January 2012

Transformation of Stimulus Function Through Relational Networks: The Impact of Derived Stimulus Relations on Stimulus Control of Behavior

Samantha Rose Florentino
University of South Florida, florentino.samantha@gmail.com

Follow this and additional works at: http://scholarcommons.usf.edu/etd
Part of the American Studies Commons, Behavioral Disciplines and Activities Commons, and the Psychology Commons

Scholar Commons Citation

This Thesis is brought to you for free and open access by the Graduate School at Scholar Commons. It has been accepted for inclusion in Graduate Theses and Dissertations by an authorized administrator of Scholar Commons. For more information, please contact scholarcommons@usf.edu.
Transformation of Stimulus Function Through Relational Networks:
The Impact of Derived Stimulus Relations on Stimulus Control of Behavior

by

Samantha R. Florentino

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts
Department of Child and Family Studies
College of Behavioral and Community Sciences
University of South Florida

Major Professor: Timothy M. Weil, Ph. D., BCBA
Raymond G. Miltenberger, Ph. D., BCBA
Kimberly A. Crosland, Ph. D., BCBA

Date of Approval:
July 6, 2012

Keywords: Relational Frame Theory, derived relational responding, discriminative
stimulus function, relational frames, sameness

Copyright © 2012, Samantha R. Florentino
Acknowledgements

I offer my gratitude to my advisor, Dr. Timothy Weil, for his constant support, guidance, and encouragement throughout the thesis process. I would also like to acknowledge and thank my amazing research assistants, Anna Garcia, Tricia Jeffries, and Diana Sanguino. This thesis would not be complete without your hard work. Finally, I would like to thank Laura Hanratty and Ashley Breeden for their support, understanding, and unconditional friendship throughout this process.
# Table of Contents

List of Tables ..................................................................................................................... iv

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

Abstract ............................................................................................................................. vii

Chapter 1: Introduction ........................................................................................................1
  Relational Frame Theory ................................................................................................. 3
  Mutual Entailment ........................................................................................................... 5
  Combinatorial Entailment ............................................................................................... 6
  Transformation of Stimulus Function ............................................................................. 6
  Transformation of Stimulus Function Research ............................................................ 8
  Transformation of antecedent function .......................................................................... 10
    Standard training and testing protocol ......................................................................... 10
    Establishing a function for a stimulus prior to entering it into a relational frame .......... 11

Chapter 2: Purpose ............................................................................................................. 15

Chapter 3: Method ............................................................................................................. 17
  Participants and Setting ................................................................................................... 17
  Target Behaviors and Data Collection .......................................................................... 18
  Design ............................................................................................................................ 18
  Interobserver Agreement ............................................................................................... 19
  Outline of Procedure ...................................................................................................... 20
  Stimuli ............................................................................................................................ 21
    Pre-training stimuli ....................................................................................................... 21
    Distractor stimuli ......................................................................................................... 21
    Procedure 1 stimuli ..................................................................................................... 22
    Procedure 2 stimuli ..................................................................................................... 23
  Preference Assessment .................................................................................................. 23
  Procedure ....................................................................................................................... 24
    Phase 1: pre-training .................................................................................................... 24
      Training X-Y and X-Z relations .................................................................................. 25
      Testing mutual and combinatorial entailment ......................................................... 27
      Establishing a second 3-member relational network ................................................. 27
    Procedure 1 ................................................................................................................ 28
      Phase 1: Train a 4-member frame of coordination ................................................... 28
Phase 2: Train B (or BB) stimulus as a discriminative stimulus ........................................ 29
Phase 3: Test for transformation of stimulus function .......................................................... 31
Procedure 2 ......................................................................................................................... 33
Phase 1: Train F stimulus as discriminative stimulus ............................................................ 33
Phase 2: Train a 4-member frame of coordination ................................................................ 33
Phase 3: Test for transformation of stimulus function .......................................................... 35

Chapter 4: Results ............................................................................................................. 36
McKenzie ............................................................................................................................. 36
Preference assessment ......................................................................................................... 36
Pre-training .......................................................................................................................... 37
Procedure 1 .......................................................................................................................... 37
  Phase 1 (1.1 Train Class ABCD) ....................................................................................... 37
  Phase 2 (1.2 Establish B as $S^D$) .................................................................................... 37
  Phase 3 (1.3) ..................................................................................................................... 38
Procedure 2 .......................................................................................................................... 39
  Phase 1 (Establish F as $S^D$) ........................................................................................ 39
  Phase 2 (2.2 Train Class EFGH) ..................................................................................... 39
  Phase 3 (2.3) ..................................................................................................................... 39
Number of sessions and trials .............................................................................................. 40
Harrison ................................................................................................................................. 40
Preference assessment ......................................................................................................... 40
Pre-training .......................................................................................................................... 40
  Class XYZ ......................................................................................................................... 40
  Class MNO ......................................................................................................................... 41
Procedure 1 .......................................................................................................................... 41
  Phase 1 (Train Class ABCD) ............................................................................................ 41
  Phase 2 (Establish B as $S^D$) ........................................................................................ 44
  Phase 3 (1.3) ..................................................................................................................... 45
Procedure 2 .......................................................................................................................... 45
  Phase 1 (2.1 Establish F as $S^D$) .................................................................................. 46
  Phase 2 (2.2) ..................................................................................................................... 46
  Phase 3 (2.3) ..................................................................................................................... 46
  Phase 2 (2.2.1 Train Class EEFGGHH) ......................................................................... 46
  Phase 3 (2.3.1) ................................................................................................................ 47
Number of sessions and trials .............................................................................................. 47
Susie ......................................................................................................................................... 47
Preference assessment ......................................................................................................... 47
Pre-training .......................................................................................................................... 50
  Class XYZ ......................................................................................................................... 50
  Class MNO ......................................................................................................................... 50
Procedure 2 .......................................................................................................................... 50
  Phase 1 (2.1 Establish F as $S^D$) .................................................................................. 51
  Phase 2 (Train Class EFGH) ......................................................................................... 51
Phase 3 (2.3) ..................................................................................52
Procedure 1 ..................................................................................53
  Phase 1 (Train Class ABCD) ...................................................53
  Phase 2 (Train B as $S^D$) ...................................................53
  Phase 3 (1.3) ...................................................................53
  Phase 1 (1.1) ...................................................................54
  Phase 3 (1.3) ...................................................................54
Number of sessions and trials .................................................54
Zeke............................................................................................54
  Preference assessment .......................................................54
  Pre-training ....................................................................55
    Class XYZ ....................................................................55
    Class MNO ....................................................................55
Procedure 2 .............................................................................55
  Phase 1 (2.1 Establish F as $S^D$) ........................................58
  Phase 2 (2.2 Train Class EFGH) .........................................58
  Phase 3 (2.3) ...............................................................58
  Phase 2 (2.2) ...............................................................58
  Phase 3 (2.3).....................................................................60
Procedure 1 .............................................................................60
  Phase 1 (1.1 Train Class AABBCCDD) .........................60
  Phase 2 (1.2 Train BB as $S^D$) .........................................61
  Phase 3 (1.3) ...............................................................61
Number of sessions and trials .................................................61

Chapter 5: Discussion ........................................................................................................65
Future Directions ........................................................................74

Chapter 6: References Cited ..............................................................................................77

Appendices .........................................................................................................................81
  Appendix A: Pre-Training Stimuli ........................................82
  Appendix B: Similar Distractors for McKenzie’s Pre-Training Phase ...............82
  Appendix C: Distractor Stimuli for Harrison, Susie, and Zeke’s Pre-
    Training Phase ................................................................83
  Appendix D: Procedure 1 Relational Network Stimuli for McKenzie, 
    Harrison, and Susie ........................................................83
  Appendix E: Procedure 1 Relational Network Stimuli for Zeke .......................83
  Appendix F: Additional Non-Target Stimuli for Procedure 1 .......................84
  Appendix G: Procedure 2 Relational Network Stimuli for McKenzie, 
    Susie, and Zeke .............................................................84
  Appendix H: Procedure 2 Relational Network Stimuli for Harrison ...............84
  Appendix I: Additional Non-Target Stimuli in Procedure 2 .......................84
  Appendix J: Distractor Stimuli for Procedure 1 for Zeke and Procedure 2 
    for Harrison .................................................................85
List of Tables

Table 1: Total Number of Sessions and Trials for McKenzie ..............................................43
Table 2: Total Number of Sessions and Trials for Harrison ..........................................................49
Table 3: Total Number of Sessions and Trials for Susie .............................................................57
Table 4: Total number of sessions and trials for Zeke .................................................................62
Table 5: Final transformation of stimulus function test probes for all participants ...............64
List of Figures

Figure 1: Directly trained and derived relations in the relational frame of coordination containing the picture of a car, the written word CAR, and the vocal response “car.” ............................................................5

Figure 2: Diagram of the main procedural outline.........................................................20

Figure 3: Diagram outlining the order of steps for the two procedures......................20

Figure 4: Direct training and derived relationships in the 3-member stimulus class composed of stimuli X, Y, and Z.............................................................26

Figure 5: Direct training and derived relationships in the 3-member stimulus class composed of stimuli M, N, and O .........................................................28

Figure 6: Four-member frame of coordination trained in Phase 1 of Procedure 1 for McKenzie, Harrison, and Susie ..............................................................30

Figure 7: Four-member relational network of coordination trained in Phase 2 of Procedure 2 for McKenzie, Susie, and Zeke ......................................................34

Figure 8: Preference assessment results for McKenzie .................................................36

Figure 9: Pre-training results for McKenzie, demonstrating her ability to engage in derived relational responding.................................................................38

Figure 10: Graphical representation of McKenzie’s training and testing data for Procedures 1 and 2 .................................................................42

Figure 11: Results for McKenzie’s transformation of stimulus function test probes for both Procedures 1 and 2 .................................................................43

Figure 12: Preference assessment results for Harrison ..................................................44

Figure 13: Pre-training results for Harrison, demonstrating his ability to engage in derived relational responding .............................................................45
Figure 14: Graphical representation of training and testing data for Harrison for both Procedure 1 and 2...................................................................................48

Figure 15: Results for Harrison’s transformation of stimulus function test probes for both Procedures 1 and 2...........................................................................49

Figure 16: Preference assessment results for Susie .........................................................51

Figure 17: Pre-training results for Susie, demonstrating her ability to engage in derived relational responding .................................................................52

Figure 18: Results of Susie’s training and testing data for Procedure 1 and 2..............56

Figure 19: Results for Susie’s transformation of stimulus function test probes for both Procedures 1 and 2 .................................................................57

Figure 20: Preference assessment results for Zeke .........................................................59

Figure 21: Pre-training results for Zeke, demonstrating his ability to engage in derived relational responding .................................................................59

Figure 22: Graphical representation of Zeke’s training and testing data for Procedure 1 and 2 ...........................................................................................63

Figure 23: Results for Zeke’s transformation of stimulus function test probes for both Procedures 1 and 2 .................................................................64
Abstract

Relational Frame Theory research involves either of two protocols utilized to establish relational networks and functions for stimuli in those relational networks. Years of research indicate the most prevalent method involves first establishing a relational frame, conditioning one of the stimuli to acquire a particular function, and then providing a test to see if the function trained to one of the stimuli in the network transferred through the relational network to other stimuli. The less common method involves first training a particular function for a stimulus, entering that stimulus in a relational network with at least two other stimuli, and then subsequently providing a test to see if the function transferred. Hayes, Kohlenberg, and Hayes (1991) hypothesized that not only do both procedures work, but there is also no differentiation between the two with regards to transformation of stimulus function. Although both protocols have been used in the RFT literature, a direct comparison has never been made. The current study directly examines that comparison in a within-subject analysis to determine if there may be differentiated results in transformation of stimulus function based on the protocol used. A within-subjects analysis indicates that subsequent probes of transformation of stimulus function probes yielded similar levels of correct responding in both training protocols, and thus supporting the hypothesis put forth by Hayes and colleagues (1991).
Chapter 1:

Introduction

Language has been the focus of philosophy and science for thousands of years (Torneke, 2010). While young, the field of psychology has put forth considerable effort in its attempts to gain a greater understanding of human language and the processes involved (Skinner, 1957; Torneke, 2010). Unfortunately, with the rise and dominance of a cognitive orientation to language, attention has been diverted to hypothetical mental constructs where the behavior of the organism is said to serve as a proxy of what occurs in the metaphysical realm (DeHower, 2011). In other words, behavior is not considered an appropriate subject matter in its own right, but rather serves as an identifier of sorts for that which is said to occur in our mind. Contrary to this, the behaviorist position does not break the person into convenient pieces said to be responsible for behavior, but rather looks at the whole organism as it behaves with both an historical and situational context. In this (behavioral) conception of language, words and their meanings, whether spoken, thought, written, or signed, are behaviors that are fully amenable to a behavior analysis that does not fall subject to hypothetical constructs and reductionism (Skinner, 1957, 1974).

Of particular interest in a behavioral perspective is the investigation of language as merely operant behavior which was put forth by Skinner in Verbal Behavior (1957).
Skinner’s operant analysis of language provides a conceptual framework for understanding language as behavior – his term for this behavior being ‘verbal behavior,’ and it includes a taxonomy of verbal operants that are functionally, rather than formally, distinct. More recently, his account which is based solely on associative processes, has been found wanting (Hayes, Barnes-Holmes, & Roche, 2001; Sidman, 2008, 2009).

Research on derived stimulus relations has opened the door to investigation in non-associative operant processes that appear to have an effect on both the development of language and the alteration of functions for stimuli impacted by language.

The research on derived stimulus relations (dsr) began with Sidman’s work on equivalence relations in the latter part of the 20th century (1971). Through conditional discriminations, training establishes that one stimulus (A) is equivalent to a second stimulus (B). Further training establishes that stimulus B is equivalent to Stimulus C. The outcomes of this training produce derived relations between stimulus B and stimulus A, between stimulus C and stimulus B (symmetry), as well as, between stimuli A and C (transitivity) (Sidman, 2009). These outcomes are said to be due to the absence of explicit training for the reversed relations. While Sidman’s research on stimulus equivalence began the investigation of non-associative operant processes, it was said to be limited in development and theory due to Sidman’s identification of derived relational responding (drr) as phylogenic in nature, and the inclusion of only one relation (Hayes et al., 2001).

Regarding the former, Sidman explains the phenomena of derived stimulus relations as an artifact of the learning context; that is, the exposure to multiple exemplars through conditional discrimination training develops an ability that is already inherent in
human genetic endowment. It appears that Sidman struggled with the notion of dsr
ability and operant psychology based in associative principles – thus leading to the only
possible behavioral explanation – we are prepared to derive. Regarding the latter point,
stimulus equivalence is limited to only frames of coordination. There is no account of the
many other relations that we are exposed to in the world of experience. Other possible
relational frames include comparative (more than-less than, bigger-smaller, etc.),
hierarchical, deictic, before-after, spatial, opposition, distinction, and conditionality, to
name a few (Hayes et al., 2001).

Hayes et al. (2001) expanded the concept of basic stimulus equivalence through
the development of Relational Frame Theory (RFT). RFT provides a more robust
behavioral account of processes that affect the development of verbal behavior and how
drr impacts the alterations of functions for related stimuli. All stimuli that we are
exposed to take part in building a relational network of incredible complexity. This
network is not structural, as in Piaget’s scaffolding (Wadsworth, 2004), but rather is a
functional network where stimulus relations are based on both direct experience and the
experiences that have shaped how we derive relations. Before continuing, it will be best
to further unpack the concept of relational framing and review literature that illustrates
the process of derived relational responding.

**Relational Frame Theory**

Relational Frame Theory is a theory of verbal behavior that expands on the core
behavior analytic viewpoint of language and cognition and extends the theory of stimulus
equivalence put forth by Sidman (1971), by providing a theory supportive of derived
relational responding as an operant behavior. RFT proposes that words, and stimuli in
general, form relational networks, from which they obtain their “meaning,” function, and relationship to other stimuli, or words (Toreneke, 2010). Hayes et al. (2001) indicate that there are a variety of different relational frames that form networks between stimuli. Relational frames of coordination are those that deal with sameness and stimulus equivalence, developing stimulus classes where Stimulus A is functionally the same as Stimulus B. That is the only relational frame that Sidman (1971; 2008; 2009) studied. However, Hayes et al. (2001) expanded this to include a number of other relationships, all of which can emerge/be derived without explicit training. Because these relational frames deal with much more than equivalence, new defining characteristics emerged accordingly. Three characteristics of derived relational responses are: mutual entailment, combinatorial entailment, and transformation of stimulus function.

Additionally, and of considerable importance, behavior is said to be verbal only if it can be shown to participate in a relational network with these three defining characteristics (Hayes et al, 2001). For example, upon learning the tact “car,” Skinner’s analysis would indicate that the vocal verbal response “car” is verbal if in the presence of the non-verbal stimulus, an individual emits “car” and receives a generalized reinforcer. From an RFT perspective, the vocal emission is not verbal in any special sense until it enters into a relational frame that expands the mutually entailed relation (the stimulus car and the vocal verbal “car” are said to be equivalent) to include at least one other stimulus which permits a derived response between two stimuli that were never trained together. For instance, if we added the written word CAR to the relational network and trained it specifically with respect to the picture of a car, we could then test for the emergence of a combinatorially entailed relation between the spoken word “car” and the written word
CAR although these two stimuli have never been seen together, much less trained together. As these are complex constructions, we will revisit each below.

**Mutual entailment.** Mutual entailment refers to the bi-directionality of relationships between stimuli (Hayes, Gifford, & Wilson, 1996). If A is related to B, then it is derived that B is also related to A. In the relational network depicted below, there are two mutually entailed relationships. The picture of the car is directly trained to the written word CAR; as such the learner acquires the relationship of the car being the same as the written word CAR. In addition, the picture of the car is directly trained to the vocal response “car,” as such the learner acquires the relationship of the car being equivalent to the verbalization “car.”

Unlike symmetry, where all relationships are equal, and thus, the derived relationship is the same as the trained relationship, the derived relation in mutual entailment depends on what relationship is taught between stimuli to begin with. For

![Diagram](image.png)

**Figure 1.** Directly trained and derived relations in the relational frame of coordination containing the picture of a car, the written word CAR, and the vocal response “car.”
example, if you are taught that A is smaller than B, you will derive that B is bigger than A (this derived relation is a demonstration of mutual entailment).

**Combinatorial entailment.** Combinatorial entailment involves the combination of two mutually entailed relationships (Hayes et al., 1996). For combinatorial entailment to be present, a relational network between at least three stimuli must develop. If A is related to B and A is related to C, B and C are also related to each other in some characteristic way. Combinatorial entailment refers to the derived relationship between B and C. That is, without being directly trained on any relationship between B and C, humans derive the appropriate relationship between the two. In the relational network of cars depicted above, there are also two combinatorially entailed relations. After the direct training conducted between the picture of the car and the written word CAR and between the picture of the car and the vocal response “car,” an individual will derive that the written word CAR is also equivalent to the vocal verbal response “car,” and vice versa; thus demonstrating combinatorial entailment through derived relational responding.

Because Relational Frame Theory encompasses relationships other than equivalence, the derived relationship between B and C does not necessarily have to be one of equivalence. As with mutual entailment, the combinatorially entailed relations depend on the initially trained relationship between the stimuli. For example, if a subject is taught that A is smaller than B and A is larger than C, the subject would derive that B is larger than C and C is smaller than B (combinatorial entailment).

**Transformation of stimulus function.** Transformation of stimulus function (TSF) is the third characteristic of a relational network. It refers to when the function of
one stimulus is transferred to a second stimulus in the relational network and subsequently transforms the function of the second stimulus. The term transformation is preferred over the term transfer as the latter term infers that a previously neutral stimulus attains the function of another stimulus in the relational network so that they both have the same exact function, practically mirror images of one another. The term ‘transformation’, on the other hand, acknowledges that the second stimulus in the relational network may already have its own functional properties and may not be a neutral stimulus. When transformation of stimulus function occurs, a function is transferred through the relational network from one stimulus to another. The receiving stimulus may maintain its initial function in some contexts. However, in the context that is currently being trained, the function of the receiving stimulus is combined with any other previously acquired functions that may also be activated in the current context, and thus the stimulus will function as a result of the combination of functions as opposed to a supplanting of function (Hayes et al., 2001).

Transformation of stimulus function is of particular importance for the present study as the current study seeks to extend the basic literature on transfer/transformation of antecedent function through relational networks. The literature pertaining to transformation of antecedent function focuses on: respondent elicitation (Augustson & Dougher, 1997; Augustson, Dougher, & Markham, 2000; Dougher, Augustson, Markham, Greenway, & Wulfert, 1994; Dougher, Hamilton, Fink, & Harrington, 2007; Roche & Barnes, 1997; Valverde, Luciano, & Barnes-Holmes, 2009); contextual cues (Dougher, Perkins, Greenway, Koons, & Chiasson, 2002; Gatch & Osborne, 1989; Griffe & Dougher, 2002; Kohlenberg, Hayes, & Hayes, 1991; Perkins, Dougher, & Greenway,
Before moving forward with a review of the literature, it is important to highlight the implications of the formation of a derived discriminative stimulus. In basic operant analysis, a stimulus acquires discriminative control over a response due to a history where the stimulus is present when a response is reinforced. Over several pairings of this sort, the stimulus is said to acquire stimulus control over the behavior (Cooper, Heron, & Heward, 2007). As a result of transformation through relational networks, however, it is possible to develop stimulus control without the history of pairing said to be necessary in the development of a discriminative stimulus. Instead, it is a stimulus that has acquired its function through its participation in a relational network where the function of another stimulus (in this example, discriminative function) was acquired indirectly through the relational network. The implications of this pertain to the scientific system of behavior analysis as associationistic accounts of discriminative stimuli cannot predict this outcome and cannot account for the development of discriminative function without a history of pairing otherwise.

**Transformation of Stimulus Function Research**

Many researchers have investigated the concept of transformation of stimulus function as it pertains to both the transfer of antecedent function and consequence functions (although to a lesser extent with discriminative function). As is evident by the sheer number of articles put forth on each topic, the majority of this research investigates respondent elicitation. In addition, those studies on respondent elicitation (Augustson & Dougher, 1997; Augustson et al., 2000; Dougher et al., 1994; Dougher et al., 2007;
Roche & Barnes, 1997; Valverde et al., 2009) utilize an operant task to test for transformation of stimulus function across equivalence class. Therefore, an investigation of functions as it pertains to operant behavior, in general, is necessary.

The typical sequence for training and testing the construction of stimulus networks and testing transformation of stimulus function is to first establish a stimulus network of three or more stimuli through conditional discriminations, establish a function for one of the stimuli in the class, and then provide subjects with a test to see if the function transferred to other stimuli in the relational frame (Hayes et al., 2001). Whether working with antecedent or consequent functions, a review of the literature has demonstrated that this sequence is the most common procedure used across researchers (Augustson & Dougher, 1997; Augustson et al., 2000; Barnes & Keenan, 1993; Dougher et al., 1994; Dougher et al., 2007; Dougher et al., 2002; Gatch & Osborne, 1989; Green et al., 1991; Griffé & Dougher, 2002; Kohlenberg et al., 1991; Perkins et al., 2007; Valverde et al., 2009; Wulfert & Hayes, 1988).

Although this seems to be the standard procedure, some researchers have constructed studies to evaluate the sequence of establishing a function for a stimulus first and then entering the stimulus into the stimulus network and testing for a transfer of function across stimuli (Gatch & Osborne, 1989; Hayes et al., 1991; 1989; Lazar, 1977; Roche & Barnes, 1997; Whelan & Barnes-Holmes, 2004). Although both types of training and testing procedures exist, to date, it is unknown if there is a differential effect of transformation of stimulus function across a relational network as a function of when the function is trained to the relational network.
Transformation of antecedent function. As it pertains to the research investigating transformation of stimulus function, the primary focus weighed heavily on the investigation of antecedent function. Furthermore, both evocative antecedents (such as discriminative stimuli and contextual cues) and respondent elicitation have been studied, with the primary focus on respondent elicitation. Although the main focus of the literature revolves around the standard testing and training protocol, an analysis of both protocols as it pertains to transformation of antecedent function is necessary for the current proposed study.

Standard training and testing protocol. The typical, or standard, protocol consists of establishing a stimulus network containing three or more stimuli using conditional discriminations, establishing a function for one of the stimuli in the class, and then providing subjects a test to see if the function transferred to other stimuli in the stimulus network (Hayes et al., 2001).

Dougher and colleagues (1994) demonstrated the use of this training and testing protocol as it pertains to respondent elicitation. After using matching-to-sample to establish two four-member equivalence classes, researchers paired the presentation of shock with one stimulus (B1) but not with the other stimulus (B2). Researchers utilized skin-conductance measures to measure respondent elicitation. To evaluate the effects of the B1 stimulus (shock), an operant task was used. Subjects were given a key pressing task and believed they had to press the keys to earn points. While engaged in the task, stimuli appeared on the screen in a semirandom order. Whenever the B1 stimulus was presented, the onset of shock occurred with the termination of the stimulus. No shock followed the B2 stimulus. Following this phase, subjects again engaged in the task;
however, C and D stimuli were shown on the screen in addition to the B stimuli. Shock again followed the B1 stimulus however, it did not follow any of the other stimuli. Skin-conductance measures were again collected for all of the stimuli. For six of eight subjects, transformation of respondent function occurred. Transformation of stimulus function was said to occur when the skin-conductance responses were greater for all the members of the class containing the B1 stimuli than for the stimuli in the class containing the B2 stimulus.

Similarly, Barnes and Keenan (1993) utilized this procedure to demonstrate the transformation of a discriminative function. After using conditional discriminations to establish two 3-member equivalence classes, a low-rate performance was trained in the presence of B1 and a high-rate performance was trained in the presence of B2. When subjects were later exposed to the C stimuli, subjects performed at similar rates to the corresponding B stimulus. Furthermore, the discriminative function transferred from C stimuli to stimuli that were physically similar.

*Establishing a function for a stimulus prior to entering it into a relational frame.* Establishing a stimulus network prior to establishing a function for a particular stimulus is not the only procedural order that researchers can use. The alternative protocol involves establishing a function for a stimulus, constructing a three-member stimulus class, and then providing a test to see if the function transferred through the stimulus class.

Gatch and Osborne (1989) established a contextual function for two stimuli by giving subjects the task of forming groups depending on which stimulus is present. Undergraduate subjects first arranged six stimuli into two groups based on which
contextual stimulus was present. After completing this task, the contextual stimuli were entered into three-member relational frames of coordination. Subsequent tests were provided to determine if transformation of stimulus function occurred.

To establish the function of the contextual cue, computerized conditional matching-to-sample procedures were used to establish the contextual cue to function as ‘same’. The contextual cue and sample stimuli were presented first, followed by three comparison stimuli, and instructions to select the comparison stimulus that went with the sample. After training each stimulus as a contextual cue, those stimuli were entered into two 3-member relational frames of equivalence. After training took place, matching-to-sample was utilized to test for mutual and combinatorial entailment. Finally, a test for transformation of stimulus function was delivered by presenting trials containing a mix of samples, including both the original contextual stimuli, and the derived contextual stimuli, to see if the subjects selected the same comparison stimulus under both conditions. Of the six subjects, five performed at criterion during the test for transformation of stimulus function. These results indicate that transformation of stimulus function occurred in five subjects for contextual stimuli that acquired a function prior to being entered into a relational frame of coordination.

Instead of focusing on operant behavior, Roche and Barnes (1997) investigated transformation of function after establishing a respondent elicitation function for a particular stimulus and then entering it into a relational network. Adult males watched sexually explicit and emotionally neutral films, both of which where paired with different nonsense syllables (C1 was paired with the sexually explicit film and C3 was paired with the neutral film). Thus, these syllables were shown to the men while they watched the
films in order to condition the stimuli. Subjects were then exposed to matching-to-sample conditional discriminations to establish two 3-member equivalence classes; each class contained one of the two original nonsense syllables.

After testing for derived relational responding, subjects were again exposed to the respondent conditioning training (showing the C1 and C3 stimuli and the movie clips); however, the researchers measured the subjects’ responses (change in electrical activity in the skin) when they viewed the C1 and C3 stimuli. Immediately following this phase, subjects were exposed to other stimuli in the relational network (stimuli were shown individually on the computer screen) and subjects’ responses were again measured. Results indicated that transformation of stimulus function occurred for five of the six stimuli; that is, for five individuals, if higher responses were seen in C1 compared to C3, higher responses were also seen in A1 compared to A3.

Further experimentation indicated that the transformation of respondent elicitation can be demonstrated without formally testing the emergence of derived relational responding (Roche & Barnes, 1997). These results are similar to those of Hayes and colleagues (1991), who established a consequential function for a stimulus before entering it into a relational network and then tested for transfer of stimulus function from that stimulus to other stimuli in the network. Hayes et al. ran a number of experiments to determine whether or not direct testing of equivalence relations was necessary to test for transformation of stimulus function. Results indicated that after training of the primary relations (such as A=B and A=C), it is not necessary to explicitly test if all the derived relations (B=A, C=A, B=C, C=B) are present before testing if transformation of stimulus function occurred.
This finding is important for several reasons as it pertains to the current proposed study. Hayes et al. (1991) investigated this idea because testing for the emergence of derived relations involves presenting those stimuli together (as samples and comparisons). For example, the primary equivalence relations above were A=B and A=C and researchers established functions for the B stimulus. By testing directly for all derived relations, the B and C stimuli would appear together; however, if you don’t directly test these relations, B and C never appear together. As a result, when transformation does occur, one can more reliably indicate this is a result of derived relational responding and the relationship between stimuli in the relational network rather than possibly being influenced by the association in testing procedures.
Chapter 2:

Purpose

The studies mentioned to this point have investigated only one of two possible training and testing procedures; no one has evaluated the two in a within-subjects comparison. Hayes et al. (1991) hypothesized from their study that transfer of function occurs when the function is established before or after stimulus equivalence classes are formed. Given this hypothesis, it is irrelevant if the stimulus function is acquired before or after the stimulus enters into a relational network. That is, there should be no differential effects on responding in tests of transformation of stimulus function to other stimuli within the relational frame. Although Hayes et al. hypothesized this finding based on the experiments conducted, a comparison of the two procedures has not been directly examined.

The purpose of the current study was to compare the two sequence procedures described above. One procedure (Procedure 1) involves undergoing conditional discrimination training to establish a four-member frame of coordination, then establishing a function for one of the stimuli through direct training, and finally, testing for transformation of stimulus function through the relational network to two other stimuli that are one- and two-nodal distances from the trained stimulus (the stimulus explicitly conditioned as a discriminative stimulus). The second procedure (Procedure 2)
involves establishing a discriminative function for one of the stimuli through direct training, conditional discrimination training to establish a four-member frame of coordination, and finally, testing for transformation of stimulus function. Half of the subjects underwent Procedure 1 followed by Procedure 2, while the other half were exposed to Procedure 2 and then Procedure 1.

This study expands the research on transformation of stimulus function in that it provides insight as to whether there are any significant differential effects on the evocative effects of stimuli after transformation of function has occurred. Furthermore, this study adds to the literature by providing hypotheses about the benefits of using each procedure and what contexts one procedure may be preferred over another.
Chapter 3:

Method

Participants and Setting

Two girls and two boys participated in this study. All four children were typically developing and had no known developmental delays as reported to the primary investigator by the children’s parent(s). McKenzie was a 7-year-old female who attended the second grade. Susie was a 7-year-old female who attended the first grade. Harrison was an 8-year-old male who attended the third grade. Zeke was a 7-year-old boy who attended the second grade.

Sessions were conducted in the participants’ homes 1-3 times per week and 3-8 training blocks were conducted per visit. Training took place at a table for all children with the exception of McKenzie. McKenzie’s training sessions took place on the living room floor. To avoid distractions, the only materials nearby consisted of the necessary training materials, reinforcers, and video camera during a particular session.

Participants were recruited through USF students, staff, and faculty, as well as community contacts. Interested parents contacted the first author. An initial email or phone interview was conducted to brief the parent on the study and gain background information about the potential participant to see they met initial study inclusion criteria. An in home meeting was scheduled following the initial phone/email interview so that
the researcher could meet the potential participant and obtain verbal assent from the child and written informed consent from the parent. In order to participate in this study, participants needed to demonstrate derived relational responding, which was determined through a pre-training phase, immediately following obtaining informed consent. All children recruited from the study reached mastery criteria in the pre-training phase, indicating they engaged in derived relational responding (discussed in the results section below).

**Target Behaviors and Data Collection**

Throughout all phases of the experiment, data was collected on correct and incorrect responses on a trial-by-trial basis. The percentage of responses correct per session is reported on the graphs, as well as in the results section. In the pre-training phase, phase 1 of Procedure 1, and phase 2 of Procedure 2, a response was considered correct if the subject pointed to or placed a small item (such as a coin, or binder clip) on the correct comparison stimulus on the laminated piece of paper. In phase 2 of Procedure 1, phase 1 of Procedure 2, and phase 3 of both Procedures 1 and 2, a response was considered correct if the subject put the correct colored poker chip on top of or next to the stimulus presented by the first author for a particular trial. For scoring purposes, a trial was only considered correct if the participant responded correctly independently on the first exposure of the trial without receiving any prompts.

**Design**

Two designs were utilized in this study. McKenzie and Harrison were exposed to an ABC design, where A is the pre-training phase, B is Procedure 1 (see Outline of Procedure section below), and C is Procedure 2 (see Outline of Procedure section below).
Susie and Zeke were exposed to an ACB design. That is, following the pre-training phase, participants were exposed to Procedure 2 followed immediately by Procedure 1 in order to counterbalance for sequencing effects.

The design that a particular participant was exposed to was determined in a semi-random fashion. The assignment was counterbalanced so there was a female and male participating in each design and Susie and Harrison were exposed to opposite designs because they resided in the same household. The pre-training phase for each participant was designed as a multiple baseline across relational frames.

**Interobserver Agreement**

Interobserver agreement was assessed by having 2 observers simultaneously but independently record data on the target behaviors. All sessions were video recorded so that a second observer could score them independently at a later time. Interobserver agreement percentages were obtained by comparing the observer’s data of recording each participant’s response as correct or incorrect to the first author’s data. If all trials were recorded the exact same way for a particular session, that session was scored as an agreement.

Overall, 86.9% of sessions across participants were independently observed and scored by a second observer. There was a 96% agreement between the second observer and the first author overall. For McKenzie, a second observer independently observed 83.3% of sessions with a 97.5% agreement between the two observers. For Harrison, a second observer independently observed 96.9% of sessions with a 96.8% agreement between the two observers. For Susie, a second observer independently observed 93% of sessions with a 95% agreement between the two observers. For Zeke, a second observer
independently observed 75% of sessions with a 94.7% agreement between the two observers.

**Outline of Procedure**

![Diagram of the main procedural outline](image)

*Figure 2. Diagram of the main procedural outline. McKenzie and Harrison were exposed to the sequence on the left; Susie and Zeke were exposed to the sequence on the right.*

![Diagram outlining the order of steps for the two procedures](image)

*Figure 3. Diagram outlining the order of steps for the two procedures*
Stimuli

In order to reference stimuli throughout this section, each stimulus has been assigned an alphanumeric. In this section, the alphanumerics for each type of stimulus are given. Pictorial representations of all stimuli discussed below can be found in Appendix A.

Pre-training stimuli. Six stimuli (X, Y, Z, M, N, and O) were utilized in the pre-training phase of each procedure. Through direct training and subsequent testing, these six stimuli formed 2 three-member frames of coordination. Including these six stimuli in the current study had three functions: First, it familiarized the subjects with the matching-to-sample procedure. Second, it allowed the researcher to test mutual and combinatorial entailment directly. This second point is important because Hayes and colleagues (1991) indicate that direct testing for combinatorial entailment may influence transformation of stimulus function testing. To test directly for the emergence of these relationships in the current study could possibly confound the subsequent transformation of stimulus function test because the stimuli need to be presented together in the matching-to-sample tests. Therefore, the researchers did not test these relationships in Phase 1 (Procedure 1) or Phase 2 (Procedure 2) of the experiment. Including pre-training phase in the current experiment demonstrated that the subject was capable of derived relational responding. Finally, these stimuli were used in the subsequent phases of both procedures as distractor stimuli for some of the participants.

Distractor stimuli. For McKenzie, distractor stimuli during the pre-training phase consisted of three pictures of familiar objects (frog, cellphone, dice, pig, truck, and snow man) in baseline probes and 30 nonsense stimuli (X, Y, Z, M, N, and 0, each letter
numbered 1-5) for derived relational responding probes. For Harrison, Susie, and Zeke, distractor stimuli in the pre-training phase were six stimuli (1, 2, 3, 4, 5, and 6) previously utilized in Steele and Hayes (1991). Distractor stimuli utilized in Procedure 1 for McKenzie, Harrison, and Susie and Procedure 2 for McKenzie, Susie, and Zeke were the six pre-training stimuli (X, Y, Z, M, N, and O). Distractor stimuli utilized in Procedure 1 for Zeke and Procedure 2 for Harrison were three stimuli (7, 8, and 9) previously utilized in Steele and Hayes (1991).

**Procedure 1 stimuli.** Four stimuli (A, B, C, and D) were utilized in Procedure 1 to form one 4-member frame of coordination for McKenzie, Sophie, and Harrison. Four different stimuli (AA, BB, CC, and DD) were utilized in Procedure 1 to form one 4-member frame of coordination for Zeke. Different stimuli were used for Zeke because he engaged in exclusion at the beginning of Procedure 1. It is hypothesized that exclusion occurred because the same distractors were used in both Procedure 1 and Procedure 2. Zeke had already been exposed to Procedure 2, during which Zeke’s behavior of picking particular stimuli (and thus, for not picking other, distractor stimuli) was reinforced. When Procedure 1 began with stimuli A, B, C, and D and the same distractor stimuli, he chose the new stimulus in the array, choosing away from the same stimuli he chose away from in Procedure 2, thus demonstrating exclusion. Therefore, a new class of stimuli (AA, BB, CC, and DD) and new distractor stimuli were used for Zeke only. None of the other participants demonstrated exclusion when exposed to the Procedure 1 stimuli. For all participants, four additional stimuli were used in Procedure 1 as non-target stimuli. In Phase 2, two stimuli (J, K) were used and in phase 3, two other stimuli (I, L) were used.
**Procedure 2 stimuli.** Four stimuli (E, F, G, and H) were utilized in Procedure 2 to form one 4-member frame of coordination for McKenzie, Susie, and Zeke. When Phase 2 of Procedure 2 commenced with Harrison, he engaged in exclusion like Zeke had demonstrated with Procedure 1. Therefore, new stimuli (EE, GG, and HH) were introduced to create a different 4-member frame of coordination, which consisted of these three stimuli and stimulus F. For all participants, four additional stimuli were used in Procedure 2 as non-target stimuli. In Phase 1, two stimuli (U, V) were used and in Phase 3, two stimuli (P, Q) were used.

**Preference Assessment**

The preference assessment was originally conducted by administering an informal questionnaire with the participants, in which a list of preferred candy was compiled. Once the list was complied, the first author sat with each participant’s parent/guardian to review the list and obtain verbal assent to use these items as potential reinforcers during subsequent sessions. Immediately before the beginning of each session, the participant was exposed to the array of all food items available to be earned for that session. The first author then asked the participant which food item s/he wanted to earn that session. This process was repeated at the beginning of each session (even when multiple sessions were conducted in a day) and for each session, all food items, even ones previously chosen were available in the array. At the beginning of the experiment, food items were delivered on an FR1 schedule; however, this schedule was systematically faded to a VR3 schedule during the course of the experiment. Although the schedule of reinforcement for tangible items was delayed, verbal praise was delivered on an FR1 schedule throughout the experiment.
Procedure

Phase 1: pre-training. As noted earlier, pre-training was used to familiarize subjects with table-top matching-to-sample training and testing procedures, demonstrate that the subject is capable of derived relational responding, and establish distractor stimuli for the remainder of the experiment. Through direct training and subsequent testing for derived relational responding, two 3-member frames of coordination were established. The first frame of coordination was composed of stimuli X, Y, and Z. The second frame of coordination was composed of stimuli M, N, and O.

This phase is of great importance moving forward. Research has indicated that directly testing for combinatorial entailment may influence subsequent transformation of stimulus function testing (Hayes et al., 1991). In order to test for combinatorial entailment, the stimuli involved would have to be presented together in a matching-to-sample testing trial. A limitation to the transformation of stimulus function testing following a direct testing of combinatorial entailment is that the stimuli have appeared together before so critics indicate that transfer only occurs because the stimuli have been associated. Hayes et al. (1991) demonstrated that it is not necessary to directly test this relationship to show transformation has occurred. If a subject is able to demonstrate transformation of stimulus function without directly testing combinatorial entailment, it can be said that the subject did in fact derive that relationship.

By eliminating the direct testing of combinatorial entailment in subsequent phases of the experiment, the potential limitation of prior exposure to stimuli is eliminated. By directly training and testing the pre-training stimulus classes, it is demonstrated that the participants are capable of derived relational responding.
**Training X-Y and X-Z relations.** Each training session consisted of 20 trials. Each trial involved a table-top matching-to-sample procedure. Research has indicated that using nonautomated matching-to-sample procedures can produce a number of variables affecting the results of the trial (Dymond, Rehfeldt, & Schenk, 2005). To bypass these threats to internal variability, which include spacing between stimuli, presenting the stimuli at precisely the same time, and random rotation of the comparison stimuli, the sample and comparison stimuli were presented as a single unit on a laminated sheet of paper (Dymond et al., 2005). Each trial was represented on a separate sheet of laminated paper. The sample stimulus measured 4 in. by 3 in. Each comparison stimulus measured 2 in. by 2 in. The comparison stimuli had an inch between each of them. The sample stimulus was centered above the middle comparison stimulus, placed an inch above the row of comparison stimuli. Additionally, each stimulus set (laminated sheet of paper) had the randomized position of the comparison stimuli counterbalanced to avoid overselective position responding (i.e. the incorrect choice is always on the left).

For each trial, the participant was instructed: “Match with same” or “Match.” Contingent on choosing the correct comparison stimulus, the subject was told “Correct” or “Good Job,” received the highly preferred edible item from the preference assessment, and the laminated paper for that trial was removed. If the participant made an incorrect response, the first author ended the trial, removed the laminated paper, and initiated a new trial. No error correction procedures or prompting were used. Sessions were run without an error correction procedure because the researchers wanted participants to form contingency-based responses rather than ruled-governed behavior. That is, it was hypothesized that if any prompting was used, it would possibly result in participants
making some type of arbitrary rule for picking the correct stimulus rather than the reinforcement contingency shaping their behavior.

Subjects were first exposed to massed trials for the X-Y relationship until criterion was reached. Criterion for training was set at 2 consecutive sessions at 100%. After meeting criterion on each relationship in massed trial format, subjects were exposed to random rotation of X-Y and X-Z relations, where both Y and Z were randomly presented as the correct choice among the comparison stimuli. Order was counterbalanced so that neither stimulus was presented more than twice in a row as the correct comparison stimulus. In addition, Y and Z were never presented at the same time among comparison stimuli. Reinforcement in the form of verbal praise and edible items was still available contingent on correct responses during random rotation.

Following a subject meeting criterion on the random rotation trials, post-instructional probes were conducted with the subject. During post-instructional probes, no prompting or reinforcement were provided by the trainer. These probes were also presented as random rotation sessions, with 1 session being composed of 20 trials. In addition, Y and Z again were rotated as the correct comparison stimulus, always ensuring that those
stimuli were never presented together during the same trial. Post instructional probes were administered until criterion was met. Criterion for post instructional probes was 2 consecutive sessions at 95% correct with a correct response made on the first trial.

**Testing mutual and combinatorial entailment.** After reaching master criterion in massed trials for each relationship, random rotation of the two relationships, and post instructional probes, subjects were tested for the emergence of mutual and combinatorial entailment. These sessions are referred to as the derived relational responding probes. Each session was composed of 5 trials of each mutually entailed relationship (5 Y-X and 5 Z-X) and 5 trials of each combinatorially entailed relationship (5 Y-Z and 5 Z-Y), totaling 20 trials for any given session. The Y and Z stimuli were randomly rotated as the sample stimulus. On any given trial, there was only one correct selection among the comparison stimuli. For example, if Y was presented as the sample stimulus, X would be the correct comparison stimulus if testing mutual entailment; Z would be the correct comparison stimulus if testing combinatorial entailment. Therefore, X and Z would never be presented together among comparison stimuli. Testing continued until a subject reached criterion, which was set at 95% correct with a correct response made on the first trial for 2 consecutive trials. Testing procedures followed the same table-top matching-to-sample procedure that was used to train initial relationships.

**Establishing a second 3-member relational network.** A second 3-member frame of coordination was established simultaneously using the exact training procedures that were described above to establish the first 3-member frame of coordination containing the stimulus set X, Y, and Z. The only difference from the above procedure is that this second class was composed of a different stimulus set (M, N, and O).
Phase 1: Train a 4-member frame of coordination. For all participants except for Zeke, stimuli A, B, C, and D were used in this phase of the experiment. For Zeke, stimuli AA, BB, CC, and DD were used in this phase of the experiment. Direct training in table-top matching-to-sample format was used to directly train 3 relationships. Those 3 relationships were A-B (or AA-BB), A-C (or AA-CC), and C-D (or CC-DD). The training procedures were identical to those described for the X-Y and Y-Z relationships described in Phase 1 of the experiment. For A-B (or AA-BB), the sample stimulus was A (or AA) and the correct comparison stimulus was B (or BB). For A-C (or AA-CC), the sample stimulus was A (or AA) and the correct comparison stimulus was C (or CC). For C-D (or CC-DD), the sample stimulus was C (or CC) and the correct comparison was D (or DD).

Procedure 1. As noted above, all four participants underwent Procedure 1 training and testing procedures. McKenzie and Harrison were exposed to Procedure 1 immediately after they reached criteria for derived relational responding probes for both 3-member frames of coordination in the pre-training phase. Susie and Zeke were exposed to Procedure 1 immediately following the final transformation of stimulus function test probe in Phase 3 of Procedure 2.
A session was composed of 20 trials. Subjects were exposed to massed trials of A-B (or AA-BB), followed by massed trials of A-C (or AA-CC), and finally, C-D (CC-DD). A subject continued training on a particular relationship until the criteria of 2 consecutive sessions at 100% correct responding was reached. Once mastery criterion was reached, the subject moved onto the next relationship in the sequence. The characteristics of the massed trials were identical to those explained in the pre-training phase. After mastery criterion was reached for each individual relationship, random rotation of the three relationships occurred. A and C (or AA and CC) were randomly presented as the sample stimulus, with the order counterbalanced so no relationship was presented more than twice in a row. This random rotation continued until the subject reached 2 sessions at 100% correct responding. Finally, once that criterion was reached, the subject moved into post instructional probes. Post instructional probes had no reinforcement component that was present in the massed trials and random rotation sessions.

**Phase 2: Train B (or BB) stimulus as a discriminative stimulus.** This phase of the experiment involved utilizing an operant task to directly train stimulus B (or BB) as a discriminative stimulus. The operant task consisted of picking a colored poker chip when presented with stimulus B (or BB). Two other stimuli (J and K) were also be used during this phase of the experiment to train different responses, picking different colored poker chips when presented with these stimuli. Therefore, for each participant, a color (black, blue, red, or green) was randomly chosen by the first author to be the correct answer for each of the three stimuli. All three stimuli had a different correct answer. For example,
one set of correct answers may be: when B is presented, the correct answer was picking green; when J was presented, the correct answer was picking red, and when K was presented, the correct answer was blue. The correct answers differed from participant to participant. Training two neutral stimuli as discriminative stimuli for other operant responses was important for the upcoming test for transformation of stimulus function.

Each session consisted of 30 trials. The three stimuli were randomly rotated within a session, with ten presentations of each stimulus. Order was counterbalanced so that no stimulus was presented more than twice in a row. Prior to any training sessions, subjects were instructed that different pictures were going to be shown one at a time and
that they were supposed to choose one of the three colored poker chips that they thought was correct. This instruction was given only once, at the beginning of the phase. No other instructions or prompts were given during the training sessions. Each stimulus B (or BB), J, and K was expanded in size to 3 inches by 4 inches and printed on its own laminated piece of paper. Contingent on correct responses, subjects were told “Correct” or “Good Job,” delivered a piece of the highly preferred tangible item from the preference assessment administered prior to the session, the stimulus was removed, and a new trial was initiated. If the subject responded incorrectly, the first author prompted the child to trial a different color. This process continued until the child responded by picking the correct color. Contingent on the child responding correctly, verbal praise was delivered, the stimulus was removed, and a new trial was initiated. No tangible reinforcer was delivered.

Sessions continued until criterion was reached. Criterion was set at two consecutive trials with 90% correct responding with the first trial correct per stimulus. That is, for a particular session, the participant had to respond correctly for the first exposure to B (or BB), J, and K, and get 90% of the 10 trials correct for each relationship. Once the criterion was reached, post instructional probes were given to the subject. During these probes, no reinforcement was used. In addition, if a subject responded incorrectly, s/he was not asked to try the trial again. Probes continued until the criterion of one session at 100% correct.

**Phase 3. Test for transformation of stimulus function.** Testing for transformation of stimulus function (TSF) was similar procedurally to that of Phase 2. However, the purpose of this phase is to present the C and D (or CC and DD) stimuli
separately and see if they evoke the same operant response that was trained in the presence of the B (or BB) stimulus. The C or D (or CC or DD) stimulus was presented and data was collected on whether or not the subject picked the same color that s/he was trained to pick in the presence of stimulus B (or BB).

A testing probe session was composed of 15 trials. For 5 of those trials, stimulus C (or CC) was presented to see if it evoked the operant response trained in Phase 2. For 5 trials, stimulus D (or DD) was presented to see if it evokes the same operant response trained in Phase 2. In both cases, a response would be considered correct if the subject picked the same color poker chip that s/he did when presented with stimulus B (or BB) in Phase 2. The other 5 trials consisted of presenting stimuli I or L as non-target stimuli and tasks. Two novel stimuli were presented in this test probe because it was hypothesized that if C (or CC) and D (or DD) were presented with J and K, it would be possible for the subject to engage in exclusion, choosing the correct color because they already were directly trained on the other two stimuli. Therefore, I and L were introduced so that the possibility of exclusion occurring was avoided entirely. The order of C (or CC), D (or DD), I, and L stimuli was counterbalanced to avoid a stimulus appearing more than two times in a row. Similar to other probe conditions, no prompting or reinforcement was utilized in testing conditions. Only one session was presented.

If the subject obtained a 0% correct for either the C (or CC) or D (or DD) stimuli, the subject was re-exposed to a portion of Phase 1 of Procedure 1. The subject underwent the random rotation training and post instruction probes portions of the conditional discrimination to re-train the frame of coordination. After the subject again reached mastery criterion for the relational frame training, a testing probe session of C (or
CC), D (or DD), I, and L stimuli was again presented to the subject. Regardless of the subject’s score for this probe, the subject was not exposed to any further training or testing and Procedure 1 was ended.

**Procedure 2.** As noted above, all four participants underwent Procedure 2 training and testing procedures. Susie and Zeke were exposed to Procedure 2 immediately after they reached criteria for derived relational responding probes for both three-member frames of coordination in the pre-training phase. McKenzie and Harrison were exposed to Procedure 1 immediately following the final transformation of stimulus function test probe in Phase 3 of Procedure 2.

**Phase 1: Train F stimulus as a discriminative stimulus.** This phase is identical to Phase 2 of Procedure 1 with the exception that a different combination of the colored poker chips was used and that the target operant response was trained in the presence of the F stimulus. Stimulus F acquired the discriminative function upon the completion of this phase. In addition, stimuli U and V will be utilized in this phase to train two other operant tasks (choosing different colored poker chips). These two stimuli served the same function as stimuli J and K in Phase 2 of Procedure 1.

**Phase 2: Train a 4-member frame of coordination.** Stimuli E, F, G, and H were used in this phase of the experiment for McKenzie, Susie, and Zeke. Stimuli EE, F, GG, and HH were used with Harrison. Training took place with the exact same procedures outlined in Phase 1 of Procedure 1. The only difference in this phase is the stimuli being trained. The three frames of coordination were E-F (or EE-F), E-G (or EE-GG), and G-H (or GG-HH). For E-F (or EE-F), the sample stimulus was E (or EE) and the correct comparison stimulus was F. For E-G (or EE-GG), the sample stimulus was E (or EE) and
the correct comparison stimulus was G (or GG). For G-H (or GG-HH), the sample stimulus was G (or GG) and the correct comparison stimulus was H (or HH).

A session was composed of 20 trials. Subjects were exposed to massed trials of E-F (or EE-F), followed by massed trials of E-G (or EE-GG), and finally, G-H (or GG-HH). A subject continued training on a particular relationship until the criteria of 2 consecutive sessions at 100% correct responding was reached. Once criterion was reached, the subject moved onto the next relationship in the sequence. The characteristics of the massed trials were identical to those explained in the pre-training phase. After criterion was reached for each individual relationship, random rotation of
the three relationships occurred. E (or EE) and G (or GG) were randomly presented as
the sample stimulus, with the order counterbalanced so no stimulus was presented as the
sample more than twice in a row. This continued until the subject reached 2 sessions at
100% correct responding. Finally, once that criterion was reached, the subject moved
into post instructional probes. Post instructional probes had no reinforcement component
that was present in the massed trials and random rotation sessions and continued until the
criterion of 2 consecutive sessions at 95% correct responding with the first trial correct
was reached.

Phase 3. Test for transformation of stimulus function. This phase was exactly
the same as Phase 3 in Procedure 1 with two exceptions. Derived discriminative stimuli
G and H (or GG and HH) were presented during the TSF probe sessions. Stimuli P and
Q were presented during the probe as non-target stimuli. If a subject was unable to meet
criteria, s/he underwent the same procedure discussed at the end of Phase 3 in Procedure
1; however, they underwent the random rotation training and post instructional probes in
Phase 2 of Procedure 2 to retrain the relational frame used in this procedure of the
experiment.
Chapter 4:

Results

McKenzie

Preference assessment. During McKenzie’s initial preference assessment, McKenzie identified sour path kids, nerds, and laffy taffy as items that she would like to use as reinforcers. During the course of the experiment, she asked if I could include sour watermelon candy and sour gummi worms as well. Sour watermelon and sour gummi worms were both the most highly preferred items, chosen 50% of the time it was presented. See Figure 8 for McKenzie’s preference assessment graph.

Figure 8. Preference assessment results for McKenzie. Sour Watermelon and sour gummi worm candies were the most highly preferred items.
**Pre-training.** McKenzie’s derived relational responding was shown in the pre-training phase. McKenzie scored 100% on both baseline probes for each relationship (class XYZ and class MNO). Due to her level of responding in baseline, no training took place. Instead, mutual and combinatorial entailment probes were conducted. McKenzie reached mastery criteria for each relationship within two sessions. See Figure 9 for the graphical representation of McKenzie’s pre-training data.

**Procedure 1.** A graphical display of McKenzie’s Procedure 1 results can be found in Figure 10. Note that the information in the parentheses in each phase label below refers to the section of the graph that the data being discussed can be found.

**Phase 1 (1.1 Train Class ABCD).** McKenzie scored 0% in the initial baseline (B/L) probe. She then underwent massed trial (MT) training sessions to establish three relationships, A-B, A-C, and C-D. McKenzie reached mastery criterion in: three sessions with an average score of 97% correct responses each session for A-B, two sessions with an average score of 100% correct responses each session for A-C, and three sessions with an average score of 95% correct responses each session for C-D. Following massed trial training sessions, McKenzie was exposed to random rotation (RR) training sessions of all three relationships. McKenzie reached mastery criteria within two sessions with an average score of 100% correct responses each session. McKenzie then participated in post-instructional probes (PIP), which she also met criteria within two sessions with an average score of 100% correct responses each session.

**Phase 2 (1.2 Establish B as S^D).** In the baseline probe (BL), McKenzie scored 0% for the target stimulus, B, and 50% and 20% for two non-target stimuli, J and K,
respectively. McKenzie reached mastery criterion for training of all three stimuli (RR training) in three sessions, with an average of 90% correct responses each session for stimulus B, and 97% correct responses each session for both stimuli J and K. McKenzie was then exposed to post-instructional probes (PIP) and reached mastery criterion in one session, scoring 100% for all stimuli.

**Phase 3 (1.3).** McKenzie was exposed to one transformation of stimulus function probe, scoring 80% correct responding for stimulus C and 20% correct responding for stimulus D. See Figure 11 for a graphical representation of all transformation of stimulus function probes for McKenzie.
Procedure 2. A graphical display of McKenzie’s Procedure 2 results can be found in Figure 10. Note that the information in the parentheses in each phase label below refers to the section of the graph that the data being discussed can be found.

Phase 1 (2.1 Establish $F$ as $S^D$). In the baseline probe, McKenzie scored 0% for the target stimulus, $F$, and 20% for each of the two non-target stimuli, $U$ and $V$. McKenzie reached mastery criterion for training of all three stimuli in three sessions, with an average of 90% correct responses each session for stimulus $F$, 93% correct responses each session for stimulus $U$, and 90% correct responses each session for stimulus $V$. McKenzie was then exposed to post-instructional probes and reached mastery criterion in 1 session, scoring 100% for all stimuli.

Phase 2 (2.2 Train Class $EFGH$). McKenzie scored 35% in the initial baseline probe. She then underwent training sessions to establish three relationships, $E-F$, $E-G$, and $G-H$. McKenzie reached mastery criterion in: three sessions with an average score of 97% correct responses each session for $E-F$, two sessions with an average score of 100% correct responses each session for $E-G$, and three sessions with an average score of 98% correct responses each session for $G-H$. Following massed trial training sessions, McKenzie was exposed to random rotation training sessions of all three relationships. McKenzie reached mastery criteria within three sessions with an average score of 97% correct responses each session. McKenzie then participated in post-instructional probes, which she met criteria within two sessions with an average score of 100% correct responses each session.

Phase 3 (2.3). McKenzie was exposed to one transformation of stimulus function probe, scoring 60% correct responding for stimulus $G$ and 40% correct
responding for stimulus H. See Figure 11 for a graphical representation of all transformation of stimulus function probes for McKenzie.

**Number of sessions and trials.** McKenzie participated in 16 sessions (360 trials) in Procedure 1 prior to the final transformation of stimulus function probe. She participated in 17 sessions (380 trials) in Procedure 2 prior to the final transformation of stimulus function probe. Note that the total number of sessions included all training sessions (massed trials and random rotation) and post instructional probe sessions, but excluded any baseline probes. See Table 1 for total number of sessions and trials per relationship for McKenzie.

**Harrison**

**Preference assessment.** The array of edible stimuli available for Harrison’s preference assessment consisted chocolate chip cookies, Doritos, dots, gummi worms/bears, laffy taffy, mini M&Ms, nerds, sour gummi worms, sour patch kids, and sour watermelon. Sour gummi works was the most highly preferred item, chosen 32.5% of the time it was presented. Sour patch kids was the second most highly preferred item, chosen 32.3% of the time it was presented. See Figure 12 for Harrison’s preference assessment graph.

**Pre-training.** Harrison’s derived relational responding was shown in the pre-training phase.

**Class XYZ.** Harrison scored 45% on the baseline probe, and then reached mastery criterion: in three sessions with an average of 88% correct responses each session for massed trial training (MT) of X-Y and in two sessions with 100% correct responses each session for massed trial training (MT) of X-Z. Harrison then reached
criterion for random rotation (RR) and post instructional probes (PIP), each in two sessions with an average of 100% correct responses each session. Mutual and combinatorial entailment probes (DRR probes) were then conducted with Harrison and he reached mastery criterion for each relationship within two sessions.

Class MNO. Harrison scored 25% in each of the two baseline probes. He reached mastery criterion in: two sessions with an average of 95% correct responses per session for massed trial training (MT) of M-N, and two sessions with an average of 100% correct responses per session for massed trial training (MT) of M-O. Harrison then reached criterion for random rotation (RR) and post instructional probes (PIP), each in two sessions with an average of 100% correct responses each session.

Mutual and combinatorial entailment probes (DRR probes) were then conducted with Harrison and he reached mastery criterion for each relationship within 2 sessions. See Figure 13 for the graphical representation of Harrison’s pre-training data.

Procedure 1. A graphical display of Harrison’s Procedure 1 results can be found in Figure 14. Note that the information in the parentheses in each phase label below refers to the section of the graph that the data being discussed can be found.

Phase 1 (1.1 Train Class ABCD). Harrison scored 65% in the initial baseline probe. He then underwent massed trial (MT) training sessions to establish three relationships, A-B, A-C, and C-D. Harrison reached mastery criterion in: two sessions with an average score of 100% correct responses each session for A-B, three sessions with an average score of 98% correct responses each session for A-C, and two sessions with an average score of 100% correct responses each session for C-D. Following
Figure 10. Graphical representation of McKenzie’s training and testing data for Procedures 1 and 2. Key: B/L refers to baseline probes, MT refers to massed trial training, RR refers to random rotation training, and PIP refers to post-instructional probes.
Figure 11. Results for McKenzie’s transformation of stimulus function test probes for both Procedures 1 and 2.

<table>
<thead>
<tr>
<th>Procedure One Trainings</th>
<th>Number of Sessions (# Trials) to Mastery Criteria</th>
<th>Procedure Two Trainings</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-B (MT)</td>
<td>3 sessions (60)</td>
<td>3 sessions (90)</td>
</tr>
<tr>
<td>A-C (MT)</td>
<td>2 sessions (40)</td>
<td>1 session (30)</td>
</tr>
<tr>
<td>C-D (MT)</td>
<td>3 sessions (60)</td>
<td>3 sessions (60)</td>
</tr>
<tr>
<td>A-B, A-C, &amp; C-D (RR)</td>
<td>2 sessions (40)</td>
<td>2 sessions (40)</td>
</tr>
<tr>
<td>A-B, A-C, &amp; C-D (PIP)</td>
<td>2 sessions (40)</td>
<td>3 sessions (60)</td>
</tr>
<tr>
<td>B = S_D RR</td>
<td>3 sessions (90)</td>
<td>E-F, E-G, &amp; G-H (RR)</td>
</tr>
<tr>
<td>B = S_D PIP</td>
<td>1 session (30)</td>
<td>E-F, E-G, &amp; G-H (PIP)</td>
</tr>
</tbody>
</table>

Total Exposures for Procedure One: 16 Sessions (360)
Total Exposures for Procedure Two: 17 sessions (380)

Transformation of Stimulus Function Probe:
One Nodal Distance (C) = 80%
Two Nodal Distance (D) = 20%

Transformation of Stimulus Function Probe:
One Nodal Distance (G) = 60%
Two Nodal Distance (H) = 40%
massed trial training sessions, Harrison was exposed to random rotation (RR) training sessions of all three relationships. He reached mastery criteria within two sessions with an average score of 100% correct responses each session. Following those training sessions, Harrison participated in post-instructional probes (PIP), which he also met criteria within two sessions with an average score of 100% correct responses each session.

**Phase 2 (1.2 Establish B as S°).** In the baseline probe (BL), Harrison scored 10% for the target stimulus, B, and 10% and 70% for two non-target stimuli, J and K, respectively. Harrison reached mastery criterion for training (RR training) of all three stimuli in four sessions, with an average of 98 correct responses each session for stimulus B, 95% correct responses each session for stimulus J, and 93% correct responses each session for stimulus K. Harrison was then exposed to post-instructional probes and reached mastery criteria in one session, scoring 100% for all stimuli.
**Phase 3 (1.3).** Harrison was exposed to one TSF probe, scoring 40% correct responding for stimulus C and 60% correct responding for stimulus D. See Figure 15 for the graphical representation of all TSF probes for Harrison.

**Procedure 2.** A graphical display of Harrison’s Procedure 2 results can be found in Figure 14. Note that the information in the parentheses in each phase label below refers to the section of the graph that the data being discussed can be found.

*Figure 13. Pre-training results for Harrison, demonstrating his ability to engage in derived relational responding.*
Phase 1 (2.1 Establish F as S\textsuperscript{D}). In the baseline probe (BL), Harrison scored 20% for the target stimulus, F, and 40% and 10% for each of the two non-target stimuli, U and V, respectively. Harrison reached mastery criterion for training (RR training) of all three stimuli in four sessions, with an average of 95% correct responses each session for stimulus F and 100% correct responses each session for both Stimuli U and V. Harrison was then exposed to a post-instructional probe (PIP) and reached mastery criterion in one session, scoring 100% for all stimuli.

Phase 2 (2.2). Harrison scored 100% on two baselines probes (B/L) for the relational frame of stimuli E, F, G, and H. Therefore, no training was conducted on this relational frame and he moved into Phase 3 of the experiment.

Phase 3 (2.3). Harrison was exposed to one TSF probe, scoring 40% correct responding for both stimuli, G and H.

Phase 2 (2.2.1 Train Class EEFGGHH). Since there was no opportunity to conduct training on the initial relational frame (E, F, G, and H), a new relational frame was introduced to Hazen. Since he had already established a discriminative function for stimulus F in Phase 2 of this experiment, F remained part of the new relational frame. The new relational frame consisted of stimuli EE, F, GG, and HH.

Harrison scored 25% in the initial baseline probe (B/L). He then underwent training sessions to establish three relationships, EE-F, EE-GG, and GG-HH. Harrison reached mastery criterion of massed trial training (MT) in: three sessions with an average score of 95% correct responses each session for EE-F and two sessions with an average score of 100% correct responses each session for both EE-GG and GG-HH. Following massed trial training sessions, Harrison was exposed to random rotation training (RR)
sessions of all three relationships. Harrison reached mastery criteria within 2 sessions with an average score of 100% correct responses each session. He then participated in post-instructional probes (PIP), which he met criteria within 2 sessions with an average score of 100% correct responses each session.

**Phase 3 (2.3.1).** Harrison was exposed to one TSF probe, scoring 40% correct responding for both stimuli, GG and HH. See Figure 15 for the graphical representation of all TSF probes for Harrison. Please note that Figure 15 does not contain the first TSF test probe in Procedure 2 because no training was conducted with the relational network.

**Number of sessions and trials.** Harrison participated in 16 sessions (370 trials) in both Procedure 1 and Procedure 2 prior to the final transformation of stimulus functions probes in each procedure. Note that the total number of sessions includes all training sessions (massed trials and random rotation) and post-instructional probe sessions, but excludes any baseline probes. See table 2 for total number of sessions and trials per relationship for Harrison. Note that totals reported here and in Table 2 for Procedure 2 are representative of sessions involving stimuli from the relational network consisting of EE, F, GG, and HH.

**Susie**

**Preference assessment.** The array of edible stimuli available for Susie’s preference assessment consisted chocolate chip cookies, Doritos, dots, gummi worms/bears, laffy taffy, mini M&Ms, nerds, sour gummi worms, sour patch kids, and sour watermelon. Sour patch kids were the most highly preferred item, chosen 30% of the time it was presented. See Figure 16 for Susie’s preference assessment graph.
Figure 14. Graphical representation of training and testing data for Harrison for both Procedures 1 and 2. Key: B/L refers to baseline probes, MT refers to massed trial training, RR refers to random rotation training, and PIP refers to post-instructional probes.
Figure 15. Results for Harrison’s transformation of stimulus function test probes for both Procedures 1 and 2.

Table 2. Total Number of Sessions and Trials for Harrison.

<table>
<thead>
<tr>
<th>Procedure One Trainings</th>
<th>Number of Sessions (# Trials) to Mastery Criteria</th>
<th>Procedure Two Trainings</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-B (MT)</td>
<td>2 sessions (40)</td>
<td>F = S^D RR</td>
</tr>
<tr>
<td>A-C (MT)</td>
<td>3 sessions (60)</td>
<td>F = S^P PIP</td>
</tr>
<tr>
<td>C-D (MT)</td>
<td>2 sessions (40)</td>
<td>EE-F (MT)</td>
</tr>
<tr>
<td>A-B, A-C, &amp; C-D (RR)</td>
<td>2 sessions (40)</td>
<td>EE-GG (MT)</td>
</tr>
<tr>
<td>A-B, A-C, &amp; C-D (PIP)</td>
<td>2 sessions (40)</td>
<td>GG-HH (MT)</td>
</tr>
<tr>
<td>B = S^D RR</td>
<td>4 sessions (120)</td>
<td>EE-F, EE-GG, &amp; GG-HH (RR)</td>
</tr>
<tr>
<td>B = S^P PIP</td>
<td>1 session (30)</td>
<td>EE-F, EE-GG, &amp; GG-HH (PIP)</td>
</tr>
</tbody>
</table>

Total Exposures for Procedure One: 16 Sessions (370)

Total Exposures for Procedure Two: 16 Sessions (370)

Transformation of Stimulus Function Probe:
One Nodal Distance (C) = 40%
Two Nodal Distance (D) = 60%

Transformation of Stimulus Function Probe:
One Nodal Distance (GG) = 40%
Two Nodal Distance (HH) = 40%
**Pre-training.** Susie’s derived relational responding was demonstrated in the pre-training phase.

**Class XYZ.** Susie scored 0% on the baseline probe, and then reached mastery criteria for massed trial (MT) training: in three sessions with an average of 95% correct responses each session for X-Y and in four sessions with an average of 96% correct responses each session for X-Z. Susie then reached criterion for random rotation (RR) and post instructional probes (PIP), each in two sessions with an average of 100% correct responses each session. Mutual and combinatorial entailment probes were then conducted with Susie and she reached mastery criterion for each relationship within two sessions.

**Class MNO.** Susie scored 10% and 20% in the two baseline probes. She reached mastery criterion in: two sessions with an average of 100% correct responses per session for M-N, and three sessions with an average of 98% correct responses per session for M-O. Susie then reached criterion for random rotation and post instructional probes, each in two sessions with an average of 100% correct responses each session. Mutual and combinatorial entailment probes (DRR probes) were then conducted with Susie and she reached mastery criterion for each relationship within two sessions. See Figure 17 for the graphical representation of Susie’s pre-training data.

**Procedure 2.** A graphical display of Susie’s Procedure 2 results can be found in Figure 18. Note that the information in the parentheses in each phase label below refers to the section of the graph that the data being discussed can be found.
Phase 1 (Establish F as $S^0$). In the baseline probe, Susie scored 20% for the target stimulus, F, and 40% and 30% for each of the two non-target stimuli, U and V, respectively. Susie reached mastery criterion for training of all three stimuli in four sessions, with an average of 83% correct responses each session for stimulus F, 88% correct responses each session for both stimulus U, and 85% correct responses each session for stimulus V. Susie was then exposed to a post-instructional probe (PIP) and reached mastery criterion in 1 session, scoring 100% for all stimuli.

Phase 2 (Train Class EFGH). Susie scored 20% in the initial baseline probe. She then underwent massed trial (MT) training sessions to establish three relationships, E-F, E-G, and G-H. Susie reached mastery criterion in: five sessions with an average score of 98% correct responses each session for E-F and two sessions with an average score of 100% correct responses each session for both E-G and G-H. Following massed trial training sessions, Susie was exposed to random rotation (RR) training sessions of all three relationships. Susie reached mastery criteria within three sessions with an average
score of 98% correct responses each session. She then participated in post-instructional probes (PIP), which she met criteria within 2 sessions with an average score of 100% correct responses each session.

**Phase 3 (2.3).** Susie was exposed to one TSF probe, scoring 40% correct responding for stimulus G and 20% correct responding for stimulus H. See Figure 19 for the graphical representation of all Susie’s TSF probes.

*Figure 17. Pre-training results for Susie, demonstrating her ability to engage in derived relational responding.*
**Procedure 1.** A graphical display of Susie’s Procedure 1 results can be found in Figure 18. Note that the information in the parentheses in each phase label below refers to the section of the graph that the data being discussed can be found.

**Phase 1 (Train Class ABCD).** Susie scored 60% in the initial baseline probe (B/L). She then underwent massed trial (MT) training sessions to establish three relationships, A-B, A-C, and C-D. Susie reached mastery criterion in: three sessions with an average score of 98% correct responses each session for A-B, two sessions with an average score of 100% correct responses each session for A-C, and two sessions with an average score of 100% correct responses each session for C-D. Following massed trial training sessions, Susie was exposed to random rotation (RR) training sessions of all three relationships. She reached mastery criteria within two sessions with an average score of 100% correct responses each session. Following those training sessions, Susie participated in post-instructional probes (PIP), which she also met criteria within two sessions with an average score of 100% correct responses each session.

**Phase 2 (Train B as S).** In the baseline probe (BL), Susie scored 0% for the target stimulus, B, and 0% for two non-target stimuli, J and K. Susie reached mastery criterion for training (RR Training) of all three stimuli in three sessions, with an average of 93% correct responses each session for stimuli B and J, and 100% correct responses each session for stimulus K. Susie was then exposed to post-instructional probes (PIP) and reached mastery criterion in one session, scoring 100% for all stimuli.

**Phase 3 (1.3).** Susie was initially exposed to one TSF probe, scoring 0% correct responding for both stimuli C and D.
Phase 1 (1.1). Since the TSF probe indicated that the discriminative function trained to stimulus B did not transfer at all to either stimuli C or D, Susie was exposed to one session of random rotation training and one session of post-instructional probes. She scored 100% on both sessions.

Phase 3 (1.3). Susie was exposed to a final TSF probe, scoring 100% correct responding for stimulus C and 0% correct responding for stimulus D. See Figure 19 for the graphical representation of all Susie’s TSF probes.

Number of sessions and trials. For Procedure 1, Susie participated in 15 sessions (340 trials) in Procedure 1 prior to the initial TSF probe. She then participated in two additional training sessions, totaling 17 sessions (380 trials), prior to the final TSF probe. For Procedure 2, Susie participated in 19 sessions (420 trials) in prior to the final TSF probe. Note that the total number of sessions includes all training sessions (massed trials and random rotation) and post-instructional probe sessions, but excludes any baseline probes. See table 3 for total number of sessions and trials per relationship for Susie.

Zeke

Preference assessment. The array of edible stimuli available for Zeke’s preference assessment consisted of Crunch, cookies and cream chocolate, double chocolate cookies, Hershey chocolate, Kit Kat, Skittles, sour gummi worms, sour path kids, Starburst, and tootsie rolls. Sour patch kids were the most highly preferred item, chosen 81% of the time it was presented. See Figure 20 for Zeke’s preference assessment graph.
**Pre-Training.** Zeke’s derived relational responding was demonstrated in the pre-training phase.

**Class XYZ.** Zeke scored 0% on the baseline probe, and then reached mastery criteria of massed trial (MT) training: in three sessions with an average of 95% correct responses each session for X-Y and in three sessions with an average of 97% correct responses each session for X-Z. Zeke then reached criterion for random rotation and post instructional probes, each in two sessions with an average of 100% correct responses each session. Mutual and combinatorial entailment probes (DRR probes) were then conducted with Zeke and he reached mastery criterion for each relationship within two sessions.

**Class MNO.** Zeke scored 5% and 35% in the two baseline probes. He reached mastery criteria of massed trial (MT) training in: two sessions with an average of 100% correct responses per session for M-N, and three sessions with an average of 92% correct responses per session for M-O. Zeke then reached criterion for random rotation (RR) and post instructional probes (PIP), each in two sessions with an average of 100% correct responses each session. Mutual and combinatorial entailment probes (DRR probes) were then conducted with Zeke and he reached mastery criterion for each relationship within two sessions. See Figure 21 for the graphical representation of Zeke’s pre-training data.

**Procedure 2.** A graphical display of Zeke’s Procedure 2 results can be found in Figure 22. Note that the information in the parentheses in each phase label below refers to the section of the graph that the data being discussed can be found.
Figure 18. Results for Susie’s training and testing data for Procedure 1 and 2. Key: B/L refers to baseline probes, MT refers to massed trial training, RR refers to random rotation training, and PIP refers to post-instructional probes.
Figure 19. Results for Susie’s transformation of stimulus function test probes for both Procedures 1 and 2.

Table 3. Total Number of Sessions and Trials for Susie.

<table>
<thead>
<tr>
<th>Procedure One Trainings</th>
<th>Number of Sessions (# Trials) to Mastery Criteria</th>
<th>Procedure Two Trainings</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-B (MT)</td>
<td>3 sessions (60)</td>
<td>4 sessions (120)</td>
</tr>
<tr>
<td>A-C (MT)</td>
<td>2 sessions (40)</td>
<td>1 session (30)</td>
</tr>
<tr>
<td>C-D (MT)</td>
<td>2 sessions (40)</td>
<td>5 sessions (100)</td>
</tr>
<tr>
<td>A-B, A-C, &amp; C-D (RR)</td>
<td>2 sessions (40)</td>
<td>2 sessions (40)</td>
</tr>
<tr>
<td>A-B, A-C, &amp; C-D (PIP)</td>
<td>2 sessions (40)</td>
<td>G-H (MT)</td>
</tr>
<tr>
<td>B = S³RR</td>
<td>3 sessions (90)</td>
<td>E-F, E-G, &amp; G-H (RR)</td>
</tr>
<tr>
<td>B = S³ PIP</td>
<td>1 session (30)</td>
<td>E-F, E-G, &amp; G-H (PIP)</td>
</tr>
</tbody>
</table>

Total Exposures for Procedure One: 15 Sessions (340)  
Total Exposures for Procedure Two: 19 Sessions (420)

Transformation of Stimulus Function Probe:  
One Nodal Distance (C) = 0%  
Two Nodal Distance (D) = 0%  
A-B, A-C, & C-D (RR)  
A-B, A-C, & C-D (PIP)  
Total Exposures for Procedure One: 17 sessions (380)  
Total Exposures for Procedure Two: 19 Sessions (420)

Transformation of Stimulus Function Probe:  
One Nodal Distance (C) = 100%  
Two Nodal Distance (D) = 0%
**Phase 1 (2.1 Establish F as S^D).** In the baseline probe, Zeke scored 30% for the target stimulus, F, and 10% and 30% for each of the two non-target stimuli, U and V, respectively. Zeke reached mastery criterion for training of all three stimuli in five sessions, with an average of 92% correct responses each session for stimulus F, 100% correct responses each session for both stimulus U, and 98% correct responses each session for stimulus V. Zeke was then exposed to a post-instructional probe and reached mastery criterion in one session, scoring 100% for all stimuli.

**Phase 2 (2.2 Train Class EFGH).** Zeke scored 70% in the initial baseline (B/L) probe. He then underwent massed trial (MT) training sessions to establish three relationships, E-F, E-G, and G-H. Zeke reached mastery criteria in: two sessions with an average score of 100% correct responses each session for E-F, three sessions with an average score of 98% correct responses each session for E-G, and three sessions with an average score of 97% correct responses each session for G-H. Following massed trial training sessions, Zeke was exposed to random rotation (RR) training sessions of all three relationships. Zeke reached mastery criteria within three sessions with an average score of 98% correct responses each session. He then participated in post-instructional probes (PIP), which he met criteria within two sessions with an average score of 100% correct responses each session.

**Phase 3 (2.3).** Zeke was exposed to an initial TSF probe, scoring 0% correct responding for stimulus G and 40% correct responding for stimulus H.

**Phase 2 (2.2).** Due to Zeke’s low level of responding on the TSF probe, he was re-exposed to part of Phase 1 for further training. He underwent two sessions of random rotation (RR) to meet criteria (1 session at 100% correct responding) with
Figure 20. Preference assessment results for Zeke. Sour patch kids were the most highly preferred item.

Figure 21. Pre-training results for Zeke, demonstrating his ability to engage in derived relational responding.
an average of 98% correct responses per session. He was then exposed to one post-
instructional probe (PIP) session with a score of 100% correct responses.

**Phase 3 (2.3).** Zeke was then exposed to a final TSF probe, scoring 0% correct
responding for stimulus G and 20% correct responding for stimulus H. See Figures 23
for the graphical representation of Zeke’s TSF probes.

**Procedure 1.** A graphical display of Zeke’s Procedure 1 results can be found in
Figure 22. Note that the information in the parentheses in each phase label below refers
to the section of the graph that the data being discussed can be found.

Phase 1 of Procedure 1 initially began with the same relational frame used with
other participants, composed of stimuli A, B, C, and D. However, he scored 100% on 2
baseline probes so no training could be conducted. A new relational frame with four new
stimuli (AA, BB, CC and DD) was then introduced. Zeke’s performance with those
stimuli is presented below.

**Phase 1 (1.1 Train Class AABBCCDD).** Zeke scored 15% in the initial baseline
(B/L) probe. He then underwent massed trial (MT) training sessions to establish three
relationships, AA-BB, AA-CC, and CC-DD. Zeke reached mastery criterion in: three
sessions with an average score of 98% correct responses each session for AA-BB, two
sessions with an average score of 100% correct responses each session for AA-CC, and
five sessions with an average score of 98% correct responses each session for CC-DD.
Following the massed trial training sessions, Zeke was exposed to random rotation (RR)
training sessions of all three relationships. He reached mastery criteria within 3 sessions
with an average score of 98% correct responses each session. Following those training
sessions, Zeke participated in post-instructional probes (PIP), which he met criteria within two sessions with an average score of 98% correct responses each session.

**Phase 2 (1.2 Train BB as S^0).** In the baseline probe (BL), Zeke scored 0% for the target stimulus, B, and 50% and 0% for the two non-target stimuli, J and K, respectively. Zeke reached mastery criterion for training (RR Training) of all three stimuli in three sessions, with an average of 93% correct responses each session for stimulus B, 97% correct responses each session for stimulus J, and 100% correct responses each session for stimulus K. Zeke was then exposed to post-instructional probe (PIP) and reached mastery criterion in one session, scoring 100% for all stimuli.

**Phase 3 (1.3).** Zeke was exposed to TSF probe, scoring 20% correct responding for both stimuli CC and DD. See Figure 23 for the graphical representation of all Zeke’s TSF probes.

**Number of sessions and trials.** For Procedure 1, Zeke participated in 19 sessions (420 trials) prior to the final TSF probe. For Procedure 2, Zeke participated in 19 sessions (440 trials) prior to the initial TSF probe. He then participated in 3 additional training sessions, totaling 22 sessions (500 trials), prior to the final transformation of stimulus function probe. Note that the total number of sessions includes all training sessions (massed trials and random rotation) and post-instructional probe sessions, but excludes any baseline probes. See Table 4 for total number of sessions and trials per relationship for Zeke.
Table 4. Total number of sessions and trials for Zeke.

<table>
<thead>
<tr>
<th>Procedure One Trainings</th>
<th>Number of Sessions (# Trials) to Mastery Criteria</th>
<th>Procedure Two Trainings</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA-BB (MT)</td>
<td>3 sessions (60)</td>
<td>5 sessions (150)</td>
</tr>
<tr>
<td>AA-CC (MT)</td>
<td>2 sessions (40)</td>
<td>1 session (30)</td>
</tr>
<tr>
<td>CC-DD (MT)</td>
<td>5 sessions (100)</td>
<td>2 sessions (40)</td>
</tr>
<tr>
<td>AA-BB, AA-CC, &amp; CC-DD (RR)</td>
<td>3 sessions (60)</td>
<td>3 sessions (60)</td>
</tr>
<tr>
<td>AA-BB, AA-CC, &amp; CC-DD (PIP)</td>
<td>2 sessions (40)</td>
<td>3 sessions (60)</td>
</tr>
<tr>
<td>B = ( S^D ) RR</td>
<td>3 sessions (90)</td>
<td>3 sessions (60)</td>
</tr>
<tr>
<td>B = ( S^D ) PIP</td>
<td>1 session (30)</td>
<td>2 sessions (40)</td>
</tr>
</tbody>
</table>

Total Exposures for Procedure One: 19 sessions (420)

Transformation of Stimulus Function Probe:
One Nodal Distance (CC) = 20%
Two Nodal Distance (DD) = 20%

Total Exposures for Procedure Two: 19 sessions (440)

Transformation of Stimulus Function Probe:
One Nodal Distance (G) = 0%
Two Nodal Distance (H) = 40%

2 sessions (40)          | E-F, E-G, & G-H (RR) |
1 session (20)           | E-F, E-G, & G-H (PIP) |

Total Exposures for Procedure Two: 22 sessions (500)

Transformation of Stimulus Function Probe:
One Nodal Distance (G) = 0%
Two Nodal Distance (H) = 20%
Figure 22. Graphical representation of Zeke’s training and testing data for Procedure 1 and 2. Key: B/L refers to baseline probes, MT refers to massed trial training, RR refers to random rotation training, and PIP refers to post-instructional probes.
Figure 23. Results for Zeke’s transformation of stimulus function test probes for both Procedures 1 and 2.

Table 5. Final transformation of stimulus function test probes for all participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Procedure 1: Transformation of Stimulus Function Probe</th>
<th>Procedure 2: Transformation of Stimulus Function Probe</th>
</tr>
</thead>
</table>
| McKenzie    | One Nodal Distance (C) = 80%  
Two Nodal Distance (D) = 20% | One Nodal Distance (G) = 60%  
Two Nodal Distance (H) = 40% |
| Harrison    | One Nodal Distance (C) = 40%  
Two Nodal Distance (D) = 60% | One Nodal Distance (GG) = 40%  
Two Nodal Distance (HH) = 40% |
| Susie       | First Exposure:  
One Nodal Distance (C) = 0%  
Two Nodal Distance (D) = 0%  
Second Exposure:  
One Nodal Distance (C) = 100%  
Two Nodal Distance (D) = 0% | One Nodal Distance (G) = 40%  
Two Nodal Distance (H) = 20% |
| Zeke        | One Nodal Distance (CC) = 20%  
Two Nodal Distance (DD) = 20% | First Exposure:  
One Nodal Distance (G) = 0%  
Two Nodal Distance (H) = 40%  
Second Exposure:  
One Nodal Distance (G) = 0%  
Two Nodal Distance (H) = 20% |
Chapter 5:
Discussion

Hayes and colleagues (1991) hypothesized that transfer of stimulus function occurred regardless if the function was established prior to or following the formation of a stimulus equivalence class. Throughout the literature on derived relational responding, both procedures have been used variously. That is, some researchers train function prior to forming a relational network while other's train function following establishment of the relational network. Regardless of which is used, researchers demonstrated the phenomenon of TSF. Still, no evaluations of the two procedures in a within-subjects comparison had been demonstrated.

The current study evaluated a within-subjects comparison of Procedures 1 and 2 to determine if there were any differential effects in levels of transformation of stimulus function. From a within-subjects analysis, the TSF probe results obtained in Procedure 1 were similar to those levels obtained in Procedure 2. Between the four participants, 10 TSF probes were conducted. Within each probe, two stimuli were analyzed – one at nodal distance and one at two nodal distances from the stimulus that was directly trained to acquire function. Of these 20 separate TSF probe stimuli, transformation of stimulus function occurred in the presence of four stimuli. Levels of transformation of stimulus function for the other 16 stimuli occurred at or below chance level of responding.
An important difference in this study was the use of a discriminative function to evaluate transfer. This may have been an important factor that impacted the TSF results found in the current study. Most of the research in the area of stimulus transfer/transformation concentrates on an antecedent function in the form of respondent elicitation or a consequential function, rather than a discriminative function. In addition, most of the functions that are evaluated have a strong aversive or appetitive property; such as gruesome pictures or the presentation of shock when considering aversive stimulation, or sexual images with respect to appetitive stimuli. Thus, it can be inferred that both magnitude of stimulation and schedule of delivery directly affect the formation of networks and subsequent transfer. This is especially the case with respect to the consequential stimulation that was delivered in prior TSF studies.

However, transfer of discriminative function may be more difficult as discriminative stimuli ($S^D$) set the occasion for behavior to occur, they do not cause it as can be seen in the relationship between antecedent stimulation and conditioned response in respondent conditioning (not taking such things as fatigue and habituation into account). It is merely an opportunity to alter the probability of emission of the desired behavior. Certainly it is a logical extension to consider magnitude of antecedent stimulation when considering the alteration of probability as well. In this study, the conditioning of discriminative function occurred with FR1 schedules and contingent food delivery, which was identified through preference assessments. Perhaps the combination of the properties of the antecedent stimulus and the conditioning did not produce strong change in probability.
In the current study we found that the behavior was not always evoked in the presence of the $S^D$. It is also possible that extinction played a role in the final TSF probes in that when the correct operant behaviors were evoked, the subject did not receive reinforcement that was present on FR1 schedules in the training sessions. Reinforcement could not be delivered contingent on correct responding because once the response was reinforced, it can no longer be considered a derived response. While it is surprising that the transformation of function did not occur at a higher level across participants in the current study, it is possible that due to the aforementioned factors the discriminative function did not acquire as much valence as the consequential functions that are used in other studies in the research and subsequently, influenced the results of the TSF test probes. Across the four participants, 10 TSF probes were conducted, which evaluated a total of 20 stimuli. Of those, we saw that first responses occurred correctly on three occasions. McKenzie responded correctly to the first exposure of a stimulus two nodal distances away from the stimulus that acquired function through direct training; Harrison and Susie responded correctly to the first exposure of a stimulus that was one nodal distance away from the stimulus that acquired function through direct training. These data would suggest that for these stimuli, the SD function was strong enough to evoke the operant behavior. It would then require continued contact with reinforcement to strengthen the discriminate control.

The current study also sought to assess differential effects of the procedures on TSF of discriminative function at one and two nodal distances. Four subjects were exposed to both procedures (training function before and after establishing the relational network) in one of two procedural orders. From a within-subjects analysis of the data,
there was no substantial differentiation between the TSF probes between Procedure 1 and Procedure 2. Furthermore, while it is recognized that the between comparison is a weaker comparison, we found no difference in responding in a between-subjects analysis when analyzing the order of exposure to the procedures and the final TSF probe scores.

All TSF probes assessed two stimuli; one stimulus that was one nodal distance away from the stimulus that acquired function through direct training and one stimulus that was two nodal distances away from that directly trained stimulus. In procedure 1, the discriminative function was trained directly to stimulus B (or BB). Stimulus B (or BB) was directly trained to stimulus A (or AA), which was also directly training to stimulus C (or CC). Thus, stimulus C (or CC) was only one nodal distance away from stimulus B (or BB). However, stimulus D (or DD) was directly trained only to stimulus C (or CC), and thus, two nodal distances from stimulus B (or BB). In procedure 2, the discriminative function was trained directly to stimulus F. Stimulus F was directly trained to stimulus E (or EE), which was also directly training to stimulus G (or GG). Thus, stimulus G (or GG) was only nodal distance away from stimulus F. However, stimulus H (or HH) was directly trained only to stimulus G (or GG), and thus, two nodal distances from stimulus F.

McKenzie scored 80% and 60% for stimuli that were one nodal distance away for procedures 1 (stimulus C) and 2 (stimulus G) respectively. She scored 20% and 40% for the stimuli that were two nodal distances away in procedures 1 (stimulus D) and 2 (stimulus H) respectively. In both procedures, McKenzie responded correctly more often to the stimuli that were one nodal distance away compared to the stimuli that were two nodal distances away. However, McKenzie responded correctly more often in procedure
1 for the stimulus one nodal distance away but responded correctly more often in procedure 2 for the stimulus two nodal distances away. Neither procedure yielded the highest percentage across both nodal distances being analyzed. Finally, there was only a difference of 20% in performance for each set of stimuli at the two nodal distances, which is merely the difference of one trial.

Harrison scored 40% on both stimuli that were one nodal distance away for procedures 1 (stimulus C) and 2 (stimulus GG) and he scored 60% and 40% for the stimuli that were two nodal distances away for procedures 1 (stimulus D) and 2 (stimulus HH) respectively. Three for the four stimuli were at the same level, 40%. Similar to McKenzie, neither procedure yielded higher percentages across the two nodal distances being analyzed. However, unlike McKenzie, he responded more correctly to a stimulus that was two nodal distances away, rather than the stimuli that were one nodal distance away from the stimulus that was directly trained to evoke a particular response.

It was unexpected to find that stimulus D acquired discriminative function more so than stimulus C. Due to the construction of the relational network, if TSF occurs for stimulus D, it is hypothesized that it transformed for stimulus C as well because during formal training, D was only trained to be similar as C and did not have any training with any other stimuli. It was further hypothesized that it the transformation would be stronger for stimulus C than stimulus D. However, Harrison developed informal rules based on the formal properties of the stimuli that he vocalized during the training sessions. Although no data were collected on the presence of rules, the first author observed Harrison attending to several formal properties, such as the shading, lines, and measuring parts of the stimuli. Following this, Harrison would state rules these stimuli
were the same or different based on what he saw. Because of his concentration on formal properties, it is possible that this influenced the final TSF probes. It is hypothesized that there was some formal property in stimulus D that he got ‘stuck’ on and connected to stimulus A that was stronger than formal properties in stimulus C. This would account for having a slightly higher level of correct responding for stimulus D than stimulus C. However, it is important to note that this is only a difference of one trial.

An analysis of Harrison’s data yielded another interesting finding. Following the baseline probes in procedure 2 with the relational frame of EFGH, a TSF probe was conducted, yielding 40% correct responding for both stimuli, G and H. After the stimuli were changed to EE, F, GG, and HH, and all relationships were trained through a number of sessions, the final probe for TSF yielded 40% correct responding for both stimuli GG and HH. Although Harrison was exposed to stimuli in the second relational network (more due to all the training trials), there was no difference in how strong the transformation of stimulus function was.

For Susie, there was one probe for TSF in procedure 2, while two were conducted for procedure 1. Susie responded correctly 40% and 20% of the time for stimuli that were one-nodal (stimulus G) and two-nodal (stimulus H) distances away in Procedure 2, respectively. Initially in Procedure 1, Susie had 0% correct responding for both stimuli and after additional training, she reached 100% correct responding for the stimulus that was one-nodal distance away (stimulus C) while remaining at 0% for the stimulus that was two-nodal distances away (stimulus D). In comparing the second TSF probe of procedure 1 to that conducted in procedure 2, Susie responded similarly to McKenzie. That is, she responded correctly more often in the presence of stimuli that were one-nodal
distance away. Of the two probes conducted in procedure 1, the first was more similar in level to the probe of procedure 2.

It is hypothesized that TSF did not occur initially in Procedure 1 for two possible reasons. The first hypothesis is that there were not enough training sessions to adequately condition the stimuli. In procedure 2, Susie was exposed to 19 training sessions prior to the probe. In comparison, she was only exposed to 15 training sessions in procedure 1 prior to the probe. This was a difference of 80 trials (due to the different types of training sessions and not being equal in the number of trials per session). It is possible that the greater number of trials resulted in transfer in one procedure while it was nonexistent in the other procedure until more training sessions, and thus more opportunities to condition the relations, occurred. An alternative hypothesis is that the operant task used to establish function was not sufficient for Susie. The operant task was simple; had a different task been utilized, Susie may have responded stronger when TSF probes were administered.

Zeke, like Susie, had two TSF probes for one procedure, while there was only one probe for the other procedure. For procedure 1, Zeke scored 20% correct responding for both stimuli (CC and DD). In Procedure 2, Zeke scored 0% for the stimulus that was one-nodal distance away (stimulus G) in both probes. For the stimulus H, which was two-nodal distances away, he initially scored 40% then 20% correct responding.

Like Harrison, he too had more (or the same level of) correct responses for the stimulus that was more nodal distances from the stimulus that acquired a function through direct training in the relational network. Also like Harrison, Zeke vocalized about formal properties during the training sessions. Although no attention was given to
Zeke by the first author, she observed him talking about different formal properties (such as lines and shading) and formulated rules about why certain stimuli were the same. It is possible that this also influenced his subsequent TSF responding.

Harrison and Zeke were the only two individuals that engaged in exclusion during the procedures. In both cases, the subjects participated in the first procedure they were exposed to with no apparent issues. Initially in the second procedure, the same distractor stimuli were utilized. In the first procedure, the subjects accessed reinforcement for selecting particular stimuli; however, this also reinforced them for selecting away from particular stimuli (the distractor stimuli). Due to that history of reinforcement, when the second procedure began, both subjects engaged in exclusion responding; that is, selecting away from the distractor stimuli and thus picking the correct answer throughout all baseline probes. As a result, a new relational network with new stimuli was introduced along with distractor stimuli used for training purposes. Obviously, one of the main similarities between these two subjects was that they were the only boys. However, Zeke was the same age as both girls that participated in the study, with Harrison being slightly older. Regardless, it is hypothesized that exclusion occurred as a result of conditioning and potentially, the subject’s verbal behavior surrounding the training events experienced.

Throughout the course of the study, limitations presented themselves in the following areas. First of all, not all subjects were seen the same number of times a week. Participants were seen 1 to 3 times a week, with 3 to 8 sessions conducted per visit. This may have impacted the duration of participation, as well as, the length of time between the first exposure of stimuli and the final TSF probe in a particular procedure. As a
result, the varying lengths of calendar days may have affected the subject’s ability to maintain the relational network and function operant training and demonstrate transformation of stimulus function. Incidentally, it is possible that the results of transformation of stimulus function may have been different if there were fewer calendar days between the first and last session of a particular procedure.

A second limitation is that Harrison and Susie lived in the same household. Since they were running simultaneously, each subject was exposed to a different design to prevent the subjects being exposed to the stimuli at the same time. Prior to the beginning of their participation, the first author asked the children’s parents to minimize any talking between the subjects about their experiences. This was done to prevent any potential influence the verbal behavior may have on subsequent responding; however, it is possible that they still talked to each other about the sessions and what they were doing. It is not known if this happened, or what the particulars of these discussions might have been; however, due to the differences in level of responding in TSF probes, it is hypothesized that this did not play a huge role in the results of the study.

A third limitation is the relational frames utilized in the pre-training phase. Although Procedure 1 and Procedure 2 both utilized a 4-member frame of coordination, two 3-member frames of coordination were used in the pre-training phase. It was hypothesized that if subjects were able to demonstrate derived relational responding in a 3-member frame of coordination, it would also be present in a 4-member frame of coordination at both one- and two- nodal distances. However, combinatorial entailment at two-nodal distances was not directly tested in the current experiment. It is possible that one or more of the subjects were not capable of demonstrating combinatorial
entailment at two nodal distances, which may have effected the levels of TSF observed with these stimuli.

Finally, the operant task used to establish function may have influenced the results obtained in TSF testing. It is possible that the training was too long and/or too simple. First, sessions for function training had 30 trials and they were longer in duration compared to the training sessions for the relational network. The number of trials was increased to ensure that the subjects had equal exposures to the target and non-target stimuli. However, the sessions were approximately 3 to 4 minutes longer than sessions to train the relational network. It is possible that the participants were not as focused throughout the duration of the session because of the length. In addition, it is possible that the task was too simple for the participants. The task was originally chosen because of the simplicity. The authors decided that they did not want to incorporate a more difficult task because ideally, they wanted function to acquire quickly. However, most researchers utilized more aversive or appetitive stimuli. While function did acquire quickly with regards to the number of sessions to reach mastery criteria, it is possible that the type of task and length of session may have inadvertently affected the transformation of stimulus function. A different type of operant task, or a different type of training, such as fluency training, may result in better levels of transformation of stimulus function.

**Future Directions**

First and foremost, the current study has opened the doors for an analysis of fluency training within the current procedures. The first author is currently investigating its use in a follow-up experiment. In it, training the relational frames and transformation of stimulus function probes will be conducted the same way. However, the operant task
will be trained using fluency training. That is, training sessions will include 30-second timings until the participant reaches aim range.

The current study serves as a preliminary step for future studies in comparing the two types of training procedures. Future investigation of transformation of stimulus function can incorporate many different topics. The first, as discussed above, is changing the way function training was conducted and incorporating fluency training. Second, evaluating a consequential function or a more aversive function (either discriminative or consequential) should be done to evaluate whether the valence of the stimuli impacts level which function transforms through a relational frame. Finally, relational frames other than sameness should be compared to evaluate whether any differentiation arises between the two training procedure types when a different relational network, such as opposition, or more than/less than, is investigated.

The results of the study further strengthen the argument that direct testing of derived relational responding needs to occur. Hayes et al. (1991) indicated that it is not necessary to directly test all mutually and combinatorially entailed relationships prior to testing for transformation of stimulus function. Directly testing these derived relations involves presenting all stimuli together; subsequent transformation may be a result of the association in the testing procedures rather than the result of derived relational responding. By not directly testing these relationships in the current study and demonstrating some level of transformation of stimulus function, it is implicit that derived relational responding occurred. Otherwise, there would not be any transformation of stimulus function through the relational network.
The results of this study also hold implications for clinical work. When training relationships between stimuli, not all trainers use the same method and not all children learn in exactly the same way when considering ordering of programs and targets. The current study indicated that which procedure chosen (function first or after forming a relational network) does not appear to matter. Children exposed to either training procedure will demonstrate a similar level of transformation of stimulus function – there is no differential responding with regards to TSF dependent on the procedure chosen. It is possible that some circumstances within the clinical setting may yield the need for the use of one training procedure over another; however, trainers will now know that it is unlikely that favoring one or needing to use one because of certain circumstances will impact further responding. It is important to note that this only applies to the factors that were evaluated here – a relational frame of sameness and discriminative function. It may not hold true when other factors, such as those discussed above, are evaluated. Further research is necessary before that can be concluded.


Appendices
Appendix A: Pre-Training Stimuli

Appendix B: Similar Distractors for McKenzie’s Pre-Training Phase
Appendix C: Distractor Stimuli for Harrison, Susie, and Zeke’s Pre-Training Phase

Appendix D: Procedure 1 Relational Network Stimuli for McKenzie, Harrison, and Susie

Appendix E: Procedure 1 Relational Network Stimuli for Zeke
Appendix F: Additional Non-Target Stimuli for Procedure 1

Appendix G: Procedure 2 Relational Network Stimuli for McKenzie, Susie, and Zeke

Appendix H: Procedure 2 Relational Network Stimuli for Harrison

Appendix I: Additional Non-Target Stimuli in Procedure 2
Appendix J: Distractor Stimuli for Procedure 1 for Zeke and Procedure 2 for Harrison