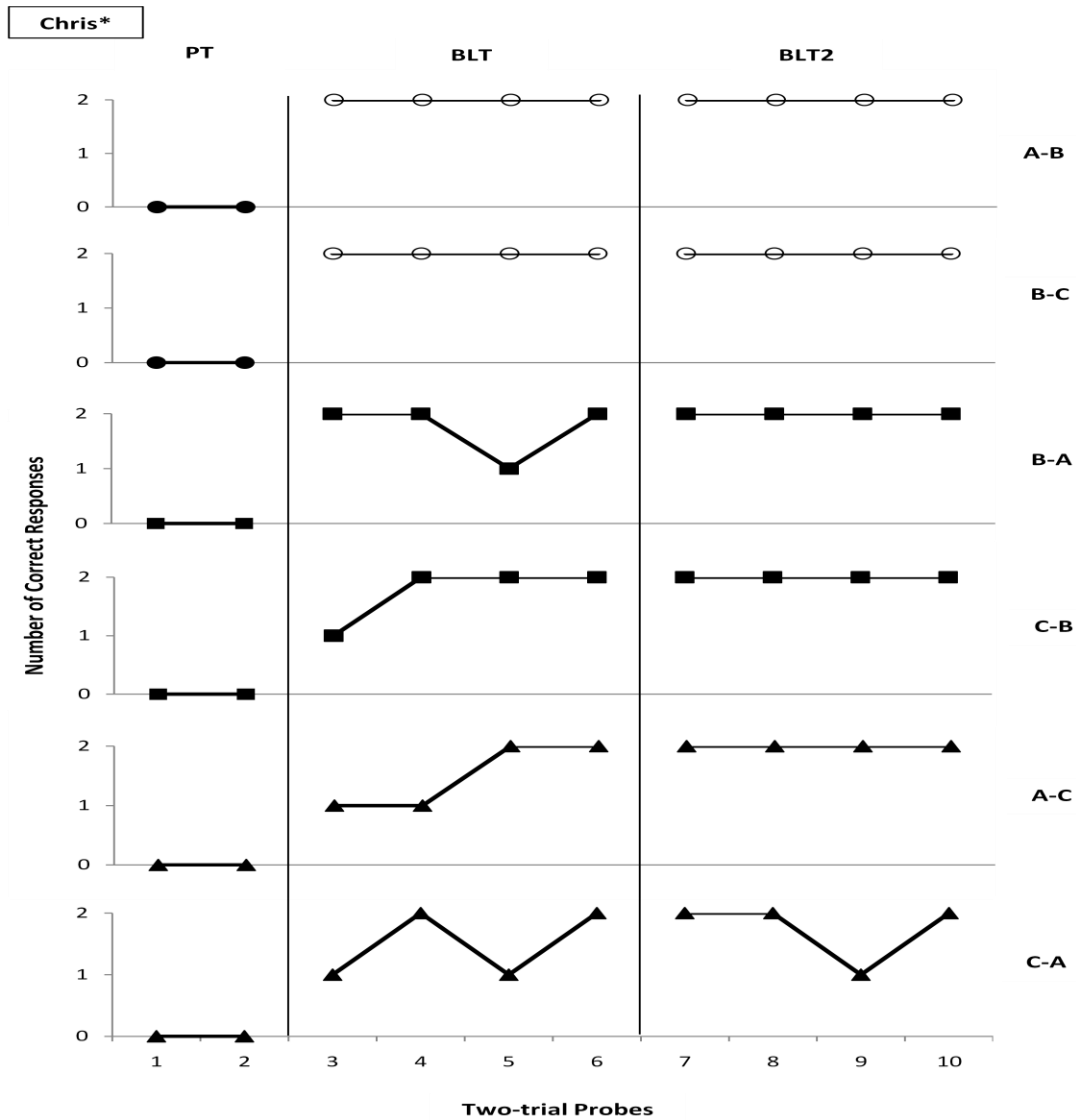

Figure 3. Correct responses to the probe of the 12 intraverbals for Chris. The “*” indicates that all novel relations emerged. Filled data points represent data of intraverbals that were not taught. Open data points represent data of intraverbals after being taught (A-B and B-C). Circles represent baseline relations, squares represent symmetric relations, and triangles represent transitive relations. “PT” indicates pre-training data, “BLT” indicates data following baseline training (i.e., A-B and B-C training), and the numbers beside “BLT” (e.g., 2 and 3) indicate additional rounds of baseline training. “Category” indicates category training, and “Exemplar” indicates exemplar training. One probe block consisted of 12-trials, and represents one column of data points. Teaching data are not presented in the figure. Solid lines represent when the participant was first exposed to a certain training (i.e., baseline, exemplar, or category), and dotted lines represent additional training.

Figure 4 shows a summary of the participants' probe performance by the type of relation tested. Following the initial A-B and B-C training, all participants demonstrated a higher level of correct responses for the symmetric relations (B-A and C-B) than for the transitive relations (A-C and C-A). For Justin and Matt, correct responses for the transitive relations remained at zero. An increase in correct responses for both types of untrained relations was observed with both participants who were administered a second round of A-B and B-C training (i.e., Matt and Chris). For Justin and Matt, correct responses for all relations increased following category training and again following exemplar training; however, Matt never achieved high accuracy on probes for the untrained relations. Chris was not exposed to category or exemplar training, as all four untrained relations emerged following A-B and B-C training alone.

Exemplar Training

Figures 5, 6, and 7 contain the individual data from probe trials for each relation. No participant responded correctly on any trials in baseline. Following A-B and B-C training, all three participants passed the test of the trained A-B and B-C relations (i.e., with Aaron receiving an additional round of A-B and B-C training and testing before maintaining the baseline relations), but none demonstrated the emergence of all four novel relations. Following A- B and B-C training, none of the novel relations emerged for Nathan. Nathan was exposed to only one round of A-B and B-C training before exemplar training was administered, whereas Aaron and Marcus were exposed to two rounds. Aaron was also exposed to a remedial round of A-B and B-C training because following the first round of training, baseline relations were not maintained at criterion. Following his remedial training

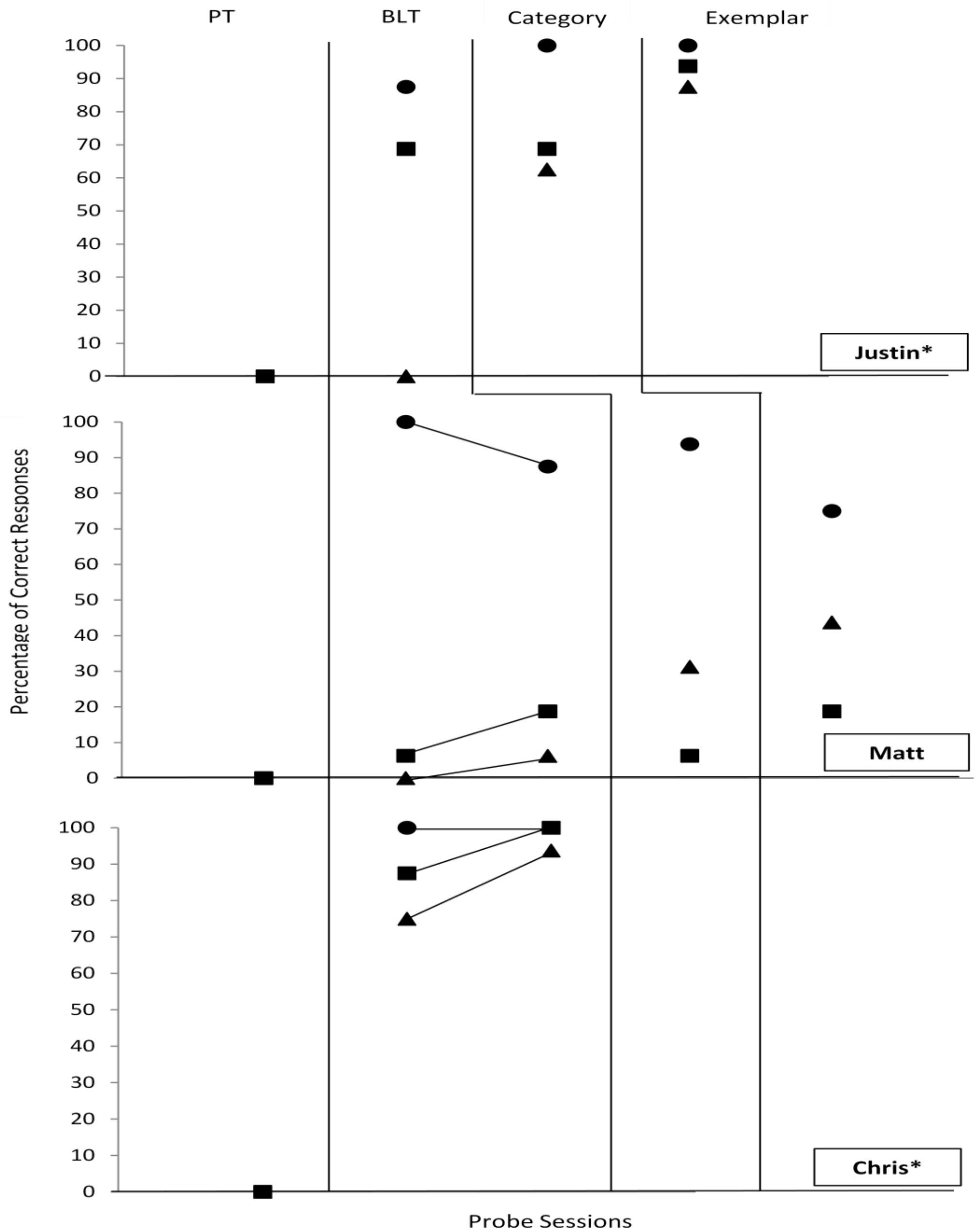

Figure 4. This figure shows the percentage of correct responses to the probe sessions for the participants who were exposed to category training first. The "*" indicates that all novel relations emerged. "PT" indicates pre-training data, and "BLT" indicates data following baseline training. Additional baseline trainings are connected by a line within that training phase. "Category" indicates category training, and "Exemplar" indicates exemplar training. Circles represent trained relations, squares represent symmetric relations, and triangles represent transitive relations. A probe session in baseline consisted of 2 blocks of 12-trial probes. A probe session following training consisted of 4 blocks of 12-trial probes.

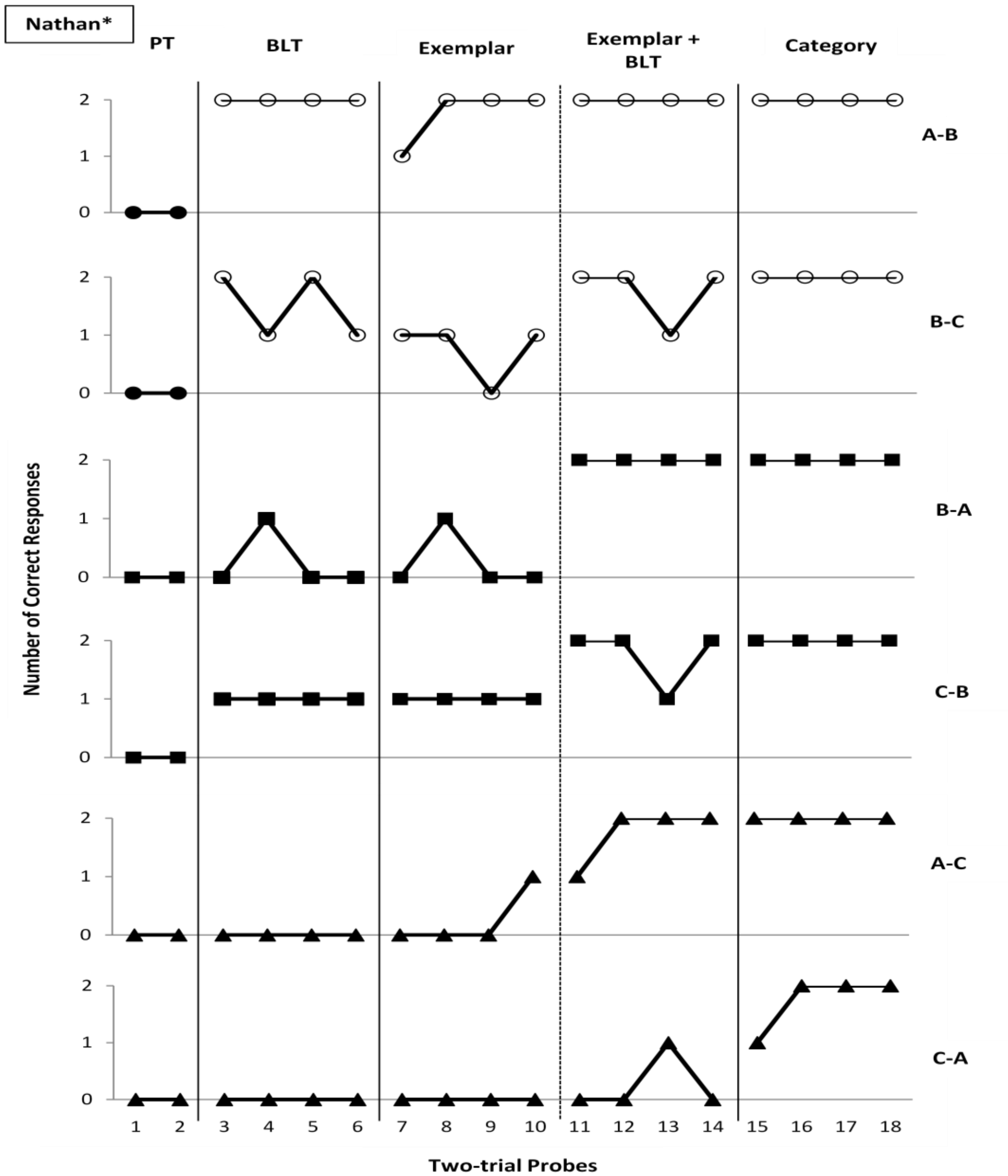

Figure 5. Correct responses to the probe of the 12 intraverbals for Nathan. The "*" indicates that all novel relations emerged. Filled data points represent data of intraverbals that were not taught. Open data points represent data of intraverbals after being taught (A-B and B-C). Circles represent baseline relations, squares represent symmetric relations, and triangles represent transitive relations. "PT" indicates pre-training data, "BLT" indicates data following baseline training (i.e., A-B and B-C training), and the numbers beside "BLT" (e.g., 2 and 3) indicate additional rounds of baseline training. "Exemplar" indicates exemplar training, and "Category" indicates category training. One probe block consisted of 12-trials, and represents one column of data points. Teaching data are not presented in the figure. Solid lines represent when the participant was first exposed to a certain training (i.e., baseline, exemplar, or category).

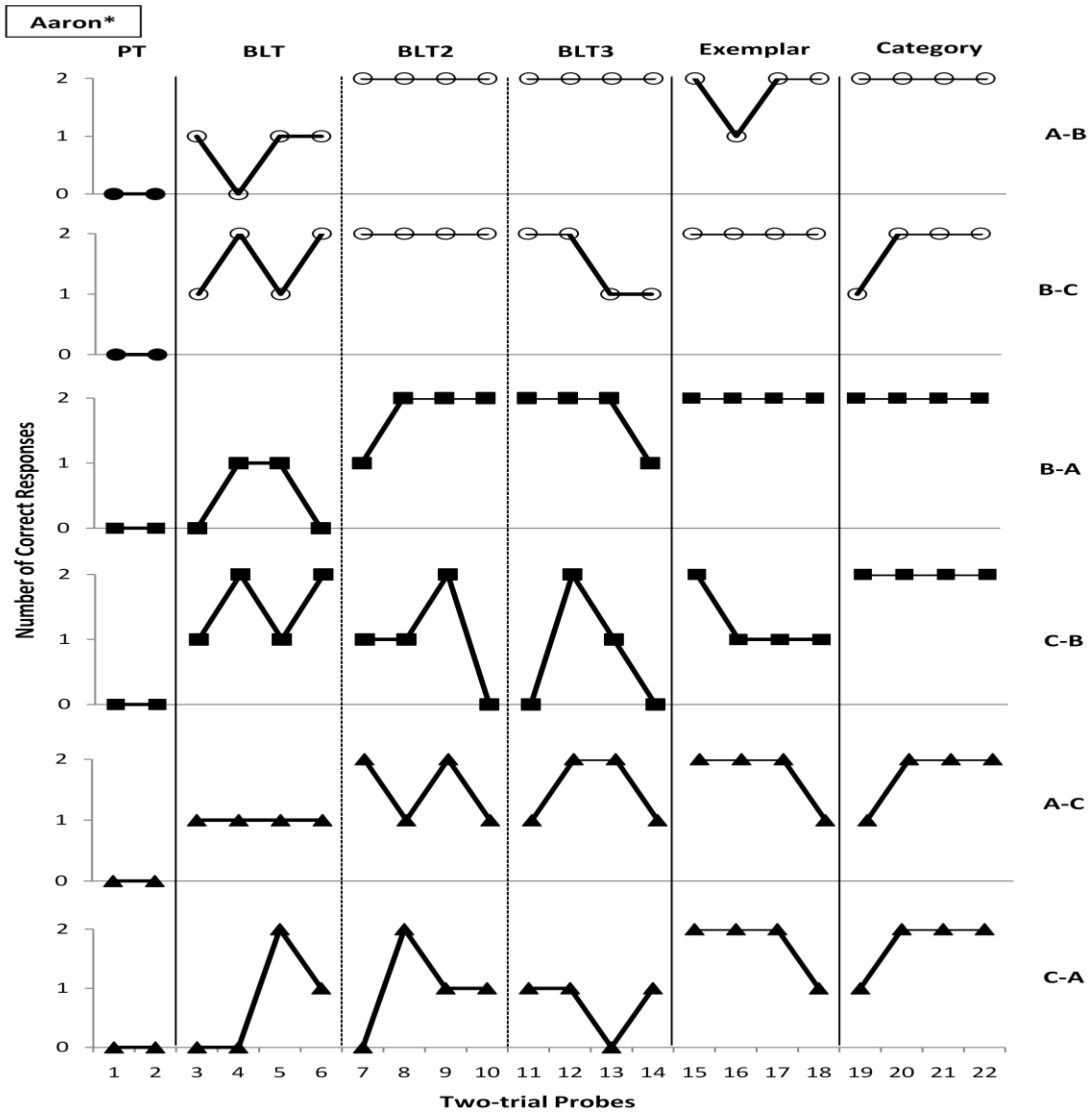

Figure 6. Correct responses to the probe of the 12 intraverbals for Aaron. The "*" indicates that all novel relations emerged. Filled data points represent data of intraverbals that were not taught. Open data points represent data of intraverbals after being taught (A-B and B-C). Circles represent baseline relations, squares represent symmetric relations, and triangles represent transitive relations. "PT" indicates pre-training data, "BLT" indicates data following baseline training (i.e., A-B and B-C training), and the numbers beside "BLT" (e.g., 2 and 3) indicate additional rounds of baseline training. "Exemplar" indicates exemplar training, and "Category" indicates category training. One probe block consisted of 12-trials, and represents one column of data points. Teaching data are not presented in the figure. Solid lines represent when the participant was first exposed to a certain training (i.e., baseline, exemplar, or category), and dotted lines represent additional training.

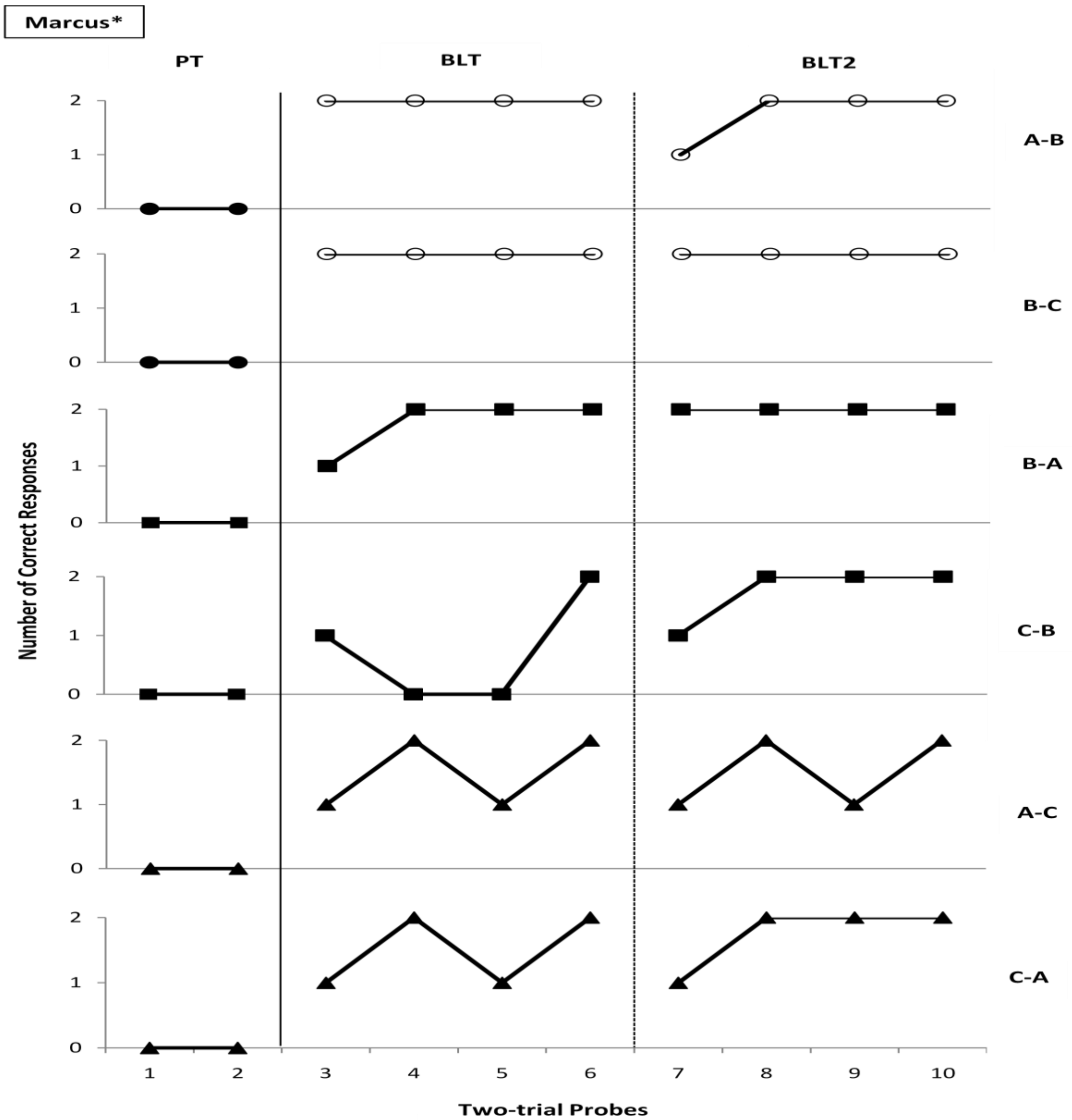

Figure 7. Correct responses to the probe of the 12 intraverbals for Marcus. The "*" indicates that all novel relations emerged. Filled data points represent data of intraverbals that were not taught. Open data points represent data of intraverbals after being taught (A-B and B-C). Circles represent baseline relations, squares represent symmetric relations, and triangles represent transitive relations. "PT" indicates pre-training data, "BLT" indicates data following baseline training (i.e., A-B and B-C training), and the numbers beside "BLT" (e.g., 2 and 3) indicate additional rounds of baseline training. "Exemplar" indicates exemplar training, and "Category" indicates category training. One probe block consisted of 12-trials, and represents one column of data points. Teaching data are not presented in the figure. Solid lines represent when the participant was first exposed to a certain training (i.e., baseline, exemplar, or category), and dotted lines represent additional training.

round, the B-A and A-C relations emerged, but no other relations emerged following the additional round of A-B and B-C training. For Marcus, the B-A, A-C, and C-A relation emerged following the first round of A-B and B-C training. Following the second round of A-B and B-C training, all relations emerged and criterion was met. Following exemplar training, neither Nathan nor Aaron demonstrated the emergence of all four novel relations; however, some relations emerged for specific participants that had not occurred prior to exemplar training. For Nathan, the trained baseline B-C relation was not maintained, and no novel relations emerged. Because the trained relations were not maintained, Nathan was administered mixed A-B and B-C and exemplar training. Following the mixed A-B and B-C and exemplar training, the trained relations were maintained and all relations except for the C-A relation emerged. For Aaron, the B-A and C-A relations were maintained and the C-A relation emerged. Following category training, all four novel intraverbal relations emerged for both participants.

Figure 8 shows an overall summary of the participants' performance in the probe sessions. Following A-B and B-C training, Nathan and Aaron demonstrated a higher level of correct responses for symmetric relations than for transitive relations, whereas Marcus demonstrated a higher level of correct responses for the transitive relations. Following the second round of A-B and B-C training, Aaron's level of correct responding slightly decreased for all relations, whereas both symmetric and transitive relations increased for Chris. For Nathan, correct responses for all relations increased following category training and again following exemplar training. For Aaron, correct responses for all relations increased following category training, however, only symmetric relations increased

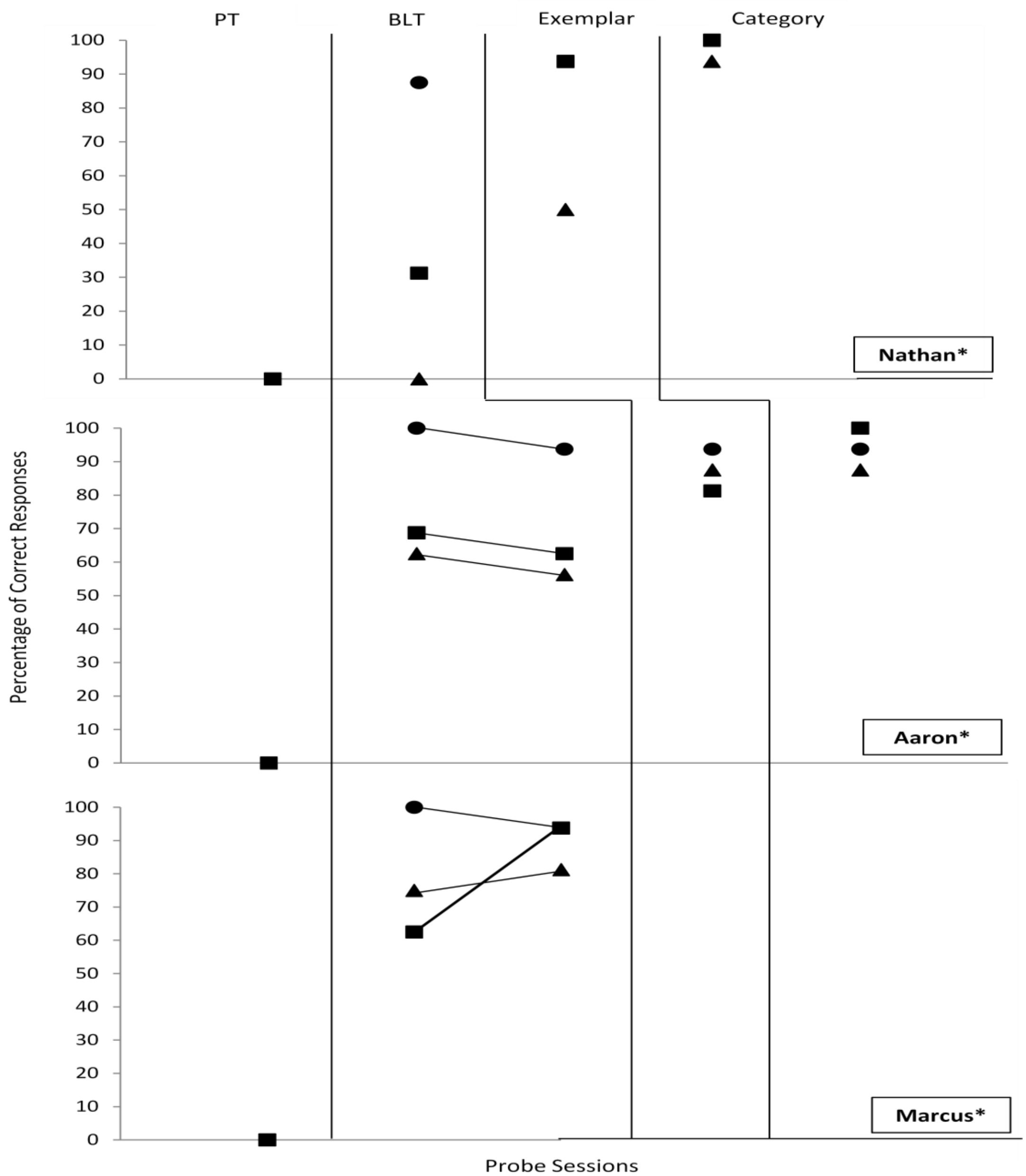

Figure 8. This figure shows the percentage of correct responses to the probe sessions for the participants who were exposed to exemplar training first. The "*" indicates that all novel relations emerged. "PT" indicates pre-training data, and "BLT" indicates data following baseline training. Additional baseline trainings are connected by a line within that training phase. "Exemplar" indicates exemplar training, and "Category" indicates category training. Circles represent trained relations, squares represent symmetric relations, and triangles represent transitive relations. A probe session in baseline consisted of 2 blocks of 12-trial probes. A probe session following training consisted of 4 blocks of 12-trial probes. Only probe sessions where participants maintained the baseline relations are shown.

following exemplar training. Marcus was not exposed to exemplar or category training, as all four untrained relations emerged following A-B and B-C training alone.

Analysis of Incorrect Responses on Probe Trials

Incorrect responses emitted during probe trials were analyzed for the participants exposed to category and exemplar training (i.e., Justin, Matt, Nathan, and Aaron). Following A-B and B-C training, the majority of incorrect responses emitted by Justin and Nathan indicated control by the S^D from baseline training over the response, and lack of control by the conditional stimulus. For example, in baseline training, these participants emitted the correct response “Branford” in the presence of “Name a city in Florida.” However, if “Florida” was the only verbal stimulus that gained control over the response “Branford”, then the participants would make an incorrect response of “Branford” in the presence of “Name a park in Florida.” For Nathan, other incorrect were seemingly unrelated to the training contingencies. For example, when presented with the verbal stimulus “Name a park in Midway” (C-B), Aaron would respond with the incorrect response “Branford”, which was neither a correct response to the conditional stimulus “park” nor the S^D “Midway”. For Aaron, the majority of incorrect responses indicated control by the conditional stimulus over the response, and the lack of control by the S^D. Incorrect responses consisted of saying the name of a state, city, or park, however, the response was the incorrect state, city, or park. Following the first type of training (category or exemplar) for Justin, Nathan, and Aaron, incorrect responses decreased for the errors emitted following baseline training and continued to decrease following the second type of training. For Matt, no dominate stimulus control error by the conditional stimulus or discriminative stimulus was shown for incorrect responses following any training (i.e., baseline training, category, and exemplar).

Trials to Criterion

Table 4 shows the participants' performance in the training phases. For the two participants administered category training first, Justin met criterion in all training phases and all four novel intraverbal relations emerged in 389 trials. Matt met criterion for all training phases in 478 trials; however, no novel intraverbals emerged. For the two participants administered exemplar training first, both participants met criterion in all training phases and all four novel intraverbal relations emerged in 1025 trials for Nathan and 593 trials for Aaron. When the two training conditions are examined separately for each participant, Justin completed category training in 172 trials and exemplar training in 114 trials, and Matt completed category training in 200 trials and exemplar training in 107 trials. Nathan completed exemplar training in 349 trials and category training in 93 trials, and Aaron completed exemplar training in 366 trials and category training in 93 trials.

Table 4

Trials to Criterion

	A-B and B-C Training	Category	Exemplar	Total (Category and Exemplar)	Grand Total (All Training)
Justin	103	172	114	286	389
Matt	171	200	107	307	478
	A-B and B-C Training	**Exemplar**	**Category**	**Total (Category and Exemplar)**	**Grand Total (All Training)**
Nathan	583	349	93	442	1025
Aaron	134	366	93	459	593

Note. Matt and Aaron were exposed to an additional round of A-B and B-C training, in which Matt met criterion in 56 trials and Aaron met criterion in 32 trials.

Section IV. Discussion

Overview of Results

The goal of the present study was to investigate whether exemplar training alone or category training alone might remediate failure of A-B and B-C training to yield novel intraverbal relations. For five out of six participants, all four novel relations emerged following repeated cycles of training and testing. However, there was no evidence that this outcome was related to a particular type of training. Three participants displayed emergence of all novel intraverbals after the addition of both category and exemplar training, but category training alone or exemplar training alone was never sufficient to bring about this outcome. Two participants, by contrast, demonstrated the emergence of all novel relations simply after repeated training of the baseline A-B and B-C relations, without any category or exemplar training. Pérez-González et al. (2008) reported similar results in their Experiment 1, in which one out of six participants displayed all four novel intraverbals after two rounds of A-B and B-C training, but no improvement was noted with the remaining five participants after as many as six rounds of training. In the multiple-probe design used in the present study, participants' lack of improvement with continued A-B and B-C training was a prerequisite for demonstrating an effect of the subsequent category or exemplar training intervention. As a result, if one or both interventions had been followed by criterion performance for those participants who did not previously perform to criterion, it would have been necessary to replicate that effect with additional participants who clearly did not benefit from continued A-B and B-C training alone, in order to verify that the outcome was specific to the intervention. However, none of the participants' data indicated that exemplar training alone or category training alone was sufficient to yield the novel intraverbals. The discussion that follows will focus on (a) possible reasons why category training alone or exemplar training alone may not suffice to remediate failures of A-B and B-C training to yield novel intraverbals, (b) possible reasons why some children might demonstrate emergence of the novel relations with repeated A-B and B-C training alone, and (c) other observations of potential relevance to future research.

Category and Exemplar Training

Experiment 2 of Pérez-González et al. (2008) demonstrated that all novel relations emerged following combined A-B and B-C, category, and exemplar training for all participants. In the present study, the four children who did not meet the criterion following A-B and B-C training alone also failed to meet it following their first round of category or exemplar training. The intraverbals that are trained during the initial A-B and B-C training are composed of two relevant stimuli. The training contingencies need to establish stimulus control for both stimuli over a response for the participant to be able to respond correctly to the novel intraverbals in a testing probe; therefore, the participant has to make a conditional discrimination to emit a correct response. Several studies have reported that a previous history with simple discriminations facilitates acquisition of conditional discriminations (Kennedy & Laitinen, 1988; Pérez-González & Martinez, 2007; Saunders & Spradlin, 1989; Saunders & Spradlin, 1990; Saunders & Spradlin, 1993). The participants from the current study were able to meet criterion and respond correctly to the testing trial probes after being trained with more simple intraverbals such as the categories and exemplars. Category and exemplar training teach more basic relations that involve only one stimulus that needs to gain stimulus control over the response. For example, in category training the intraverbal "What is Florida?" with the correct response being "state" (i.e., the category), is presented to the participant. “Florida” is the only verbal stimulus that needs to gain control over the response “state,” and vice versa in regards to exemplar training. These results add support to the literature on teaching conditional discriminations, in that teaching relations with one relevant stimulus may facilitate the learning of relations with two relevant stimuli. However, neither category nor exemplar training alone was sufficient to achieve this outcome.

The analysis of incorrect responses during probe trials suggests that the error(s) made by each participant following baseline training were reduced following the first intervention training, and reduced even more following the second intervention training. Following baseline training, two participants demonstrated errors due to the failure of the conditional stimulus to gain control over the response, and one participant demonstrated errors due to the failure of the S^D to gain control over the response. Regardless of the type of error, the intervention trainings reduced the errors established by faulty stimulus control via baseline training. Pérez-González et al. (2008) suggested that category and exemplar training address control of the conditional stimulus over the response; however, the results from the present study suggests that category and exemplar training do not address a specific type of stimulus control error. It is possible that training simple discriminations, regardless of the type of training (i.e., category or exemplar), may actually address stimulus control by both the conditional stimulus and the S^D when accompanied by A-B and B-C maintenance training as in the present study. Therefore, it is possible that the first instance of training simple discriminations simply did not result in complete acquisition, and once additional training was conducted the novel relations emerged. In addition, given that two participants demonstrated all four novel relations with A-B and B-C training alone, it is possible that the increase observed following other participants’ category and exemplar training was simply due to continued training involving the stimuli, and not related to the type of training that they received.

Although category and exemplar training facilitated acquisition of intraverbal conditional discriminations, no novel relations emerged following either category or exemplar training for one participant. Other participants exposed to the training interventions demonstrated specific errors of stimulus control in their incorrect responses following baseline training, and the intervention training addressed and reduced these errors. Matt demonstrated no dominate stimulus control error by the conditional stimulus or discriminative stimulus for incorrect responses following any of the training conditions (i.e., baseline training or either of the two intervention trainings). It is possible that during baseline training, Matt learned to respond to the specific stimulus compounds that were presented on each trial (e.g., the combination of "city and "Florida"), but either stimulus by itself did not acquire control over his responding. If this was the case, category and exemplar training may not have addressed the problem because these conditions addressed control only by the conditional stimulus, but not by the S^D. Further research should be conducted on the variables of category and exemplar training and why stimulus control may not be maintained in testing sessions.

With regard to the number of trials to meet criterion for category and/or exemplar training, the second type of training took a fewer number of trials, regardless of which kind of training, than did the first training administered. Therefore, the first training seems to facilitate the second training. Additionally, the total number of trials taken to complete both training conditions was substantially less for the participants who received category training first. Results showed that when category training was administered first it was completed in fewer trials than it took for the participants to met criterion when exemplar training was administered first. However, these results should be interpreted with caution, as (a) there were only two participants in each condition, and (b) both participants who received exemplar training first demonstrated emergence of all four novel intraverbals, and only one of the two participants who received category training first demonstrated emergence.

Effects of Repeated Training and Testing

Delayed emergence. Two participants met criterion for novel relations following repeated A-B and B-C training. A similar effect has frequently been observed in the stimulus equivalence literature in match-to-sample tasks that employ selection-based responding. Selection-based responding refers to a response form (e.g., pointing, looking, touching, etc.) that indicates a specific stimulus (Sundberg & Sundberg, 1990). The response form (e.g., pointing) is always the same, although different stimuli are selected on different trials. In stimulus equivalence research, match-to-sample training phases are conducted using reinforcement contingencies to establish baseline relations (e.g., A-B and B-C relations), and match-to-sample testing phases are conducted in extinction to demonstrate novel conditional discriminations (e.g., symmetry and transitivity relations). Equivalence researchers have repeatedly demonstrated that novel conditional discriminations may emerge with repeated nonreinforced testing (e.g., Bush, Sidman, & Tania de Rose, 1989; Devany, Hayes, & Nelson, 1986; Fields, Adams, Verhave, & Newman, 1990; Gatch & Osborne, 1989; Harrison & Green, 1990; Lazar, Davis-Lang, & Sanchez, 1984; Lynch & Cuvo, 1995; Saunders, Wachter, & Spradlin, 1988; Sidman, Cresson, Willson-Morris, 1974; Sidman, Kirk, & Willson-Morris, 1985; Sidman, Willson-Morris, & Kirk, 1986; Sigurdardottir, Green, & Saunders, 1990; Spadlin, Cottor, & Baxley, 1973). This phenomenon has come to be known as delayed emergence (Sidman, 1994). Most reported cases of delayed emergence have employed procedures in which (a) baseline relations continued to be presented within tests for novel relations and (b) baseline relations are presented between tests of novel relations (e.g., baseline relations are retrained and novel relations are retested following failure of novel relations to emerge, and this cycle continues until novel relations are demonstrated).

Although delayed emergence is well documented in selection-based responding, it has not been well documented with topography-based responding. In topography-based responding, the response form distinguishes one verbal response from another so that each response to a stimulus is a different verbal response (Sundberg & Sundberg, 1990). If a child were presented with different pictures of food items, each food item would evoke a different response form. For example, in the presence of one picture the child may say "pizza", whereas in the presence of a different picture the child may say "hamburger". By analogy to memory testing, selection-based trials test recognition, whereas topography-based trials test recall. To date, only one study with adults has demonstrated delayed emergence in topography-based responding (Polson & Parson, 2000), in addition to one participant in the Pérez-Gonzalez et al. (2008) study and two participants in the present study. One reason that delayed emergence has not been well documented with topography-based responding is that many studies have failed to control for additional training when attempting to intervene on failure of baseline training to produce novel topography-based responses (e.g., Pérez-González et al., 2007; Fiorile & Greer, 2007; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005; Greer, Yuan, & Gautreaux, 2005). The present data suggest that delayed emergence can occur with topography-based responding. As a result, it is crucial that research on variables that contribute to the emergence of novel verbal relations control for effects of repeated baseline training.

Why does delayed emergence occur? One possible reason why delayed emergence may have occurred in the present study is that the first instance of training simply did not result in complete acquisition, and once additional training was conducted the novel relations emerged. Delayed emergence is typically demonstrated following additional rounds of training in the stimulus equivalence literature (e.g., Bush et al., 1989; Gatch & Osborne, 1989; Lynch & Cuvo, 1995; Saunderset al., 1988; Sidman et al., 1974; Sigurdardottir et al., 1990). However, it has also been demonstrated with additional rounds of non-reinforced testing without any intervening training trials, or with additional rounds of non-reinforced testing where intervening training trials were conducted under extinction (e.g., Devany et al., 1986; Fields et al., 1990; Harrison & Green, 1990; Lazaret al., 1984; Sidman et al., 1985;). Devany et al. (1986) suggested that delayed emergence might occur due to response-contingent feedback provided during testing in which responding is based on a common source of control. Humans have histories in which responding consistently has been more likely to be reinforced, and subjects may therefore, discriminate the source of control over responses in each trial. At first, a response may be at strength because of the physical similarities between sample and comparison stimuli, but this type of responding is not consistent, and will be discarded because reinforcement has rarely followed inconsistent responding in the past. Only responding controlled by an equivalence class will be at strength in every trial and come to dominate other possible responses.

Sidman (1994) offered another explanation for delayed emergence in the case of selection-based responding, by stating that each stimulus is a member of many different classes, including the class for which the experimenter establishes training contingencies in an experiment. Because tests for stimulus equivalence are conducted under extinction, no differential consequences are delivered for correct responses; therefore, other aspects of the environment (i.e., the context) will set the occasion for the prevailing class. The context may be historical, current, or both, and many test trials may be required before the participant finally decides which class is in effect and relevant for every test trial. Therefore, in selection-based responding, the context of the match-to-sample test (e.g., different sample stimuli, different comparison stimuli, location of the comparison stimuli, etc.) for every test trial plays an important role which comparison stimulus the participant chooses. Not only is a participant's performance on any test trial based on the context of that specific test trial (i.e., the stimuli in the trial or the participants history with the stimuli in the trial), but also by the relations between other stimuli that have been presented on different trials (Paul & Paul, 1966). When stimulus equivalence involves topography-based responding, verbal contextual stimuli are needed to evoke the appropriate relations (Hall & Chase, 1991). For example, when training an A-B relation and testing for symmetry, the contextual stimulus "new word" may be presented during A-B training, and "symmetric relation" in testing for the emergence of B-A. These verbal contextual stimuli may serve the same contextual function as comparison stimuli in selection-based responding, and set the occasion for reflexive, symmetric, or transitive relations within the overall task.

Individual differences. Interestingly, in some studies on topography-based responding, a majority of participants have *not* displayed delayed emergence even after many additional trainings (e.g., Barnes-Holmes, Barnes-Holmes, Roche, & Smeets, 2001; Barnes-Holmes, Barnes-Holmes, Roche, & Smeets, 2001b; Pérez-González et al., 2008). In the present study, Matt and Aaron did not perform to criterion after repeated A-B and B-C training. It is possible that additional rounds of training would have brought about criterion performance. However, Pérez-González et al. (2008) demonstrated that all novel relations did not occur in the majority of participants even after as many as six additional A-B and B-C trainings.

According to Hall and Chase (1991), equivalence relations should not be expected to emerge in topography-based responding without verbal contextual stimuli. In the present study, the conditional stimuli “state,” “city,” and “park” would be considered the contextual cues that indicate which type of relation to derive in response to a state name, city name, or park name. Therefore, contextual verbal stimuli were present to set the occasion for novel relations to emerge. If contextual cues are present in both selection-based and topography-based responding, why is delayed emergence more easily demonstrated in selection-based responding? Every study that has controlled for additional trainings in topography-based responding and not demonstrated emergent relations has not used a traditional match-to-sample preparation for either training or testing. A traditional match-to-sample format provides visual contextual cues on each testing trial that provides information to the participant about the relationship between the sample stimulus and the comparison stimuli. Therefore, as the participant experiences more testing trials and gains more information about the context, an increase in correct responding is demonstrated. In the present study, only one verbal conditional stimulus was presented to the participant. In a match-to-sample task, there are many visual stimuli presented to the participant. It is possible that the number of contextual cues, as well as their presentation (i.e., visual or auditory), affect delayed emergence. Furthermore, there is no specific training required for contextual stimuli to control responding in match-to-sample tasks (i.e., the participant can already select a stimulus when presented with comparison stimuli). However, in topography-based responding, such training may be required for some participants but not others, depending on their prior experiences with “state,” “city,” and “park.”

Because delayed emergence is not consistently demonstrated in topography-based responding, the results of the present study and previous studies may indicate that there are individual differences in the extent to which delayed emergence may be observed in children’s topography-based responding. It is possible that delayed emergence might be a function simply of naturally occurring cognitive development. The participants that demonstrated delayed emergence following additional baseline training were seven years old, whereas the other participants were only six years old. Piaget (1948) suggests that “the effort to understand other people and to communicate one’s thought objectively does not appear in children before the age of about 7 or 7 ½” (pg. 126). According to Piaget (1948), children between the ages of 6 and 7 are in an ego-centric stage of language development. Therefore, the child at this stage talks to a great extent for himself alone, without trying to gain the attention of others. This causes conversations between children at this stage to be void of causal and logical relations. The child focuses on events of a story rather than on the relations of time (order) or cause which unites them. Additional data should be collected to clarify whether or not these results are related to age. For example, more participants from both younger and older age groups could be tested after repeated baseline training. If novel intraverbals emerge only in older participants after baseline training and only in younger participants after being exposed to category and exemplar training as well as baseline training, the data may support that addressing control of the conditional stimuli is necessary only for younger children. On the other hand, if some younger participants show delayed emergence, the data will underscore a need for including control conditions involving continued baseline training in studies that attempt to influence emergence of novel relations.

In addition to age, cognitive development could be related to certain instructional experiences that the child has been exposed to via past histories. Hayes, Barnes-Holmes, and Roche (2001) hypothesize that the ability to derive novel relations from baseline training arises from repeated experiences with naturally occurring instruction in deriving such relations in the presence of appropriate contextual cues. The two participants that demonstrated delayed emergence following additional baseline training were in the middle of their first grade year whereas the other participants were in kindergarten or were at the beginning of their first grade year. This difference in educational histories may have been an important contributing factor to the emergence of the novel relations. For first grade, the Texas Essential Knowledge and Skills (TEKS) for English Language Arts are divided into many different objectives that the student must acquire by the end of the year. Students do not start learning to make inferences about what they are reading or hearing until the second, third, or even fourth nine week session of the school year (Texas Education Agency, 2009). After these skills are introduced, teachers continue to work on the skills throughout the school year to increase competency. Therefore, Chris and Marcus may have already been trained on prerequisite skills to answer all of the questions presented to them in the probe trials and should have been very competent on those skills by the end of the school year.

Additional Observations

Sequence of emergent relations. In the stimulus equivalence literature, symmetry relations typically emerge before transitivity relations and are suggested to be a pre-requisite for the emergence of transitivity relations (Sidman, 1994). This was the case for two participants in the present study in that both symmetrical relations emerged before or during the same probe sessions as the transitivity relations. However, Pérez-González et al. (2008) reported that, following baseline training, the C-B and A-C relations emerged first for the majority of participants, but correct responding for the C-B relation was inconsistent. Only one participant demonstrated emergence of the B-A relation, and one participant demonstrated emergence of the C-A relation. Therefore, one transitivity relation (i.e., the A-C relation) emerged before symmetrical relations consistently emerged. In the present study, the results are consistent with Pérez-González et al. (2008) in that the A-C relation emerged before both symmetrical relations had emerged for three of the six participants. This finding suggests that when both trained and tested relations are topography-based, the relations that define symmetry may not be a pre-requisite for transitivity relations to emerge. One possible explanation for why the A-C relation emerged before both symmetrical relations had emerged for three of the six participants is that the A-C relation does not require the participant to reverse the stimulus and response. Studies evaluating reverse intraverbals relations have failed to show the emergence of reverse intraverbals until reverse intraverbals have been directly trained (e.g., Barnes-Holmes et al., 2001; Barnes-Holmes et al., 2001b; Pérez-González et al., 2007); therefore, reversing the stimulus and response may not be an easy task in regards to intraverbals. The A-C relation contains the same stimuli as the A-B baseline relation and the same responses as the B-C baseline relation, and does not require the stimuli and responses to be reversed; therefore, this relation may emerge more easily than other relations.

Adequacy of training procedures. The results from the present study, as well as the Pérez-González et al. (2008) study, demonstrate that the training procedure in these two studies results in inconsistent responding of the trained baseline relations during probe sessions. Perez-Gonzalez et al. (2008) reported inconsistencies in the trained relations and suggested that research should evaluate reinforcement schedules in training sessions. The present study addressed this issue by implementing an FR1 and a correction only condition into the last phase of each type of training. This was done to increase the similarity between training and testing phases. However, inconsistencies in the trained baseline relations were still shown. For example, both Nathan and Aaron repeated certain types of training due to the failure of the baseline relations to be maintained in the testing probes. Nathan demonstrated that baseline relations were not maintained in the testing probes following exemplar training, therefore, Nathan was exposed to an additional round of training that included both exemplar and baseline training. Aaron did not maintain the baseline relations in the testing probes following baseline training, therefore, he was exposed to an additional round of baseline training. In the present study, the baseline relations were always presented together during training and maintenance; however, during the testing session the baseline relations were presented with other similar questions. It is possible that the testing context differed enough from the trained context (i.e., all 12 probes *vs.* the four trained intraverbals) to cause inconsistent responses to occur in the baseline relations during testing probes. More research should be conducted on how the relations are trained as well as what variables affect responding in testing trials, for example, would trained relations be maintained during the testing probes if the trained relations were presented randomly during the training session with other distracter questions instead of all together in one block?

Future Research

Future research on establishing intraverbals that involve conditional discriminations could take several different directions. First, it might be worthwhile to teach intraverbal responses that require conditional discriminations and evaluate their effects on other intraverbals that require conditional discriminations of verbal stimuli. For example, if baseline training consisted of A-B and A-C instead of A-B and B-C training, participants would need to respond to both the contextual stimuli and S^D on each training trial. Alternatively, it might be possible to train verbal responses that require discriminations of visual stimuli and evaluate their effects on intraverbals that require conditional discriminations of verbal stimuli; for example, conducting tact training or multiple tact training prior to A-B and B-C training. Tact training involves presenting the child with a nonverbal stimulus (e.g., a picture of a map of Florida), and asking the child "What is this?" Multiple tact training requires participants to not only name each picture presented, but also to name the category to which it belongs (Miquel et al., 2005). For example, when the child is presented with a picture of an apple and asked "What is this?" a correct response from the cid would be "It's Florida and a state." Although functional independence has been shown between tacts and intraverbals, no studies to date have evaluated tact training or multiple tact training before evaluating intraverbal conditional discriminations in a stimulus equivalence paradigm. It might also be interesting to teach visual-visual conditional discriminations (e.g., match-to-sample training) to first establish equivalence classes among the stimuli, and then evaluate intraverbal conditional discriminations in a stimulus equivalence paradigm. This would consist of conducting match-to-sample training following tact training, then evaluating the emergence of intraverbal conditional discriminations. For example, the A stimuli could be states (e.g., Nebraska, North Carolina, and New Hampshire), the B stimuli could be the state's bird (i.e., a Meadowlark, a Cardinal, and a Finch), and the C stimuli could be the state's flower (i.e., a Goldenrod, Dogwood, and a Lilac). First tact training would be conducted so that the child could name the stimuli. Then match-to-sample training would commence in which the child would learn three A-B and three B-C relations, and then be tested to see if three 3-member equivalence classes would emerge (i.e., A1-B1-C1, A2-B2-C2, and A3-B3-C3). Following the emergence of the three equivalence classes, intraverbal conditional discriminations would be evaluated. In the intraverbal test, the experimenter could present questions involving conditional discriminations such as "Name the bird that goes with Florida"(A-B), "Name the state that goes with Lilac" (C-A), etc.

Second, future research could evaluate effects of instructional procedures that have been shown to enhance stimulus control in general; for example, the use of a differential observing response (DOR) requirement to the conditional stimulus. In match-to-sample studies, participants are often required to emit a unique response to each sample stimulus prior to the presentation of the comparison stimuli, and this unique response is referred to as a DOR. Research on conditional discriminations has shown that attention to the sample (e.g., the conditional stimulus in the present study) is a prerequisite for stimulus control (for a review, see Dinsmoor, 1985). A DOR increases attention to the sample stimulus, as well as ensures that the participant can discriminate relevant aspects of the sample stimulus (Fisher, Kodak, & Moore, 2007). Faster acquisition of conditional discriminations has been demonstrated when the participant is required to make a differential observing response (DOR) to the sample stimulus such as naming or an identity-matching response (e.g., Constantine & Sidman, 1975; Dube & McIlvane, 1999; Geren, Stromer, & MacKay, 1997;

Saunders & Spradlin, 1989; Saunders & Spradlin, 1990; Saunders & Spradlin, 1993). It is possible that teaching a child a DOR to the conditional stimulus would increase stimulus control and facilitate the emergence of novel intraverbals. For example, teaching the child to wave when the experimenter says the word “state”, to hold a thumb up when the experimenter says the word “city”, and to clap when the experimenter says the word “park”.

Third, future research could evaluate whether the combined category and exemplar training described by Perez-Gonzalez et al. (2008) is in fact more efficient than simply training the symmetric and transitivity relations directly. In the present study, both category and exemplar training required approximately 1,000 trials for one participant. It is possible that direct training of the tested relations would be more economical. It is also possible that direct training on a subset of the relations that define symmetry would be sufficient for the remaining novel relations to emerge. Such an outcome has been shown in some studies on the effects of multiple-exemplar training on novel or derived stimulus relations (e.g., Barnes-Holmes et al., 2001; Barnes-Holmes et al., 2001b). Finally, future research could evaluate the use of environmental cues in emergent intraverbals. When a person is asked the time, a clock is usually present to aid the person in the correct topography-based response. It may be interesting to implement the same procedure as the present study, but have comparison stimuli present on a computer screen or on flash cards in front of the participant. This would be a variation on a match-to-sample format because comparison stimuli would be present, but the response would still be topography-based. Therefore, delayed emergence might be more easily demonstrated than it has been in previous studies.

References

Axe, J. B. (2008). Conditional discrimination in the intraverbal relation: A review and recommendations for future research. *The Analysis of Verbal Behavior, 24,* 159–174.

Barnes-Holmes, Y., Barnes-Holmes, D., Roche, B., & Smeets, P. M. (2001). Exemplar training and a derived transformation of function in accordance with symmetry. *The Psychological Record, 51*, 287-308)

Barnes-Holmes, Y., Barnes-Holmes, D., Roche, B., & Smeets, P. M. (2001b). Exemplar training and a derived transformation of function in accordance with symmetry: II. *The Psychological Record*, *51*, 589-603)

Braam, S. J., & Poling, A. (1983). Development of intraverbal behavior in mentally retarded individuals through transfer of stimulus control procedures: Classification of verbal responses. *Applied Research in Mental Retardation, 4,* 279–302.

Bush, K. M., Sidman, M., de Rose, T. (1989). Contextual control of emergent equivalence relations. *Journal of Experimental Analysis of Behavior*, *51*, 29-45.

Catania, A. C. (2007). *Learning, fourth edition.* NY: Sloan.

Constantine, B., & Sidman, M. (1975). The role of naming in delayed matching to sample. American Journal of Mental Deficiency, 79, 680-689.

Devany, J. M., Hayes, S. C., & Nelson, R. O. (1986). Equivalence class formation in language-able and language-disabled children. *Journal of the Experimental Analysis of Behavior*, *46*, 243-257.

Dinsmoor, J. A. (1985). The role of observing and attention in establishing stimulus control. *Journal of the Experimental Analysis of Behavior, 43*, 365-381.

Dube, W. V., & McIlvane, W. J. (1999). Reduction of stimulus overselectivity with nonverbal differential observing responses. *Journal of Applied Behavior Analysis, 32*, 25-33.

Fields, L., Adams, B. J., Verhave, T., Newman, S. (1990). *The effects of nodality on the formation of equivalence classes, 53*, 345-358.

Finkel, A. S., & Williams, R. L. (2001). A comparison of textual and echoic prompts on the acquisition of intraverbal behavior in a six-year-old boy with autism. *The Analysis of Verbal Behavior, 18*, 61–70.

Fiorile, C. A., Greer, R. D. (2007). The induction of naming in children with no prior tact responses as a function of multiple exemplar histories of instruction. *The Analysis of Verbal Behavior, 23*, 71-87.

Fisher, W. W., Kodak, T., & Moore, J. W. (2007). Embedding an identity-matching task within a prompting hierarchy to facilitate acquisition of conditional discriminations in children with autism. *Journal of Applied Behavior Analysis, 40*, 489-499.

Gatch, M. B., & Osbourne, J. G. (1989). Transfer of contextual stimulus function via equivalence class development. *Journal of the Experimental Analysis of Behavior, 51*, 369-378.

Geren, M. A. Stromer, R. & Mackay, H. A. (1997). Picture naming, matching to sample, and head injury: A stimulus control analysis. *Journal of Applied Behavior Analysis, 30*, 339-342.

Greer, R. D., Stolfi, L., Chavez-Brown, M., & Rivera-Valdes, C. (2005). The emergence of the listener to speaker component of naming in children as a function of multiple exemplar instruction. *The Analysis of Verbal Behavior, 21*, 123-134.

Greer, R. D., Yuan, L., & Gautreaux, G. (2005). Novel dictation and intraverbal responses as a function of a multiple exemplar instructional history. *The Analysis of Verbal Behavior, 21*, 99-116.

Hall, G. A., & Chase, P. N. (1991). The relationship between stimulus equivalence and Verbal Behavior. *The Analysis of Verbal Behavior, 9*, 107-119.

Harrison, R. J., & Green, G. (1990). Development of conditional and equivalence relations without differential consequences. *Journal of the Experimental Analysis of Behavior, 54*, 225-237.

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational frame theory: A post-Skinnerian account of human language and cognition*. New York: Plenum Press.

Horne, P. J., & Lowe, C. F. (1996). On the origins of naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior, 65*, 315–340.

Kennedy, C. H., & Laitinen, R. (1988). Second-order conditional control of symmetric and transitive stimulus relations: The influence of order effects. *The Psychological Record, 38*, 437-446.

Lazar, R. M., & Davis-Lang, D., & Sanchez, L. (1984). The formation of visual stimulus equivalences in children. *Journal of Applied Behavior Analysis, 41*, 251-266.

Lynch, D. C., & Cuvo, A. J. (1995). Stimulus equivalence instruction of fraction-decimal relations. *Journal of Applied Behavior Analysis, 28*, 115-126.

Luciano, M. C. (1986). Acquisition, maintenance, and generalization of productive intraverbal behavior through a transfer of stimulus control procedures. *Applied Research in Mental Retardation, 7,* 1–20.

Miguel, C. M., Petursdottir, A. I., & Carr, J. E. (2005). The effects of multiple-tact and receptive-discrimination training on the acquisition of intraverbal behavior. *The*

Analysis of Verbal Behavior, 21, 27–41.

Partington, J. W., & Bailey, J. S. (1993). Teaching intraverbal behavior to preschool children. *The Analysis of Verbal Behavior, 11,* 9–18.

Paul, C., & Paul, H. (1968). Transfer-mediated response sets in verbal learning and transfer. *Psychological Record, 75*(6), 537-549.

Pérez-González, L. A., García-Asenjo, L., Williams, G., & Carnerero, J. J. (2007). Emergence of intraverbals with antonyms as responses in children with pervasive developmental disorder. *Journal of Applied Behavior Analysis, 40,* 697–701.

Pérez-González, L. A., Herszlikowicz, K., & Williams, G. (2008). Stimulus relations analysis and the emergence of novel intraverbals. *The Psychological Record, 58,* 95–129.

Pérez-González, L. A., & Martinez, H. (2007). Control by contextual stimuli in novel second-order conditional discriminations. *The Psychological Record, 57,* 117-143.

Petursdottir, A. I., Carr, J. E., Lechago, S. A., & Almason, S. M. (2008). An evaluation of intraverbal training and listener training for teaching categorization skills. *Journal of Applied Behavior Analysis, 41,* 53–68.

Petursdottir, A. I., Olafsdottir, A. R., & Aradottir, B. (2008). The effects of tact and listener training on the emergence of bidirectional intraverbal relations. *Journal of Applied Behavior Analysis, 41,* 411-415.

Piaget, J. (1948). The language and thought of the child. London: Routledge and Kegan Paul.

Polson, D. A. D., & Parsons, J. A. (2000). Selection-based versus topography-based responding: An important distinction for stimulus equivalence? *The Analysis of Verbal Behavior, 17,* 105–128.

Saunders, R. R., & Spradlin, J. E. (1989). Conditional discrimination in mentally retarded adults: The effect of training the component simple discriminations. *Journal of the Experimental Analysis of Behavior*, *52,* 1-12.

Saunders, R. R., & Spradlin, J. E. (1990). Conditional discrimination in mentally retarded adults: The development of generalized skills. *Journal of the Experimental Analysis of Behavior*, *54,* 239-250.

Saunders, R. R., & Spradlin, J. E. (1993). Conditional discrimination in mentally retarded adults: Programming and learning set. *Journal of the Experimental Analysis of Behavior*, *60,* 571-585.

Saunders, R. R., Wachter, J., & Spradlin, J. E. (1988). Establishing auditory stimulus control over an eight-member quivalence class via conditional discriminations procedures. *Journal of the Experimental Analysis of Behavior, 49,* 95-115.

Sautter, R. A., & LeBlanc, L. A. (2006). Empirical applications of Skinner's analysis of verbal behavior with humans. *The Analysis of Verbal Behavior*, *22*, 35–48.

Sidman, M. (1994). *Equivalence relations and behavior: A research story*. Boston: Authors Cooperative.

Sidman, M., Cresson, O., & Willson-Morris, M. (1974). Acquisition of matching to sample via mediated transfer. *Journal of the Experimental Analysis of Behavior*, *22,* 261-273.

Sidman, M., Kirk, B., Willson-Morris, M. (1985). Six-member stimulus classes generated by conditional-discrimination procedures. *Journal of the Experimental Analysis of Behavior*,*43,* 21-42.

Sidman, M., Willson-Morris, M., & Kirk, B. (1986). Matching-to-sample procedures and the development of equivalence relations: The role of naming. *Analysis and Intervention in Developmental Disabilities, 6,* 1-19.

Sigurdardottir, Z. G., Green, G., Saunders, R. R. (1990). Equivalence classes generated by sequence training. *Journal of the Experimental Analysis of Behavior*, *53,* 47-63.

Spradlin, J. E., Cotter, V. W., & Baxley, N. (1973). Establishing a conditional discrimination without direct training: A study of transfer with retarded adolescents. *American Journal of Mental Deficiency, 5,* 556-566.

Skinner, B. F. (1957). *Verbal behavior.* Acton, MA: Copley.

Sundberg, M. L. & Michael, J. (2001). The benefits of Skinner's analysis of verbal behavior for children with autism. *Behavior Modification, 25*, 698–724.

Sundberg, C. T., & Sundberg, M. L. (1990). Comparing topography-based verbal behavior with stimulus selection-based verbal behavior. *The Analysis of Verbal Behavior, 8,* 31-41.

Texas Education Agency (2009). *First Grade Language Arts TEKS Timeline*. Retrieved from http://www.cfisd.net/dept2/curricu/ellang/1curr_align_std.htm

VITA

Education

2000 – 2004 **B.S. in Psycholo*gy***
Texas Christian University, Fort Worth, Texas
Minor: Mathematics

Publications

Hubbard, T. L., Kumar, A. M., & **Carp, C. L.** (2009). Effects of spatial cue timing and relevance on representational momentum. *Journal of Experimental Psychology: Learning, Memory,and Cognition, 35*(3), 666-677.

Work in Progress

Carp, C. L.& Petursdottir, A. I. Effects of category and exemplar training on the emergence of novel intraverbal relations. Data collection in progress.

Peterson, S. P., **Carp, C. L.**, Petursdottir, A. I, & Ingvarsson, E. Effects of identity-matching and echoic prompts on the acquisition of auditory-visual conditional discriminations. Data collection in progress.

Petursdottir, A. I., & **Carp, C. L.** Emergence of intraverbal conditional discriminations following tact training. Data collection in progress.

Petursdottir, A. I., **Carp, C. L.**, Esch, B. E. Establishing preferences for speech sounds for children with autism. Manuscript in preparation.

Petursdottir, A. I., **Carp, C. I.**, Peterson, S. P. Emergence of visual-visual conditional discriminations following intraverbal training. Data collection in progress.

Clinical Experience

2005 – 2007 **7th Grade Math Teacher**
Katy Junior High, Katy, Texas

August 2008 – January 2009 **Behavior Analysis Tutor**
Child Study Center, Fort Worth, TX
Autism Services

Professional Memberships

Texas Association of Behavior Analysis
Association of Behavior Analysis International

ABSTRACT

EFFECTS OF CATEGORY AND EXEMPLAR TRAINING ON EMERGENT INTRAVERBAL RELATIONS

By Charlotte Lynn Carp, M. S., 2009
Department of Psychology
Texas Christian University

Thesis Advisor: Anna I. Petursdottir, Assistant Professor of Psychology

The present study addressed the acquisition of intraverbals under conditional stimulus control. Six typically developing children ages 6 – 7 were first taught two A-B (i.e., state to city) and two B-C (i.e., city to park) intraverbals, then probed on 12 A-B, B-C, B-A, C-B, A-C, and C-A intraverbals. If novel intraverbal relations did not emerge, each participant received either category or exemplar training. In category training, participants were trained to respond with “state”, “city”, or “park” given names of states, cities, and parks. In exemplar training, participants were trained to name some examples of states, cities, and parks. If novel intraverbals did not emerge, the participant was exposed to the other training condition. Results showed that five out of the six participants’ demonstrated emergence of all novel relations. These results provide evidence and support existing literature demonstrating that training simple discriminations facilitates acquisition of conditional discriminations.