CONDITIONAL DISCRIMINATION ACQUISITION IN YOUNG CHILDREN: ARE THE FACILITATIVE EFFECTS OF NAMING DUE TO STIMULUS DISCRIMINATION?

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ABSTRACT

These experiments investigate whether the facilitative effect of naming on the acquisition of conditional discriminations in young children is due to enhancing discrimination of the sample and comparison stimuli or whether naming serves additional functions. Seventeen typically developing children, ages 4 to 6, were presented with a three-choice arbitrary MTS AB conditional discrimination on Macintosh computers. The participants were randomly selected to be in one of two sequences of conditions. The conditions utilized in Experiment 1 were Tacting Condition 1 (naming sample stimuli); Tacting Condition 2 (naming sample and comparison stimuli); Tally Sheet Condition 1 (marking sample stimuli); and Tally Sheet Condition 2 (marking sample and comparison stimuli). The conditions utilized in Experiment 2 were Tacting Condition 1; Tacting Condition 2; Cards Condition 1 (pointing to sample stimuli); and Cards Condition 2 (pointing to sample and comparison stimuli). Five participants acquired the AB conditional discrimination; two did so without exposure to naming and without evidence of common naming, and three did so with the addition of common naming. One participant demonstrated evidence of common naming but did not acquire the AB conditional discrimination. These results demonstrate that although naming can facilitate acquisition, it is neither necessary nor sufficient.

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INTRODUCTION

Stimulus equivalence is an important area of research in the field of behavior analysis. The research on stimulus equivalence provides an empirical method of studying the meanings of words, the use of words as symbols, the emergence of novel behaviors, and the role of language in stimulus equivalence. In addition, this research may be used to develop more effective and efficient teaching methods for typically developing children, children with developmental disabilities, and adults with disabilities.

Matching-to-sample procedures are commonly used in research on stimulus equivalence. Researchers most often use an alphanumeric code to refer to the stimuli when using these procedures. The numbers represent classes of stimuli and the letters represent different members within the stimulus class (i.e. A1, B1, C1; A2, B2, C2; A3, C2, C3). For example, the A stimuli may be pictures, the B stimuli may be written words, and the C stimuli may be french written words. The relations between these stimuli are referred to as arbitrary because these relations are not based upon formal characteristics of the stimuli. An MTS procedure consists of discrete trials in which the participants are first presented with a single stimulus, also known as the sample stimulus. Most often, the participants are required to make some kind of observing response to the sample stimulus (touching a screen or clicking on the stimulus with a mouse). Once this observing response is made, additional stimuli, also known as comparison stimuli, are presented. Then, the participants are trained to select the comparison stimulus that corresponds with the sample stimulus. If they select the “correct” comparison, then the response is reinforced (e.g., edibles, brief visual display on computer). However, if they select one of the “incorrect” comparisons, then the response is not reinforced but other consequences may be presented (e.g., buzzer sound on computer). For example if A1, a picture of a dog, is presented as the sample, then selecting B1, the written word ‘dog,’ would be reinforced. However, if A1 is presented as the sample, then selecting B2, the written word ‘cat,’ would not be reinforced. Likewise, if A2, a picture of a cat, is presented as the sample, then selecting B2, the written word ‘cat,’ would be reinforced. However, if A2 is presented as the sample, then selecting B1, the written word ‘dog,’ would not be reinforced.

Matching-to-sample procedures are often used to establish conditional discriminations. Conditional discriminations are four-term contingencies that consist of a conditional stimulus (e.g., A1), a discriminative stimulus (e.g., B1), a response (e.g., mouse clicking), and a consequence (e.g., reinforcer). A conditional discrimination may be expressed by stating: In the presence of A1, the participant selects B1 and receives a reinforcer. It is important to note that selecting B1, *and only B1*, in the presence of A1 leads to the presentation of a reinforcer. Likewise, selecting B1 in the presence of A1, *and only A1,* leads to the presentation of a reinforcer. Thus, there is a dependency between the stimuli. In order to ensure that the responses are truly conditional, this must also hold true for A2 and B2. There must be at least two conditional discriminations trained in order to assess whether the relations between the stimuli are equivalent. Therefore, after the AB conditional discrimination (A1B1, A2B2, A3B3) has been trained, the BC conditional discrimination (B1C1, B2C2, B3C3) may be trained. Once both of these conditional discriminations have been trained, the relations can be assessed in order to determine whether the conditional relations are also equivalence relations.

Sidman et al. (1982) noted that it is possible that conditional discrimination procedures, such as match-to-sample procedures, merely generate conditional relations and not equivalence relations. Therefore, Sidman (1990) developed a “mathematical definition of equivalence relations” (p. 99) that consists of three tests which can be conducted to determine whether the relations established in conditional discrimination procedures are equivalence relations. The first of these tests, reflexivity, requires that the participant demonstrate that the same relation holds between identical stimuli (A=A). For example, a picture of a dog is the same as another identical picture of a dog. In the context of an MTS procedure, a reflexivity test could consist of presenting A1 as the sample and A1, A2, and A3 as comparisons. Selecting A1 when presented with A1 as the sample would illustrate the property of reflexivity. The second test, symmetry, requires that the relation between trained stimuli is reversible (if A is related to B, then B is related to A). For example, if the picture of a dog is the same as the written word ‘dog,’ then the written word ‘dog’ should be the same as the picture of a dog. In the context of an MTS procedure, the AB relation is trained prior to presenting the symmetry test. That is, the participant has already been trained to select comparison B1 when the sample is A1, B2 when the sample is A2, and B3 when the sample is A3. A symmetry test could consist of presenting B1 as the sample and A1, A2, and A3 as the comparisons. In this example, selecting A1 when presented with B1 as the sample would illustrate the property of symmetry. The third test, transitivity, requires that if A is related to B and B is related to C, then A should also be related to C. For example, if the picture of the dog is the same as the written word ‘dog,’ and the written word ‘dog’ is the same as written french word ‘chien,’ then the picture of the dog should also be the same as the written french word dog, ‘chien.’ In the context of an MTS procedure, the AB relation and the BC relation are trained prior to presenting the transitivity test. That is, the participant has already been trained, for example, to select comparison B1 when the sample is A1, and C1 when the sample is B1. A transitivity test could consist of presenting A1 as the sample and C1, C2, and C3 as comparisons. In this example, selecting C1 when presented with A1 as the sample would illustrate the property of transitivity. The requirements of all three tests must be met in order for the relation to be considered an equivalence relation. In addition, these requirements must be met without using any kind of reinforcement.

Why is Stimulus Equivalence Important?

Stimulus equivalence is important in studying many aspects of behavior. For example, stimulus equivalence procedures provide empirical methods of studying the meaning of words and the use of words as symbols. Stimulus equivalence procedures allow researchers to investigate how words, pictures, and objects, for example, become equivalent. If these stimuli are equivalent, it can be said that they all refer to the same thing or have the same meaning. For example, if the written word ‘dog,’ the spoken word “dog,” a picture of a dog, and a real dog become equivalent, then it can be said that all of these stimuli have the same meaning. Stimulus equivalence procedures allow a context for studying how these words come to have the same meaning.

Symbols often elicit or occasion responses that are similar to or the same as the responses that would be engendered by their referents. For example, Sidman (1994) discussed the power of the American flag as a symbol of our country. The flag is a symbol of American’s freedom and all that we, as Americans, stand for. The power of such a symbol is evident when individuals burn the American flag in protest. Although this act is not physically harming anyone or taking away anyone's freedom, it is viewed as an attack on the freedom and ideals of the American people. Individuals will respond to the burning of flags in a way that is similar in some ways to their response to an actual physical attack or threat to their freedom. Thus, the symbol and its referent become equivalent in some aspects. Stimulus equivalence procedures can aid in the study of how these symbols and referents become equivalent.

Stimulus equivalence is also important in the study of emergent behavior. Through the use of stimulus equivalence procedures, novel behaviors emerge that have not been explicitly taught. This has important implications for studying why and how these behaviors emerge. There are also important implications for the way that individuals learn, in that these procedures represent a more efficient teaching method due to the fact that each one of the behaviors do not have to be taught individually.

Sidman and colleagues have demonstrated that the use of the stimulus equivalence paradigm can be an effective method for teaching basic language skills. More specifically, their research indicates that participants who are trained using these procedures demonstrate oral reading, auditory receptive reading, auditory comprehension, and reading comprehension that was either not present or deficient before training. In Sidman's experiments, auditory receptive reading entails matching spoken words to their corresponding written words, and auditory comprehension entails matching spoken words to their corresponding pictures. Reading comprehension entails matching pictures to their corresponding written words and written words to their corresponding pictures. Therefore, these skills may be taught and tested using matching-to-sample procedures with pictures, spoken words, and written words, as discussed previously.

Sidman's (1971) first experiment was conducted in order to determine if the formation of auditory-visual equivalence relations was a "sufficient prerequisite" for the development of reading comprehension and oral reading. The participant in this experiment was a 17-year-old boy with severe mental retardation. The stimuli used in this procedure were 20 spoken words (A), pictures (B), and written words (C). Sidman employed matching-to-sample procedures to determine the participant's baseline performances, to train the participant to match written words to their corresponding spoken words, and to test for emergent relations. The participant's baseline performance indicated that he could not match the written words with spoken words (AC), written words to pictures (BC), pictures to written words (CB), nor could he orally read written words. However, after the participant was trained to match written words to their corresponding spoken words, he was then able to match written words to pictures (AC), written words to pictures (BC), pictures to written words (CB), and orally name written words. Therefore, the participant demonstrated that the training had established oral reading and reading comprehension skills. The most important aspect of these results was that the participant was able to successfully complete these tasks without being explicitly taught to do so. Thus, the results of Sidman's first experiment indicate that establishing auditory-visual equivalence relations was sufficient for the development of reading comprehension and oral reading.

Sidman (1971) notes that there is great practical significance to these findings as well. Through the use of automated programs, matching-to-sample procedures can be used to teach reading comprehension without the one-on-one instruction of a teacher. In addition, this method represents an efficient way for an individual to learn a number of skills without having to be taught each one of the skills individually. Therefore, these results indicate that stimulus equivalence procedures are effective and efficient methods to teach basic language skills such as auditory receptive reading, oral reading, and reading comprehension.

Sidman and Cresson (1973) conducted a systematic replication of Sidman's (1971) first experiment. The participants in this experiment were two adult males with Down's syndrome and severe mental retardation. In this experiment, Sidman and Cresson employed matching-to-sample procedures to determine the participant's baseline performances, to train identity matching, to train the participant to match written words to their corresponding spoken words, and to test for emergent relations. The same stimuli that were used in Sidman's (1971) experiment were used in this experiment. The main difference in this replicated experiment was that the participants were only taught a subset of the 20 relations at one time. However, they were tested for all 20 of the relations after each subset was taught. Sidman and Cresson theorized that "the only new relations to emerge in each test would be those which required the particular auditory-visual relations that had been explicitly taught."

The initial tests indicated that the participants had difficulty with oral reading, reading comprehension, auditory comprehension, and auditory receptive reading. The participants then underwent training via the matching-to-sample procedures. The results of the tests indicated that once the participants were explicitly taught to match spoken words with their corresponding written words, they were then able to read the words and comprehend what they were reading. Furthermore, these successful results were demonstrated only after the participants had been explicitly taught to match the specific spoken words with the written words that were being tested, which provides additional support for the effectiveness of the training procedures. This experiment also demonstrates that the basic prerequisites (e.g., identity matching) for teaching these relations can be taught using matching-to-sample procedures. Thus, the results of Sidman and Cresson's (1973) experiment also indicate that stimulus equivalence procedures are effective and efficient methods to teach basic language skills such as auditory comprehension, auditory receptive reading, oral reading, and reading comprehension.

Sidman and Tailby (1982) conducted an experiment with eight typically developing children from five to seven years old. Sidman notes that all of the experiments up to this point had dealt with three-member classes, and that if equivalence relations were limited to only three-member classes, the significance of its application would also be limited. Therefore, in this experiment, Sidman and Tailby focused on expanding the three-member equivalence classes. Matching-to-sample procedures were used to train conditional discriminations and test for equivalence relations. The stimuli used in this experiment were Greek letters and spoken Greek letter names. The AB, AC, and DC conditional discriminations were explicitly taught to the participants. After this training, six of the eight participants demonstrated that the BC, CB, DB, BD, AD, and CD conditional discriminations emerged without being explicitly taught. These participants demonstrated the formation of a four-member class (ABCD) and two sets of three-member classes (ABC and ACD) of equivalence relations. Remarkably, in this experiment only nine relations were explicitly taught and 27 relations emerged without being explicitly taught. The results of this experiment demonstrate the efficiency of using these procedures as teaching methods. That is, by expanding the class size by just one member, the emergent relations increase significantly. Thus, Sidman and Tailby's experiment provides further support for the effectiveness and efficiency of using stimulus equivalence procedures.

A number of researchers have used the stimulus equivalence paradigm in developing techniques for teaching basic language arts skills to children in the classroom. These techniques may be used to supplement current teaching methods or they may be used to evaluate the effectiveness of already existing teaching methods. In addition, Stromer, Mackay, and Stoddard (1992) note that these techniques may be "useful for remediation when the traditional teaching methods fail" (p. 252). One of the most important features of these techniques is that they allow the teacher to evaluate the individual performances of the students. Therefore, if a child is struggling in certain areas, these areas can be addressed before moving on to more advanced skills.

Stromer, Mackay, and Stoddard (1992) note that one way that the stimulus equivalence paradigm can be used in the classroom is to teach spelling via constructed-response procedures. Computer programs have been designed to teach anagram spelling, allowing children to spell by selecting written letters and putting them together to form words. For example, the program may begin by displaying a sample picture (e.g., cat) and its corresponding written word (e.g., 'cat'). In each of the subsequent stages, a fading procedure is used to remove one letter from the end of the word until all that is displayed is the sample picture (e.g. 'ca_,' 'c_ _' '_ _ _'). The children are provided with a pool of 10 letters to choose from at the bottom of the computer screen. Thus, in the first stage children can merely copy the letters to produce the word. Then in each subsequent stage they must choose the letters that complete the word. In the final stage they must choose the letters that form the entire word in the absence of any sample letters.

Stromer, Mackay, and Stoddard (1992) discuss an experiment in which the constructed-response procedure was used to teach spelling to a group of students. The students were given pretests, which indicated that they were initially unable to match written words to spoken words or to orally name written words. The students were taught to spell each of the words using the constructed-response task. After this training, the tests were given to the students again. The results indicated that the students were able to match written words to spoken words and to orally name the written words without being explicitly taught to do so. Thus, the authors note that these results indicate that equivalence classes had emerged from the spelling relations that were directly taught.

Dube, McDonald, McIlvane, and Mackay (1991) used a constructed-response matching-to-sample procedure to teach spelling to two adult males with mental retardation. As discussed previously, the participants were presented with a compound sample that consisted of a picture and its corresponding written word. The written word was gradually faded out until only the picture was presented as a sample. After the participants met the criterion for a particular word, the word was added to their cumulative baseline and training proceeded with another word. The results of the tests given before training indicated that one of the participants could spell only one word correctly and the other participant could spell four words correctly. After training, the participants were able to correctly spell eleven words and nine words, respectively. Thus, these results indicate that the constructed-response procedure is an effective method for teaching individuals to spell.

Stromer, Mackay, and Stoddard (1992) also note that there are times when students need additional instructions before beginning the constructed-response matching procedure. For example, they may exhibit problems with copying the words (identity matching) in the first stage of the task. In this case, a delayed constructed-response identity-matching procedure can be used to teach identity matching. This task begins with presenting a single sample letter and two letters as comparisons. The number of letters in the sample and the number of comparisons are increased on subsequent trials until the subject begins copying the entire word. This not only emphasizes copying the sample, but it also emphasizes putting the letters in the correct order.

The delayed identity-matching procedure may also be used to teach the relations between printed words and their corresponding pictures. In this procedure, the participant is initially presented with the sample word and the sample picture simultaneously. Then both of the samples disappear and the participant is presented with either pictures as comparisons or printed words as comparisons. They must choose either the picture or the printed word (depending on the comparisons that are presented) that corresponds with the sample that was initially presented. The participant does not know which of the comparison stimuli will be presented after the samples are removed. Therefore, he or she must remember both the sample picture and the sample printed word, including the individual letters and the correct order of the letters that make up the printed words. Stromer, Mackay, and Stoddard (1992) note that “this dual requirement of having to observe both the word and the picture may suffice to teach the relations between them" (p. 243).

Stromer, Mackay, and Stoddard (1992) conclude that the use of constructed-response procedures can be a very effective way to improve children's spelling performances. The biggest advantage is the emphasis placed on the individual letters of the words. They state that this is an important aspect because this training "might discourage, even if not eliminate, control of reading by restricted visual features of printed words." This procedure also has important implications for children who have problems with motor skills and/or visual-motor coordination. That is, children can practice spelling words without having to write the letters by hand. This will help to ensure that problems with spelling are not due to physical limitations of the child.

Dube, McDonald, McIlvane, and Mackay (1991) also note that there are several benefits of using the constructed-response procedure. One benefit is that the computer programs provide immediate feedback for responses. This procedure also ensures that the child is attending to the task. In addition, the programs provide continuous reviews and maintenance of all of the words that have been learned. Another very important aspect of this procedure is that the baselines were individualized and, therefore, the level of instruction depended upon the individual's progress. This is important because personalized instruction can help remediate specific problems that the individual may be having. It is also beneficial because it can provide instruction without the aid of a teacher's one-on-one instruction. Therefore, Dube, McDonald, McIlvane, and Mackay conclude that these procedures are efficient and effective methods of teaching which have great potential for use in a classroom setting.

McDonagh, McIlvane, and Stoddard (1984) extended the use of the stimulus equivalence paradigm to teaching coin equivalences to a 28-year-old woman with mental retardation. Before participating in this experiment, the participant could name written prices (e.g., ‘1c’, ‘5c’) and coins (e.g., penny, nickel, dime); say the value of the coins (e.g., a penny is worth 1c); and the match the coins to their written and spoken prices. However, she could not match more than one coin with its corresponding price (e.g., 5 pennies with ‘5c’) or one coin to other coins with the same value (e.g., one dime to two nickels). After training was conducted, the participant demonstrated that she had learned to match more than one coin with its corresponding written price, a single coin with a combination of coins that were of the same monetary value, and state the value of all of the coins used in the experiment without being directly trained to do so. Using the stimulus equivalence paradigm, six relations were directly trained and 46 relations emerged without direct training. Thus, the results of this experiment demonstrate the effectiveness and efficiency of using the stimulus equivalence paradigm to teach coin equivalences to individuals with mental retardation. McDonagh, McIlvane, and Stoddard (1984) emphasize the practical implications of these experiments by stating that the format used in the constructed response procedure “resembles real monetary transactions and may promote generalization of new skills to community settings” (p. 195).

Lynch and Cuvo (1995) extended the use of the stimulus equivalence paradigm to teaching math skills to seven students in fifth- and sixth-grade. These students were selected for participation because they were having trouble with tasks that involved fractions and decimals. Lynch and Cuvo utilized matching-to-sample procedures to train conditional discriminations between written fraction ratios (1/4), written fraction decimals (.25), and “pictorial representations of fractions.” Then they presented tests of symmetry, transitivity, and equivalence to test for emergent relations. The results of the matching-to-sample tests presented after training indicated that all of the participants met criterion on the symmetry, transitivity, and equivalence tests. In addition, the results indicated that the training procedures used in this experiment generated 12 equivalence classes which consisted of written fraction ratios, written decimals, and picture representations of fractions. Lynch and Cuvo note that these results “support previous research indicating that math skill acquisition relies on the development of relationships between mathematical stimuli” (p. 124).

Lynch and Cuvo (1995) also discuss several practical implications that are suggested from this research. They note that the pretests allowed the experimenters to assess the level of each participant’s math skills before beginning the experiment. Based upon these pretests, the training procedures “attempted to link relations that were familiar to students” (Lynch & Kuvo, 1995, p. 125). Therefore, these procedures can be modified to meet the needs of individual students. The authors also note that these procedures assess comprehension of the skills that the participants are being taught. Thus, this training is “concept oriented rather than strategy oriented” (Lynch & Kuvo, 1995, p. 125), which math instruction theorists suggest is a more effective way to teach math skills. Finally, this procedure is beneficial because it can be implemented without the aid of a teacher’s one-on-one instruction. Therefore, using the stimulus equivalence paradigm appears to be an efficient and effective method of teaching math skills as well.

Major Theories of Stimulus Equivalence

Sidman's Theory

Sidman (1990) proposes that stimulus equivalence is a basic, fundamental process. Thus equivalence, like any other basic process such as reinforcement, cannot be further broken down and analyzed. In fact, Sidman (1990) states that equivalence may simply have to be accepted as a "given" (p. 111). Sidman (2000) argues that equivalence is the "direct outcome of reinforcement contingencies" (p. 128). Although he originally argued that equivalence emerged only at the level of the four-term contingency, he now argues that as long as a reinforcement contingency is in place, equivalence may emerge at the level of the two-, three-, four-, or five-term contingency.

Even though it is possible for equivalence to emerge at the level of the two- or three-term contingency, the only way to test for equivalence relations is by using the four-term contingency. Matching-to-sample procedures are often used to arrange four-term contingencies. In these procedures at least two conditional discriminations are directly trained. For example, when presented with a picture of a dog as a sample, a participant is directly trained to select the corresponding comparison, the written word 'dog' (AB). The contingency holds that selecting the written word 'dog' comparison, and *only* this comparison, in the presence of the picture of the dog will be reinforced. Likewise, selecting the written word 'dog' in the presence of the picture of the dog as a sample, and *only* in the presence of this sample, will be reinforced. Then when presented with the written word 'dog' as a sample, the participant is directly trained to select the corresponding comparison, the written French word 'chien' (BC). Again, the contingency holds that selecting the French written word 'chien' comparison, and *only* this comparison, in the presence of the written word dog will be reinforced. Likewise, selecting the French written word ‘chien’ in the presence of the written word ‘dog’ as the sample, and *only* in the presence of this sample, will be reinforced. After these two conditional discriminations have been established, tests may be conducted in order to determine if equivalence relations have emerged without direct training. Thus, an important aspect of Sidman’s theory, is that equivalence relations are not directly trained. Instead, equivalence relations emerge from the conditional discriminations that are directly trained.

As mentioned previously, Sidman developed a descriptive system derived from mathematics which is defined by three properties: reflexivity, symmetry, and transitivity. Matching-to-sample procedures are used to test for these three properties. If all three of the requirements for equivalence are met, the stimuli are considered to be part of an equivalence class.

In addition, Sidman proposes that the “equivalence relation consists of ordered pairs of *all* positive elements that participate in the reinforcement contingency” (Sidman, 2000, p. 131). Thus, in addition to the picture of a dog, the written word ‘dog,’ and the written French word ‘chien,’ the response and the reinforcer could also function as part of the equivalence class. Once an equivalence class is established, all of the stimuli within the class are interchangeable.

However, Sidman (2000) notes that if the response and the reinforcer remain a part of the equivalence class, there may be a conflict between the contingency and the equivalence relation. This occurs when only a single response or reinforcer is employed in the baseline training, as is the case in many equivalence procedures. This is due to the fact that all of the elements would be related to the same reinforcer and response which, in turn, means that all of the elements would be related to each other in the same way. Sidman states that if such a conflict does take place, the reinforcer and the response must "drop out" of the equivalence relation in order to establish the analytic unit. Thus, Sidman speculates that a single, large equivalence class must form first when using contingencies with a single reinforcer and a single response requirement. After this large equivalence class forms, then the reinforcer and the response will "drop out," allowing for the smaller independent equivalence classes to form.

Sidman (2000) discusses several ways to avoid such a conflict between the contingency and the equivalence relation. One way to avoid this conflict is to employ more than one reinforcer, which is often referred to as class-specific reinforcers. For example, if A1 is the sample and the participant selects B1, the correct comparison, they will be presented with Reinforcer 1. Likewise, if A2 is the sample and the participant selects B2, the correct comparison, they will be presented with Reinforcer 2. Dube et al. (1995) demonstrated that stimuli could become members of the same equivalence class even if the only common relation between them was a reinforcer. In this experiment, the participants were presented with an identity matching procedure with class-specific reinforcers. For example, when A1 was the sample, selecting A1 as the comparison was reinforced with Reinforcer 1. When A2 was the sample, selecting A2 was reinforced with Reinforcer 2. The same training was conducted with B1 and B2. Dube et al. found that the AB relations emerged from this training, which could only have occurred based on the common reinforcer. That is, the A1B1 and A2B2 relations emerged due to the common reinforcers (Reinforcer 1 and Reinforcer 2, respectively). Thus, this research indicates that the common reinforcer brought the stimuli together into the same class.

In addition, since all of the members within the equivalence class are interchangeable, images of the reinforcers can be presented as samples or comparisons. This is an important aspect of using class-specific reinforcers because it leads to the formation of additional class relations. The formation of these additional relations demonstrates that the reinforcers do become members of the equivalence class, which provides further support for Sidman's notion that equivalence relations are generated by the reinforcement contingency.

Another way to avoid a conflict between the contingency and the equivalence relation is to employ more than one response, which is often referred to as class-specific responses. For example, if A1 is the sample and the participant uses Response 1 to select B1, they will be presented with Reinforcer 1. Likewise, if A2 is the sample and the participant uses Response 2 to select B2, they will be presented with Reinforcer 1. Sidman (2000) notes that such an experiment has not yet been conducted. However, he predicts results similar to those discussed in reference to class-specific reinforcement, in that stimuli could become members of the same equivalence class even if the only common relation between them is a response.

Sidman argues that because equivalence is a fundamental process, there are no other processes or skills, such as verbal behavior, that are necessary in order for equivalence to emerge. Sidman, Willson-Morris, and Kirk (1986) conducted an experiment in order to determine whether naming was a necessary component for the formation of equivalence relations. In this experiment, matching-to-sample procedures were used to train auditory-visual and visual-visual conditional discriminations with six children, two typically developing and four with mental retardation. After training and testing for emergent relations, the children were given oral naming tests. The oral naming tests for the auditory-visual conditional discriminations indicated that four of the six children gave common names to the stimuli within the equivalence class. However, the oral naming tests for the visual-visual conditional discriminations indicated that only one of the six children gave common names to the stimuli within the equivalence class. Interestingly, all of the children demonstrated that two sets of equivalence classes had emerged. Therefore, based upon this research, Sidman, Willson-Morris, and Kirk (1986) concluded that “naming is neither necessary nor sufficient to establish equivalence relations” (p. 302).

In addition, Sidman (2000) proposes that naming is merely a response which becomes a part of the equivalence class. That is, naming is just an example of a class-specific response. Sidman states that responses are the same as all of the other members within the equivalence class and, therefore, “require no separate treatment” (p 145). Thus, naming is just another element within the reinforcement contingency and is not a necessary component, in and of itself, for equivalence to emerge. In fact, he notes that it may be the case that equivalence helps establish naming. Sidman (1990) states that, “it is reasonable to suspect not that the common names gave rise to equivalence, but that equivalence gave rise to the common names” (p. 106).

Further support for Sidman’s argument that language is not necessary for the emergence of equivalence is provided by research that demonstrates equivalence with nonhumans. For example, Kastak, Schusterman, and Kastak (2001) used matching-to-sample procedures to train simple and conditional discriminations and to test for emergent relations with two California sea lions. The results of these experiments demonstrated the formation of equivalence classes for both of the sea lions. In addition, class-specific reinforcers were employed in this experiment. The results indicated that using class-specific reinforcers led to additional equivalence relations that emerged based on the common reinforcer. Therefore, these experiments also provide further support for Sidman's notion that the reinforcers are a part of the equivalence class.

Relational Frame Theory

Steele and Hayes (1991) define relational frames as "arbitrarily applicable relations" (p. 520). In a relational frame, the stimuli are related based on the context and not the physical forms of the stimuli. The relations are directly trained through multiple examples that are encountered throughout an individual's developmental history. Unlike Sidman's treatment, relational frames are seen as the product of explicit training and direct reinforcement.

Hayes et al. (2001) state that "early language training is an example" (p. 26) of this explicit training and direct reinforcement. Thus a parent may present a child with a ball and ask the child, "What is this?" If the child responds by saying "ball," the response is reinforced by the parent. The parent may reinforce the child's response by saying, "You're right, it is a ball." This is an example of training an object-name relation. Likewise, the parent may present the child with a ball and a teddy bear and ask, "Where is the ball?" If the child responds by pointing to or otherwise attending to the ball, the response is reinforced by the parent. This is an example of training a name-object relation.

In early language training, a number of these relations are trained and reinforced. Once these relations have been established through multiple examples, “symmetrical responding may emerge with respect to novel stimuli” (Hayes et al., 2001, p. 27). That is, when the child is presented with a new object, a toy car, and the object-name relation is trained, then the name-object relation emerges. Likewise, when the child is presented with a toy car and a doll, and the name-object relation is trained, then the object-name relation emerges. Hayes et al. state that this occurs because the child’s responses have been reinforced in this manner in the past, under these specific contextual cues. The contextual cues in this example would be the questions “what is this?” and “where is the ball/car?”

Once multiple examples have been trained, the relational frame may be abstracted and applied to novel stimuli. Abstracting a relation and applying it to different stimuli depends on the contextual cues that are presented. Contextual cues are very important to the relational frame theory because these cues tell an individual how to relate the stimuli.

Learning relations often begins with nonarbitrary relations that are based on physical features of the stimuli, such as size. For example, if a child is presented with a golf ball and a tennis ball, and the contextual cue is “bigger than,” they are trained that the tennis ball is “bigger than” the golf ball. Thus, selecting the tennis ball would be reinforced. Likewise, the child may also be presented with a baseball and a soccer ball, and trained that a soccer ball is “bigger than” a baseball. Thus, selecting the soccer ball would be reinforced. After exposure to multiple examples, when the child is presented with a stimulus that was previously the “bigger than” stimulus and a novel stimulus that is bigger, he will select the novel stimulus. For example, if the child is presented with a soccer ball (selection was previously reinforced for being “bigger than” a baseball) and a beach ball, the child will select the beach ball. Hayes et al. (2001) state that selecting the novel stimulus in this example is an indication that the child is “responding based on relational rather than absolute properties” (p. 24). Therefore, once the “bigger than” frame has been established through multiple examples, the frame can be abstracted and applied to novel stimuli. Initially, if a child is presented with two arbitrary stimuli and the contextual cues are “bigger than” and “smaller than,” it is most likely that the child will not be able to determine the relation between the stimuli. The stimuli are considered arbitrary because the physical features are no longer a determining factor in relating the stimuli. Thus, correct responding would initially be around chance level. However, with exposure to multiple examples in multiple situations, and a history of reinforcement with the stimuli, the child would learn the relation between the stimuli. For example, a child may be presented with two arbitrary shapes as stimuli (A and B). They are trained that A is “bigger than” B. Thus, when the contextual cue is “bigger than” and they are presented with A and B, selecting A is reinforced. Once this relation is established, the contextual cue may be changed to “smaller than,” and selecting B would be reinforced. Again, initially the child may not determine the relation between the stimuli. However, with exposure to multiple examples of stimuli under the contextual cues of “bigger than” and “smaller than,” when the child is presented with new arbitrary stimuli and trained that one is “bigger than” the other, the child will be able to derive the “smaller than” relation. Thus, Hayes et al. (2001) state that, “individuals given the relation in one direction will derive the relation in the other direction” (p. 27). Therefore, the child learns that if, for example, A is “bigger than” B, then B must be “smaller than” A.

Hayes et al. (2001) state that the most common type of relational responding is the “frame of coordination.” Steele and Hayes (1991) theorize that stimulus equivalence is the “result of an application of a learned frame of ‘coordination’ (sameness) to the stimuli in arbitrary matching-to-sample procedures” (p. 520). In a “frame of coordination,” the contextual cues are “same as” or “similar to.” There are also a number of other frames, such as the frame of opposition, the frame of distinction, and the frame of comparison, of which the “bigger than/smaller than” relation is a member.

Hayes et al. (2001) introduce three new terms that are defining features of the relational frame theory. These new terms were deemed necessary because the terms that are used in stimulus equivalence (reflexivity, symmetry, and transitivity) were not applicable to all stimulus relations. Hayes et al. (2001) state that based on the relational frame theory, “a wide variety of relational responses seem possible” (p. 29); therefore they propose more general terms that would apply to more relations. These terms are mutual entailment, combinatorial entailment, and transformation of stimulus functions. The first two terms are very similar to the mathematical properties of stimulus equivalence used in Sidman’s theory.

Mutual entailment holds that the first relation entails what the reverse relation will be. For example, if A is related to B, then B is related to A in some manner. Hayes et al. (2001) state that symmetry would be one example of mutual entailment. Combinatorial entailment is a combination of mutual relations. For example, if A is related to B, and B is related to C, then A and C are mutually related. Hayes et al. state that transitivity and equivalence would be one example of combinatorial entailment. However, the authors believe that theirs are more useful terms because they are more generic and will, therefore, be applicable in more cases.

Hayes et al. (2001) state that transformation of stimulus function is the "change in functions of one event that stands in relation to another" (p. 32). For example, an individual may be taught that A is the "opposite" of B, and training establishes selecting A in the presence of B when the contextual cue is "opposite." If B is paired with some form of punishment, then the individual may select A in other contexts based upon the previously established relation of opposition: A is the "opposite" of B. That is, the individual selects A because if B is paired with punishment, and A is the opposite of B, then A must not be paired with punishment. Hayes et al. suggest that "transformation" is a better term than "transfer" because the change in function for one stimulus need not be identical to the function trained for the other stimulus in the relation. This transformation must also be controlled by contextual cues, which will determine the functions that will be transformed.

Naming Theory

Horne and Lowe (1996) define naming as a "higher order bidirectional behavioral relation" (p. 207), which involves both speaker and listener behavior. Speaker behavior refers to emitting a verbal response and, in Horne and Lowe's account, important listener behaviors involve both responding to the words that someone else says and responding to the words that they say themselves. Horne and Lowe emphasize that an individual can be both the speaker and the listener. This is a very important aspect of the naming theory because it is "only through an analysis of both speaker and listener behavior that we can establish what counts as an instance of a name" (p. 189).

Naming is sometimes referred to as a “circular relation” (p. 190) in which an individual sees an object, says the name of the object, simultaneously hears the name of the object, and sees or attends to the object again. For example, a child may see a dog, say the word “dog,” hear herself say the word “dog,” and then look at the dog again. Therefore, this “circular relation” encompasses both speaker and listener behavior.

Horne and Lowe (1996) suggest that naming develops during the early stages of language learning. During these stages, children undergo extensive training in language production and language comprehension. Horne and Lowe note that another critical aspect for the development of the naming relation is that the speaker and listener behavior is reinforced by another individual, such as a caregiver. For example, in the presence of a dog, the caregiver may point to the dog and ask the child, “What is that?” The child may respond by looking at the dog, saying “dog,” hearing “dog,” and looking at the dog again. The speaker and listener behavior may then be reinforced by saying, “You’re right, that is a dog.”

As the child continues to develop, he or she will come into contact with many other examples of the stimuli that have already been named, with each additional exposure adding to the child’s repertoire. The name provides a basis on which the child may combine these additional examples together in one group. For example, a child learns to name the family pet a “dog” and then later encounters other breeds of dogs, which she is reinforced for naming (“You’re right, that is a dog”). The multiple examples of dogs that she has encountered will all become members of a stimulus class of dogs. Although the dogs may not look similar, the child learns that they all belong in the same group because they are all named “dogs.” Thus, the child is taught that certain objects that may not have similar physical characteristics, belong together because they have a similar function, that is, they occasion the same name.

Horne and Lowe (1996) state that equivalence cannot be established without naming. Therefore, the naming theory predicts that equivalence will not be demonstrated in nonhuman animals due to a lack of verbal skills and an inability to name. They also predict that humans who lack naming skills will not demonstrate equivalence. In addition, they predict that training human subjects to name stimuli in a matching-to-sample procedure can lead to success on tests of equivalence, even if the subject has failed these tests prior to the naming intervention.

One possible way in which naming may lead to equivalence is by giving the stimuli the same name. For example, a child is taught to name a picture of a dog as "dog," and also taught to name the written word 'dog' as "dog." If the child is presented with a matching-to-sample task in which the picture of a dog is a sample and written words are comparisons, the child may select the written word 'dog' based on the common name that was explicitly taught. Horne and Lowe (1996) state that this occurs because seeing the picture of the dog occasions the child to say "dog," which "evokes the previously established listener behavior of selecting" (p. 206) the word "dog."

Another possible way in which naming may lead to equivalence is through intraverbal naming. Horne and Lowe (1996) state that intraverbal naming is a "bidirectional relation" (p. 209) in which one name within the intraverbal relation occasions the child to say the other name. For example, Horne and Lowe discuss a study by Lowe and Beasty (1987) in which subjects "spontaneously" named both the sample stimulus and its corresponding comparison stimulus. When a vertical line (A1) was presented as the sample, and a red stimulus (B1) was the corresponding comparison stimulus, the subject said, “up red.” When a vertical line (A1) was presented as the sample, and a triangle (C1) was the corresponding comparison stimulus, the subject said, “up triangle.” They found that some of the subjects, when presented with one member of a stimulus class, would name all of the stimuli that were members of that class in addition to the one that was presented. For instance, if the subject was presented with a vertical line as the sample, the subject said, “up red up triangle.” Thus, the vertical line and the name “up” occasioned the subject to say “red” and “triangle” because the names “red” and “triangle” both had a history of being reinforced in the presence of the vertical line and the name “up.” Therefore, an equivalence class was established in which the names “up,” “red,” and “triangle” are interchangeable. Lowe and Beasty reported that the only subjects that were successful on tests of equivalence were the subjects that were intraverbally naming the stimuli. Therefore, based upon this research, Horne and Lowe state that intraverbal naming leads to greater success on tests of equivalence in matching-to-sample procedures.

Another critical aspect of Horne and Lowe’s (1996) theory is that naming may involve overt or covert naming. When an individual is overtly naming, they are saying the name of a stimulus out loud. When an individual is covertly naming, they are assumed to be “saying” the name of a stimulus to themselves. When individuals are successful on tests of equivalence in the absence of overt naming, Horne and Lowe assume that the individuals must be naming covertly. This aspect of the naming theory is problematic because it is not possible to determine whether an individual is really naming a stimulus covertly. However, attributing the success on tests of equivalence to covert naming allows such observations to remain consistent with the argument that equivalence cannot be established without naming.

The Role of Naming

In the research literature pertaining to stimulus equivalence, a considerable number of experiments have assessed the role of naming in the acquisition of conditional discriminations, categorization skills, and equivalence relations. A review of this literature indicates opposing views on the role of naming with respect to equivalence class formation. Some of this research suggests that naming is a necessary component, while other research suggests that naming is neither necessary nor sufficient to establish equivalence.

Dugdale and Lowe (1990) discuss an experiment conducted in order to determine whether naming is a necessary component in the acquisition of conditional discriminations and equivalence relations. The participants were six typically developing children from five to six years of age. All of the participants had failed to learn the AB relation between shapes and colors in a previous experiment. In this experiment, five of the participants were taught to say “omni” when presented with either a Y shape or the color green as a sample, and “delta” when presented with a zigzag shape or the color red as a sample. Four out of these five participants consistently applied the common name to the stimuli. In addition, four of these participants demonstrated successful results on the AB and BA matching-to-sample tests. The results also indicated that the fifth participant who did not consistently apply common names to the stimuli performed at chance levels on the AB and BA tests. However, once additional training was provided and she consistently applied the common names, she also demonstrated successful performances on the AB and BA tests. The sixth participant was not initially trained to name the stimuli. Initially, the common names were dictated by the experimenter, instead of the participant emitting the names. The results indicated that she initially performed at chance levels on the AB and BA tests. However, once she was trained to say the common names, she demonstrated successful performances on the AB and BA tests. Thus, the results of this experiment indicated that applying common names to the stimuli did facilitate the acquisition of conditional discriminations and equivalence relations. In addition, the participants' performances in the absence of common naming demonstrated that the equivalence classes had not emerged. Thus, Dugdale and Lowe (1990) conclude that applying common names to the stimuli "resulted in the emergence of both the AB and BA relation" (p. 129).

Horne, Lowe, and colleagues conducted a series of experiments that assessed the role of naming in the development of categorization skills in young children. Lowe et al. (2002) trained typically developing children to tact arbitrary stimuli. The children were taught to tact one set of stimuli as "zag" and the other as "vek." Category match-to-sample procedures with three different types of instructions were used during training. In the first type of instruction, the participant was asked to name the sample stimulus and then select the other stimuli belonging to that class (tact-sample match-to-sample-tact). The second type of instruction was similar to the first type of instruction except the experimenter did not specify which category of stimuli to select (tact-sample match-to-others). In the third type of instruction, the participant was not asked to name the sample, but instead to look at the sample and then select "the others" (look-at-sample match-to-others). The participants were presented with an "arbitrary stimuli category match-to-sample” (p. 534) test, using the look-at-sample match-to-others instruction. If the participants failed to meet criterion using this type of instruction, they were presented with the same test using the tact-sample match-to-others instruction. The results indicated that all of the participants were successful on one of the arbitrary stimuli category match-to-sample tests. Lowe et al. (2002) state that these results “show that common tact training may be an effective means of establishing arbitrary stimulus classes” (p. 537). One interesting finding in this experiment was that five of the nine participants failed the tests when they were not required to tact the samples with the look-at-sample match-to-others instruction. However, these five participants were successful on these same tests once they were required to tact the samples.

Lowe et al. (2002) conducted another experiment in order to assess whether the results in the previous experiment could be extended to six-member classes of arbitrary stimuli. Two of the children from the previous experiment served as participants in this experiment. The training procedures were the same as the previous experiment. After training, the participants were presented with six-stimulus and twelve-stimulus category match-to-sample tests using the look-at-sample match-to-others instruction. The results indicated that the participants learned to tact the new stimuli very quickly and accurately, and that they were successful on the arbitrary stimuli category match-to-sample tests. Therefore, two six-member classes of arbitrary stimuli were established. In the posttest interview, the authors note that one subject tacted both the sample and the corresponding comparisons spontaneously. The other subject did not spontaneously tact, but did so when asked why she was selecting the stimuli. When retested six months later, both of the subjects were successful in tacting and categorizing the stimuli.

Lowe et al. (2002) state that the results of these experiments suggest that “simply training a common tact response to each of a number of arbitrary stimuli establishes those stimuli as a class or category” (p. 544). They also state that other emergent relations were generated by the training procedures, most importantly, the symmetrical relations between the stimuli. Lowe et al. also note that some of the subjects failed the category match-to-sample tests when they were not required to tact the sample. However, when this requirement was enforced, they were successful on the tests. They suggest that these results provide additional support for the role of naming. Thus, these findings support Horne and Lowe’s (1996) argument that “common naming of arbitrary stimuli is sufficient to establish stimulus classes.”

Horne, Lowe, and Randle (2004) conducted an experiment in which seven typically developing children were exposed to listener training using procedures that were similar to those used in the experiments by Lowe et al. (2002). This experiment was conducted in order to determine if establishing listener relations alone was sufficient for the participants to tact the stimuli and be successful on the category match-to-sample tests. The results showed that none of the participants met the criterion for the tests when exposed to listener training alone. When they were exposed to tact training and retested using the look-at-sample instruction, only two of the seven participants met the criterion for the test. However, when they were retested using the tact-sample instruction, all of the participants met the criterion for the test. After passing this test, three of the participants were given the test with the look-at-sample instruction again, and two of them met the criterion.

Horne, Lowe, and Randle (2004) suggested that the results of this experiment indicate that training listener relations alone was not sufficient for the subjects to tact the stimuli or be successful on the category match-to-sample tests. The success that was demonstrated after tact training was presented provides support for the notion that tact training also establishes naming. The authors also argue that these results provide additional support for the notion that "naming may be necessary for the categorization of arbitrary stimuli" (Horne, Lowe, & Randle, 2004, p. 281).

Lowe, Horne, and Hughes (2005) conducted two experiments in order to test the prediction that "naming is a powerful means of transferring novel behaviors among common name members" (p. 48). In the first experiment, 10 typically developing children were trained to tact three arbitrary stimuli as "zog" and three as "vek." They were then trained to wave and clap when presented with the first arbitrary stimulus pair designated as "zog" and "vek,"respectively. They were then tested for novel behavior production, which assessed whether the participants would wave and clap in response to the other stimuli in the classes for which functions had not been trained. They were also tested for novel behavior comprehension which consisted of asking the participant, "can you give me the one that goes like this?" as the experimenter modeled either waving or clapping. Finally, they were given category match-to-sample tests. The results indicated that after being taught to tact the stimuli, all of the participants demonstrated both novel behavior performance and comprehension. In addition, they all met the criterion for the category match-to-sample tests. The participants also met the criterion on the listener behavior tests, which the authors suggest demonstrates that tact training "establishes not simply tacting but also naming."

The second experiment was conducted in order to determine whether the results in the previous experiment could be extended to new sets of stimuli by training the "common manual behaviors," but not the "common vocal tacts" (P. 59). Three participants from the previous experiment were taught to either clap or wave when presented with three pairs of new arbitrary stimuli. They were then tested for vocal tacting, vocal comprehension, and given two category match-to-sample tests. This procedure was then repeated with a third set of stimuli. The results indicated that after being taught to clap and wave when presented with the stimuli, all of the participants demonstrated tacting and vocal comprehension. In addition, they all met the criterion for the category match-to-sample tests and the manual behavior listener tests.

Lowe, Horne, and Hughes (2005) state that the results of these two experiments provide support for the notion that "naming is a powerful means of transferring novel behaviors among common name members" (p. 48). They also note that the transfer of function helped to facilitate success on the category match-to-sample tests. Most importantly, they note that a great number of untrained relations emerged throughout these two experiments.

Horne, Hughes, and Lowe (2006) conducted an experiment in order to "test whether common listener relations alone could establish category transfer of function" (p. 250). Therefore, this experiment combines the listener behavior training from the Horne, Lowe and Randle (2004) study and the transfer of function training from the Lowe, Horne, and Hughes (2005) study. The training procedures and tests used in this study were the same as those used in these two previous studies. The results showed that 10 of the 14 participants correctly tacted the stimuli after being exposed to listener training alone. In addition, these 10 participants met criterion for the category transfer-of-function Test 1 (novel behavior production) and Test 2 (novel behavior comprehension). The results also indicated that the four participants who did not correctly tact the stimuli did not meet criterion on either of the category transfer-of-function tests or the category match-to-sample tests. These four participants were exposed to tact training and presented with the category tests again. After these participants learned to correctly tact the stimuli, they passed both of the category transfer-of-function tests.

Horne, Hughes, and Lowe (2006) provide a summary of all of the data collected across this series of experiments. All 20 of the participants who applied common names to the stimuli were successful on the category match-to-sample tests. Likewise, all 19 of the participants who applied common names to the stimuli were successful on category transfer of function tests. Conversely, all 11 of the participants who did not apply common names to the stimuli failed the category match-to-sample tests. Likewise, all 4 of the participants who did not apply common names to the stimuli failed the category transfer of function tests. However, when nine of the 11 participants were trained to tact the stimuli and given the category match-to-sample tests again, seven out of nine were successful. Likewise, when three of the four participants were trained to tact the stimuli and given the category transfer of function tests again, all three of the participants were successful. Horne, Hughes, and Lowe (2006) state that “the high success rate following name training is further indication of the key role of naming in categorization of arbitrary stimuli” (p. 263). In addition, “there was not a single instance of a child passing any categorization test but failing to produce the class names” which they believe is “further evidence that naming may be necessary for categorization” (Horne, Hughes, & Lowe, 2006, p. 263). Therefore, Horne, Hughes, and Lowe (2006) conclude that this series of experiments provides the “strongest evidence yet that naming is indeed necessary” (p. 270).

Randall and Remington (1999) conducted an experiment in which 30 verbally able adults were randomly assigned to one of three conditions: rhyme, orthogonal, and diagonal. The stimuli used in this experiment were pictures of familiar objects that were “easily nameable” (p. 397). In the rhyme condition, only the name of the correct comparison rhymed with the sample stimulus. In the orthogonal condition, the names of the comparisons rhymed with each other, but did not rhyme with the sample. In the diagonal condition, the name of one of the incorrect comparisons rhymed with the sample and the names of the other two comparisons did not rhyme with each other or with the sample. The correct comparisons in the orthogonal and diagonal conditions were arbitrarily designated by the experimenter. The results of this experiment indicated that participants in the rhyme condition acquired the conditional discriminations significantly faster and with a significantly fewer number of errors than the participants in the other two conditions. In addition, all of the participants in the rhyme condition demonstrated equivalence. However, only two of the 10 participants in the orthogonal group and one of the 10 participants in the diagonal group demonstrated equivalence.

Randall and Remington (1999) note that in the naming posttest, all of the participants demonstrated a “high degree of normative stimulus naming” (p. 406). All of the participants in the rhyme condition assigned standard English terms for all of the stimuli. However, only one of the 10 participants in the orthogonal group and three of the 10 participants in the diagonal group gave the correct normative names for all of the stimuli. Thus, the authors state that “because the facilitative effect of rhyme necessarily depended on the naming of stimuli, albeit covertly, the results observed could not have occurred in the absence of naming” (p. 407). Randall and Remington suggest that one possible explanation for these results is that the selections of the participants in the rhyme condition were “verbally controlled or rule-governed” (p. 408). Therefore, it is possible that the participants in the other two conditions did not acquire the conditional discriminations as quickly because they did not have an obvious verbal rule to base their selections upon.

Randall and Remington (1999) also report that seven of the 10 participants in the orthogonal condition and four of the 10 participants in the diagonal condition met criterion on generalization tests, in which the correct comparison rhymed with the sample stimulus. None of the stimuli used in these tests were similar to those that the participants were exposed to previously. Therefore, the only basis for selecting the correct comparison was that the stimuli rhymed. Thus, the authors conclude that this experiment demonstrated that naming, specifically the phonological properties of the names, did serve a functional role in the acquisition of conditional discriminations and the establishment of equivalence relations.

Eikeseth and Smith (1992) conducted an experiment in order to assess the role of naming in establishing equivalence relations with four autistic children. All of these children had initially failed to establish equivalence relations in the absence of naming. All of the participants exhibited some form of language deficit, either receptive or expressive. Eikeseth and Smith utilized matching-to-sample procedures to train conditional discriminations and test for the emergence of equivalence relations. This experiment consisted of five phases in which AB and AC (Phase 1 and 2), DE and DF (Phase 3), EG and FH (Phase 4), and IJ and IK (Phase 5) conditional discriminations were trained. In Phases 2, 3, and 4 the participants were taught to say one common name for one stimulus class (e.g. A1, B1, C1) and another common name for the other stimulus class (e.g. A2, B2, C2). Phases 1 and 5 were conducted in order to determine the participants' performance in the absence of naming requirements.

Eikeseth and Smith (1992) found that the participants' performance were very inconsistent. In Phase 1, none of the participants met criterion on the tests for equivalence. In Phase 2 and Phase 3, only two of the four subjects met criterion on the tests for equivalence. In Phase 4, only one of the four participants met criterion on these tests. Finally, in Phase 5, only two of the four participants met criterion on these tests. Furthermore, only one of these four participants demonstrated consistent results that suggested naming played an important role in establishing equivalence relations. Interestingly, Eikeseth and Smith (1992) also found that some of the participants were correctly naming the stimuli even when they were making incorrect choices during the matching-to-sample tests. Eikeseth and Smith conclude that "most subjects' performance was inconsistent over the course of the study, and it was frequently difficult to make firm inferences from the data" (p. 132).

Pilgrim, Jackson, and Galizio (2000) found some very interesting results in regards to the role of naming in facilitating the acquisition of conditional discriminations. In their experiment, all eleven participants had failed to demonstrate acquisition of the conditional discriminations prior to implementation of the naming condition. There were two different naming conditions in which the participants either made up names for the sample stimuli (self-names condition) or they used names that had been designated by the experimenter (names-given condition). There were five participants in the self-names condition and seven participants in the names-given condition (one participant was exposed to the names-given after being exposed to the self-names condition). All of the participants were then required to name the sample stimuli before the comparison stimuli were presented. The results of this experiment indicated that none of the participants in the self-names condition demonstrated acquisition of the conditional discriminations. However, five of the seven participants in the names-given condition very quickly demonstrated acquisition of conditional discriminations. The performance of the participant exposed to both of the conditions was of particular interest. When this participant was exposed to the self-names condition, he failed to acquire the conditional discriminations. However, when the participant was exposed to the names-given condition he very quickly demonstrated acquisition.

Pilgrim, Jackson, and Galizio (2000) note that although participants in the self-names condition did not demonstrate acquisition and the majority of participants in the names-given condition did, all of the participants did demonstrate differential responding in respect to the sample stimuli. Therefore, the authors state that "other factors must be responsible for the failure to master the arbitrary task" (p. 185). The results of this experiment indicate that one factor that may play an important role is the source of the name. The authors suggest that one possible problem associated with the self-names condition is that the participants were giving the arbitrary stimuli names of other familiar objects. This may have "interfered with the development of arbitrary relations designated by the experimenter" (p. 186). In addition, they suggest that the names given by the experimenter may serve some kind of instructional role, which may help to facilitate acquisition of the conditional discriminations. Thus Pilgrim, Jackson, and Galizio state that a "simple naming account is insufficient to explain the present data" (p. 191).

Lazar, Davis-Lang, and Sanchez (1984) conducted an experiment in order to determine the role of naming in the formation of equivalence classes. Four typically developing children from five to seven years of age participated in this experiment. Matching-to-sample procedures were used to train visual-visual conditional discriminations and test for emergent equivalence relations. The participants were also given two types of naming tests upon completion of the tests for equivalence. In the first test, the participants were presented with only the sample and asked, "Tell me what this is," or "What is it?" (Lazar, Davis-Lang, and Sanchez, 1984, p. 254). In the second test, the participants were asked to name the stimuli in the same way, but were asked to do so during a session of baseline trials. Lazar, Davis-Lang, and Sanchez conducted these naming tests in order to determine whether the participants would apply common names to the stimuli within the equivalence classes and whether these common names would help facilitate the formation of equivalence relations.

Lazar, Davis-Lang, and Sanchez (1984) found that none of the participants applied a common name to the stimuli within the same class. These results were found with both types of naming tests. However, all of the participants demonstrated the formation of equivalence relations. In addition, they found that during the second type of naming test (conducted during baseline trials), none of the participants applied common names, but each of their baseline performances were 100% correct. Thus, Lazar, Davis-

Lang, and Sanchez (1984) conclude from these results that “equivalences can be formed in the absence of mediating names” (p. 263).

Sidman, Willson-Morris, and Kirk (1986) conducted an experiment in order to determine whether naming is a necessary component of establishing equivalence relations. There were six participants, two typically developing children and four young adults with mental retardation, which participated in this study. They used matching-to-sample procedures to train auditory-visual and visual-visual conditional discriminations. The participants were given oral naming tests upon completion of the equivalence tests. During the naming tests for the auditory-visual conditional discriminations, four of the participants gave common names to the stimuli within the same equivalence class. However, during the naming tests for the visual-visual conditional discriminations, only one of the subjects gave common names to the stimuli. Yet, all of the subjects demonstrated the formation of equivalence relations. Thus, based upon these results, Sidman, Willson-Morris, and Kirk (1986) argue that “naming is neither necessary nor sufficient to establish equivalence relations” (p. 302). In fact, they suggest that a simpler explanation is that naming and equivalence are both results of the training procedures.

In addition, Sidman notes that naming may serve an instructional function, thereby making it difficult to determine the factors that are responsible for the emergence of equivalence. Training subjects to name stimuli during the experiment may also “inadvertently transform visual-visual into auditory-visual matching” (Sidman, 1994, p. 305).

Saunders and Spradlin (1990) conducted an experiment in which two adult participants with mental retardation, CS and KR, were exposed to conditional discrimination training using matching-to-sample procedures. The experimenters first presented the conditional discriminations without any additional training procedures in order to determine the participants’ baseline performances. If the participants did not demonstrate acquisition, they were trained to name the sample stimuli before the comparison stimuli were presented. CS was presented with comparison discrimination training in addition to being trained to name the sample stimuli. This training consisted of presenting the two comparison stimuli with one of the comparisons designated as correct for that entire session. If the participant met criterion on one session, then the other comparison stimuli was designated as correct for the next session, until criterion was met for two consecutive sessions. KR was presented with blocked-trial procedures in addition to being trained to name the sample stimuli.

The results of this experiment indicated that neither of the participants demonstrated acquisition of the conditional discriminations during baseline. The results also indicated that sample naming alone did not facilitate the acquisition of conditional discriminations for CS. However, acquisition was demonstrated after CS was exposed to comparison discrimination training as well. Saunders and Spradlin (1990) noted that even when CS was no longer prompted to name the stimuli, she continued to do so. They also noted that initially she began to name the stimuli incorrectly, but in subsequent sessions she began naming the stimuli correctly again.

CS was then presented with four additional conditional discriminations. She continued to name the stimuli using the names that were designated by the experimenter for the first conditional discrimination. Saunders and Spradlin (1990) note that “increasingly consistent differential naming was associated with increasingly accurate conditional discrimination performance" (p. 244). These results led to an additional question of whether the differential sample naming was necessary for the participant to acquire these additional conditional discriminations. CS was taught to say the same sample name in response to both of the new sample stimuli. The results indicated that the participant demonstrated acquisition of two new conditional discriminations in a maximum of four sessions. Therefore, Saunders and Spradlin suggest that, based upon these results, differential sample naming is not necessary for the acquisition of conditional discriminations.

The results for KR indicated that the blocked-trial procedure alone did not facilitate the acquisition of the conditional discrimination. However, acquisition was demonstrated after KR was trained to name the sample stimuli as well. During the symmetry tests both of the participants continued to name the samples although naming was no longer prompted or required. Saunders and Spradlin (1990) state, "for both subjects, naming the sample correctly was usually followed by selecting the correct comparison" (p. 245). However, they also note that this was not always the case. For example, during one session KR incorrectly named the sample stimulus four times, but he selected the correct comparison two times and the incorrect comparison two times.

Saunders and Spradlin (1990) state that these results led to an additional question of whether differential responses that do not involve naming can also facilitate the acquisition of conditional discriminations. They note that there have been several studies with humans and nonhumans that support the notion that other forms of differential responding can be effective. For example, Sidman et al. (1982) discuss several relevant experiments, one involving rhesus monkeys and one involving typically developing children. In one of the experiments, Sidman et al. noticed that the monkeys were having a difficult time learning the conditional discriminations, so they taught the monkeys to respond differentially to the samples. They did this by requiring the monkeys to press the key five times for one sample (FR 5) and two times with 2s in between the responses for the other sample (DRL 2-s). By using these schedules, Sidman et al. noted that the monkeys were able to acquire the conditional discriminations more quickly and effectively. Likewise, in another experiment, Sidman et al. implemented these two different sample schedules (FR 5 and DRL 2-s) to help two of the children that were having difficulty acquiring the conditional discriminations. Sidman et al. note that these schedules "had their intended facilitative effect."

In addition, Saunders and Spradlin (1989) conducted an experiment in which two adults with mental retardation were trained to differentially respond to the sample stimuli by pressing buttons on two different schedules (DRL 3-s and FR 8). Although this differential responding alone did not facilitate acquisition, a combination of the differential responding and blocked-trial procedures did facilitate acquisition of the conditional discriminations. Saunders and Spradlin (1990) conclude that "these data suggest that the primary function of both types of differential sample responses (naming and button presses) was simply to establish the discrimination between the sample stimuli" (p. 249). Thus, based upon these results, it seems that the facilitative effect of naming was due to increased discrimination between the samples. That is, it may not be naming per se, but the discriminative control required for naming that facilitates acquisition of conditional discriminations and equivalence relations.

Purpose of the Present Experiment

The purpose of the present experiment is to investigate whether the facilitative effect of naming is due to enhancing discrimination of the sample and comparison stimuli or if naming serves additional functions which contribute to this facilitative effect. If the facilitative effect of naming is due to increased discrimination of the sample and comparison stimuli, then alternative methods that require discrimination of the sample and comparison stimuli should also facilitate the acquisition of conditional discriminations.

The Naming Theory suggests that equivalence cannot be established without naming. This theory also suggests that training participants to name stimuli in a matching-to-sample procedure can lead to success on tests of equivalence, even if the subject has failed these tests prior to the naming intervention. Thus, according to the Naming Theory, naming is necessary for the acquisition of conditional discriminations and equivalence relations. Likewise, this theory suggests that acquisition would not be demonstrated in the absence of naming (i.e., with an alternative method of discriminating the sample and comparison stimuli).

In contrast, Sidman’s theory suggests that naming is not a necessary component in the acquisition of conditional discriminations and equivalence relations. However, discriminating between the sample stimuli and the comparison stimuli is a necessary component. Thus, according to Sidman’s theory, alternative methods leading to sample and comparison discrimination should facilitate the acquisition of conditional discriminations and equivalence relations.

Therefore, naming and an alternative method of training sample and comparison stimulus discrimination will be used in this experiment. In Experiment 1, the alternative method will involve marking tally sheets. This method was chosen because it helps to ensure that the participant is attending to and discriminating between the sample and comparison stimuli. In Experiment 2, the alternative method will involve touching stimulus cards. The participants in Experiment 1 demonstrated several problems associated with marking the tally sheets. Therefore, the decision was made to employ a different method in Experiment 2. However, this method was deemed functionally equivalent to marking tally sheets, in that it also ensured that the participant was attending to and discriminating between the sample and comparison stimuli. Thus, this experiment will investigate the facilitative effects of naming and alternative methods of stimulus discrimination on the acquisition of conditional discriminations.

EXPERIMENT 1

METHOD

Participants

Eleven typically developing children, ages 4 years 4 months to 5 years 8 months at the beginning of the experiment, who attended a local day care program participated in this experiment. See Figure 1 for participant name, sex, and age at start of the experiment. The parents of each of the participants were given information regarding the experiment and gave permission, in writing, for their child to participate prior to beginning this experiment (See Appendix A for permission slip).

Apparatus and Stimuli

A three-choice match-to-sample procedure presented through an MTS computer

Participant	Experiment	Sex	Age at start	Peabody Picture Vocabulary Test – III A
JE	1	F	4/4	4/10
TA	1	F	4/4	3/6
HC	1	F	5/1	4/6
LT	1	F	5/8	5/1
PG	1	F	4/6	4/10
NC	1	M	5/8	4/4
ES	1	F	4/6	4/7
DN	1	M	5/0	4/6
NW	1	F	4/0	3/3
KC	1	F	5/4	5/2
DD	1 & 2	M	4/6	3/1
MM	2	F	4/4	3/1
AH	2	F	4/4	3/3
MD	2	M	4/10	4/8
BB	2	M	4/10	4/10

Figure 1. Participants age, gender, and Peabody Age Equivalent Scores

program (Dube 1991) was utilized in this experiment. Three desktop MacIntosh computers located at the day care were used. The stimuli were 1in. x 1in. black arbitrary shapes (See Fig. 2), which were presented on a white background and displayed on the computer screen. The sample stimulus was displayed in the middle of the computer screen, and the three comparison stimuli were displayed in three of the four corners of the screen. The participants used a mouse to move the cursor to the sample stimulus and click on it in order to produce the comparisons. They then used a mouse to move the cursor to one of the comparison stimuli and click on it. If the participant selected the “correct” stimulus, as designated by the experimenter, brightly colored stars appeared and a brief jingle was presented. If the participant selected the “incorrect” stimulus, as designated by the experimenter, a brief buzzer was presented. There were 24 trials in each session with a 1.5 s inter-trial interval.

Additional consequences were also presented at the end of each session, as follows. At the beginning of the experiment, each of the participants was given a prize chart, which had seven rows with five blocks in each row (See Fig. 3). The participants received one sticker to place on their prize chart after each session, and once all five blocks in a row were filled, they were allowed to choose a small prize out of the “prize box.” The participants also received candy and an additional sticker for their hand contingent upon their behavior during the session (e.g. paying attention/being quiet during task).

General Procedure

In the first session, the experimenter informed the participants that each day he or she will be given the opportunity to play a computer game with the experimenter. The

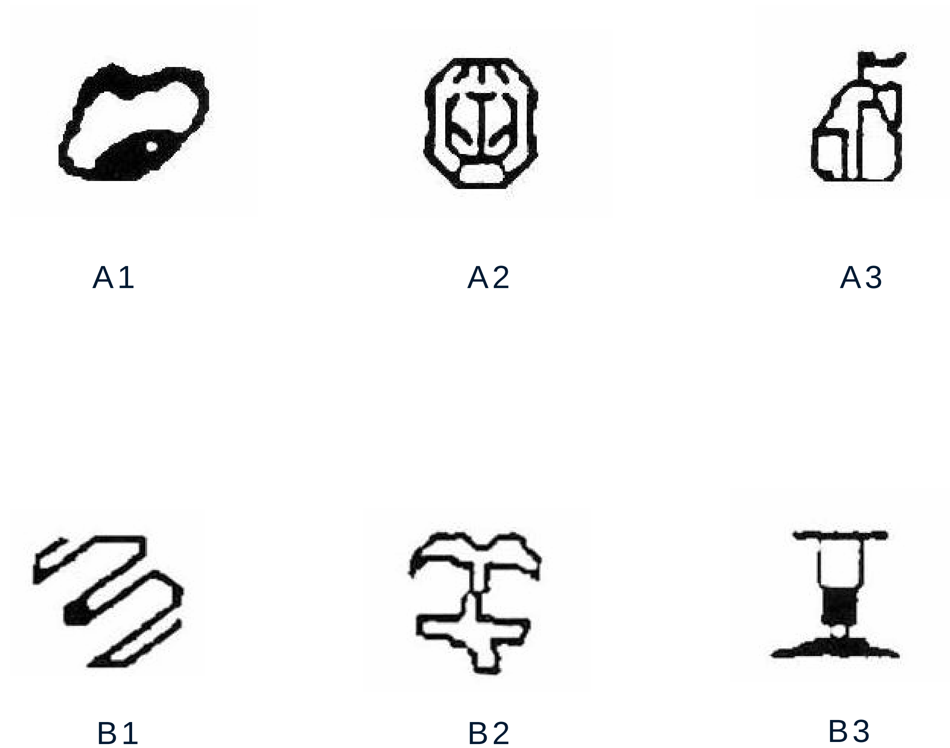


Figure 2. AB arbitrary stimuli

PRIZE CHART

Figure 3. Prize chart

experimenter told the participants that she would be there each afternoon and that they were welcome to come as often as they would like. The experimenter also told the participants that if, on any given day, they chose not to come, that it was their choice and there would be no consequences for choosing not to come. The experimenter allowed the participants to select a prize chart and explained to them how they could earn prizes, stickers, and candy. Finally, the experimenter trained the participants to use the mouse. During mouse training, a simple commercial computer game (e.g. Kids Time Deluxe) was selected in order for the participant to become familiar with using the mouse and clicking on different objects, where clicks produced immediate visual and auditory consequences. In the second session, the participants were given the Peabody Picture Vocabulary Test (Third Edition Form III A) to assess their developmental age equivalent for vocabulary according to norms for their age. See Figure 1 for Peabody age equivalent scores.

In the subsequent sessions, the participants were presented with a three-choice arbitrary MTS AB conditional discrimination training program with three sample stimuli (A1, A2, and A3) and three comparison stimuli (B1, B2, and B3). Sessions included 24 trials, with each trial beginning with the presentation of a sample stimulus. The experimenter sat with each participant and, when the sample stimulus was presented, the experimenter said, “See this. I want you to click on it.” When a participant clicked on the sample stimulus, the three comparison stimuli were presented. Once the comparisons were presented, the experimenter pointed to the sample stimulus and instructed the participant to “Pick the one that goes with this one.” If a participant asked any further questions, the experimenter repeated the above instructions but did not provide the participant with any additional feedback.

For example, in one trial type A1 was presented as the sample in the middle of the computer screen. Clicking on A1 produced B1, B2, and B3 as comparisons in three of the four corners of the screen. In this example, clicking on B1 produced a display of stars and a brief jingle, but clicking on B2 or B3 produced a brief buzzer sound. In another trial type, A2 was presented as the sample and clicking on A2 produced B1, B2, and B3 as comparisons. In this example, clicking on B2 produced a display of stars and a brief jingle, but clicking on B1 or B3 produced a brief buzzer sound. The trials in these sessions were balanced so that the same sample stimulus was never presented more than two times in a row, the comparisons were never in the same positions more than two times in a row, and the same comparison was never correct more than two times in a row. In addition, each of the AB relations (A1B1, A2B2, and A3B3) was presented an equal number of times in each session.

If there was no sign of acquisition of the arbitrary AB conditional discrimination after approximately ten sessions, the participants were exposed to one of the two training approaches, either Tacting Condition 1 or Tally Sheet Condition 1, depending on their designated sequence. If there was no sign of acquisition of the AB conditional discrimination after approximately 10 sessions in Tacting Condition 1, the participants assigned to Sequence 1 proceeded with Tally Sheet Condition 1 training. Likewise, if there was no sign of acquisition of the AB conditional discrimination after approximately ten sessions in Tally Sheet Condition 1, the participants assigned to Sequence 2 proceeded with Tacting Condition 1 training. If there was still no sign of acquisition after completing these two conditions, the participants proceeded with training for the next condition in their designated sequence. The participants continued to proceed through each of the conditions in their designated sequence until acquisition of the arbitrary AB conditional discrimination had been demonstrated. The experimenter determined whether the participants should proceed to the next condition based on visual inspection of their graphed results, as described below.

Two training approaches were compared in this experiment. The first approach involved naming conditions, which consisted of Tacting Condition 1 and Tacting Condition 2. The second approach involved tally sheet conditions, which consisted of Tally Sheet Condition 1 and Tally Sheet Condition 2 (See Fig. 4). The participants were randomly selected by the experimenter to be in one of two different sequences of these conditions (See Fig. 5). Half of the participants were presented with Sequence 1; the other half were presented with Sequence 2. The participants were exposed to standard arbitrary MTS training before beginning either of these sequences, as described below.

Naming Conditions- Training

Tacting Condition 1

This training was conducted in order to teach the participants to name the sample stimuli. The participants were exposed to echoic pretraining and tact training as described by Lowe et al. (2002) and Horne, Lowe and Randle (2004). Images of the three sample stimuli that were used in the arbitrary AB task were presented on laminated cards in this training. The names used in this condition were nonsense syllables designated by the experimenter. The participants were trained to say “zog” in the presence of A1, “vek” in the presence of A2, and “kif” in the presence of A3. Prior to beginning this training, the experimenter asked each participant, “Can you say zog

Condition	Description
Tacting Condition 1	Participants are trained to tact the sample stimulus prior to clicking on the sample stimulus.
Tacting Condition 2	Participants are trained to tact the sample stimulus prior to clicking on the sample stimulus, and to tact the comparison stimulus that they will select prior to clicking on the comparison stimulus.
Tally Sheet Condition 1	Images of the three sample stimuli are positioned at the top of the tally sheet in three separate columns. Participants are trained to make a mark on the tally sheet in the appropriate column prior to clicking on the sample stimulus.
Tally Sheet Condition 2	Images of the three sample stimuli are positioned in a row at the top of the tally sheet and the three comparison stimuli are positioned in a row in the middle of the tally sheet in separate columns. Images are positioned in three different orders (three versions) so that the image of the correct comparison stimulus is never positioned directly underneath its corresponding sample stimulus. Participants are trained to make a mark on the tally sheet in the appropriate column prior to clicking on the sample stimulus, and to mark the comparison stimulus that they will select prior to clicking on the comparison stimulus.
Tally Sheet Condition 3	Images of the three sample stimuli are positioned in a row at the top of the tally sheet and the three comparison stimuli are positioned in a row in the middle of the tally sheet in separate columns. Images of each of the correct comparison stimuli are positioned directly underneath the corresponding sample stimulus. Participants are trained to make a mark on the tally sheet in the appropriate column prior to clicking on the sample, and to mark the comparison stimulus that they will select prior to clicking on the comparison stimulus.

Figure 4. Descriptions of conditions in Experiment 1

Sequence 1	Arb AB	Tacting Condition 1	Tally Sheet Condition 1	Tally Sheet Condition 2	Tally Sheet Condition 3	Tacting Condition 2
Sequence 2	Arb AB	Tally Sheet Condition 1	Tacting Condition 1	Tacting Condition 2	Tally Sheet Condition 2	Tally Sheet Condition 3

Figure 5. Two possible sequences in Experiment 1

(vek/kif)?" This was done in order to ensure that each of the participants can pronounce the nonsense syllable correctly.

In echoic pretraining, all three of the sample cards were placed on the table in front of the participant. The experimenter pointed to each of the samples two times in a random, predetermined order and said, "This is zog (vek/kif). What is this?" If the participants responded correctly the experimenter provided verbal praise such as, "Yes, that is zog (vek/kif)," or "You're right, great job." If the participant did not respond correctly, the experimenter provided corrective feedback by repeating, "This is zog (vek/kif). What is this?" The participants were required to respond correctly on all six of these trials in order to proceed to tact training.

Tact training was first conducted with pairs of the sample stimuli. A block of eight trials was presented for each of the three sets of pairs (zog and vek; vek and kif; zog and kif). For each block of trials, the two sample cards were placed on the table in front of the participant. The experimenter then pointed to the cards in a random predetermined order and asked the participant, "What is this?" If the participant responded correctly, the experimenter provided verbal praise. If the participant did not respond correctly, the experimenter provided corrective feedback. The criterion set for tact training with pairs was seven out of eight correct responses in each block of trials. Once this criterion was met, the participants were exposed to tact training with all three sample stimuli. This training was conducted in the same way as it was for the pairs, except that the participants were presented with one block of 12 trials. The criterion set for tact training with all three sample stimuli was 11 out of 12 correct responses.

After the participants met criterion on all of the tact training tests, they were trained to name the sample stimuli in the context of the MTS procedure. The participants were given one block of 12 naming-only trials with all three sample stimuli as a review before they were presented with the arbitrary AB task. Once the first session began and the first sample appeared on the computer screen, the experimenter told the participant, “I want you to say the name before you click on it.” These instructions were faded out gradually as the participant consistently named the sample correctly without any verbal prompts. If the participant demonstrated difficulty naming the samples in this context, reviews of tact training were conducted.

Tacting Condition 2

This training was conducted in order to teach the participants to name the comparison stimuli and was very similar to the training conducted for Tacting Condition 1. The participants were exposed to echoic pretraining and tact training as described by Lowe et al. (2002) and Horne, Lowe, and Randle (2004). Images of the three comparison stimuli that were used in the arbitrary AB task were presented on laminated cards. The same nonsense syllables that were assigned to the sample stimuli were assigned to the corresponding comparison stimuli. The participants were trained to say “zog” in the presence of B1, “vek” in the presence of B2, and “kif” in the presence of B3. The echoic pretraining and tact training was conducted in the same manner as it was in Tacting Condition 1 training.

After the participants met criterion on all of the tact training tests, they were trained to name the comparison stimuli in the context of the MTS procedure. Once the first session began and the first sample appeared on the computer screen, the experimenter told the participant, “I want you to say the name before you click on it.”

After they said the name of the sample and clicked on it with the mouse, the three comparisons were presented on the computer screen. At this point, the experimenter told the participant, “I want you to say the name of the one that you are going to pick before you click on it.” These instructions were faded out gradually as the participant consistently named the sample and comparison correctly without any verbal prompts. If the participant demonstrated difficulty naming the samples or comparisons in this context, reviews of tact training were conducted.

Tally Sheet Conditions - Training

Tally Sheet Condition 1

Tally sheets were used in this condition as an alternative method of requiring discrimination between the sample stimuli. These tally sheets were divided into three columns, with a picture of one of the sample stimuli at the top of each column (See Fig. 6). The three laminated sample cards that were used in the training for Tacting Condition 1 were also used in this training. Initially, the experimenter presented the participant with a tally sheet, a marker, and the three sample cards. The experimenter pointed to each of the samples two times in a random, predetermined order and said, “Look at this. When you see this, which one of these (pointing to the pictures at the top of the tally sheet) would you mark?” If a participant placed a mark under the correct picture, verbal praise was provided by the experimenter. If a participant did not mark at all or placed a mark under an incorrect picture, corrective instruction was provided in the form of repeating the initial instructions. The participants were required to respond correctly on all six trials in order to proceed to using the tally sheet in the context of the MTS procedure. The participants were given a review of the tally sheet training before they were presented

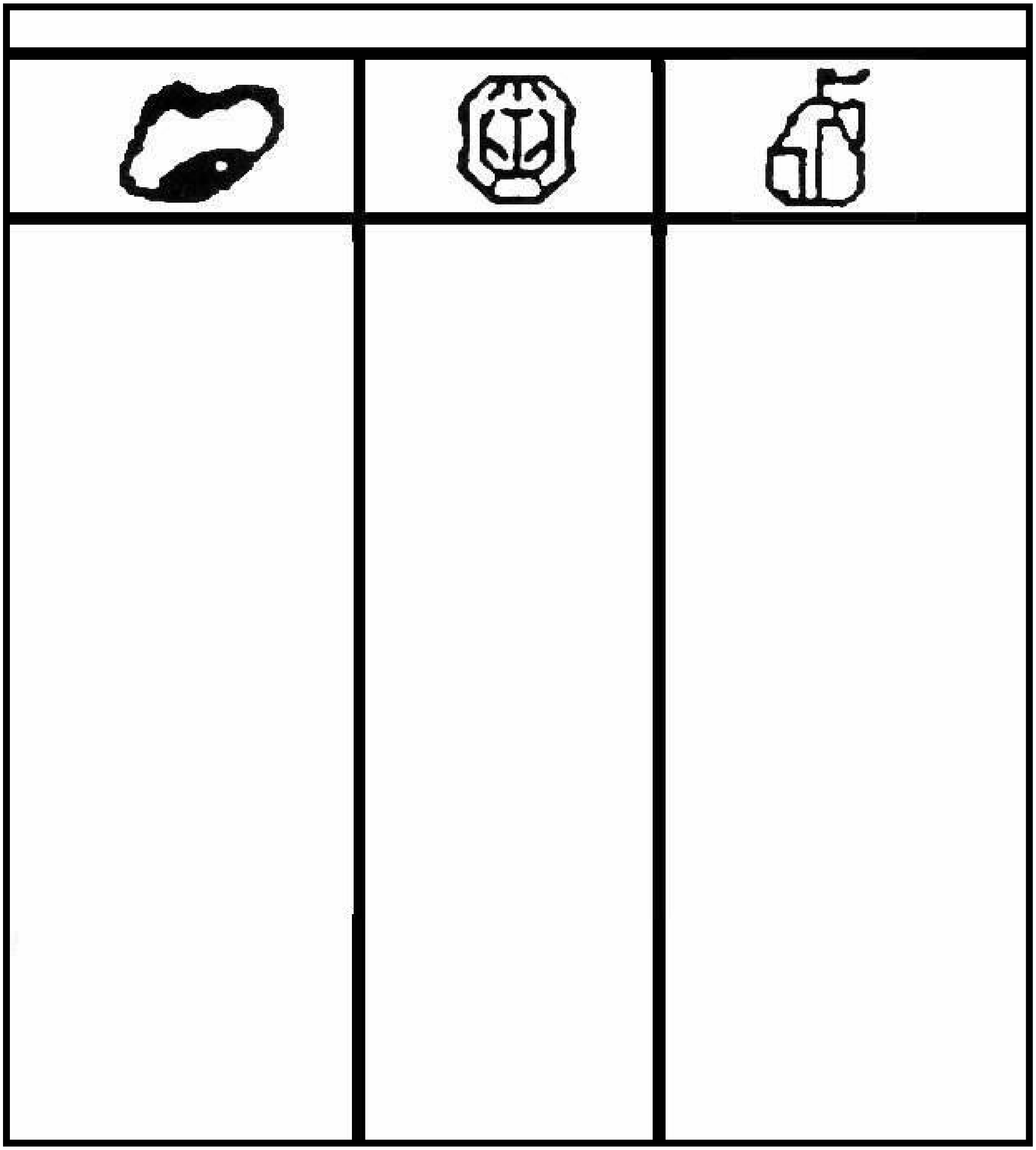


Figure 6. Tally Sheet 1

with the arbitrary AB task. Once the first session began and the first sample stimulus appeared on the computer screen, the experimenter told the participant, “I want you to place a mark under the one that you see before you click on it.” These instructions were faded out gradually as the participant consistently placed a mark under the correct sample picture without any verbal prompts. If the participant demonstrated difficulty marking the samples in this context, reviews of tally sheet training were conducted.

Tally Sheet Condition 2

Tally sheets were used in this condition as an alternative method of requiring discrimination between the sample and comparison stimuli. These tally sheets had images of the three sample stimuli and the three comparison stimuli printed on the sheet. The tally sheet was divided in half, with three columns dividing the top half of the page and three columns dividing the bottom half of the page. A picture of one of the sample stimuli was presented at the top of each column on the top half of the page, and a picture of one of the comparison stimuli was presented at the top of each column on the bottom half of the page (See Fig. 7, 8, and 9). The images of the samples and comparisons were arranged so that the image of the correct comparison stimulus was never positioned directly underneath its corresponding sample stimulus. There were three different versions of the tally sheets used in Tally Sheet Condition 2. The images were in different arrangements in each version of the tally sheet. The three different versions were used in order to discourage selections based on the arrangement of the stimuli.

The three laminated comparison cards that were used in training for Tacting Condition 2 were also used in this training. Training to mark the comparisons on the tally sheet was conducted in the same manner as it was in Tally Sheet Condition 1 training.

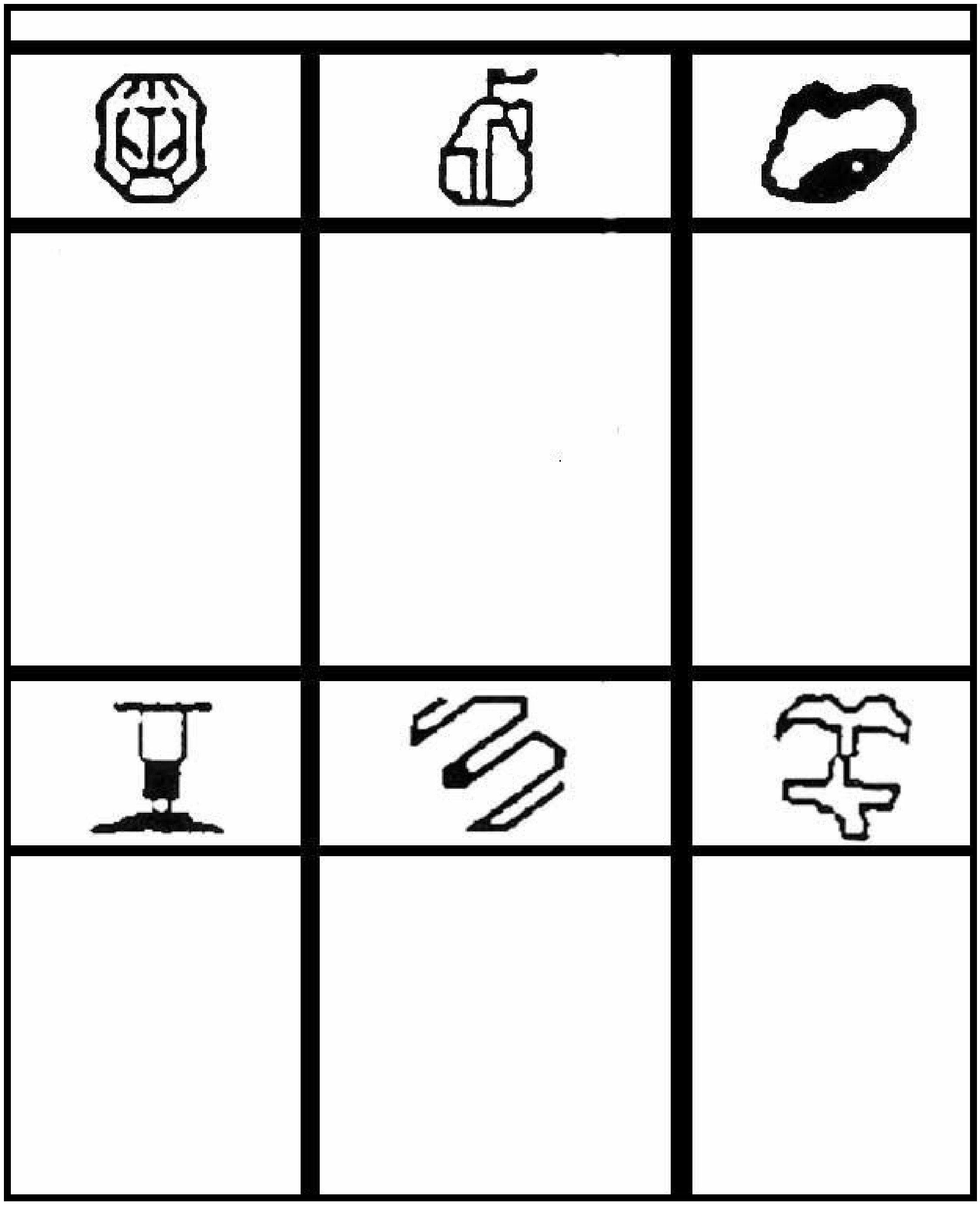


Figure 7. Tally Sheet 2 – Version 1

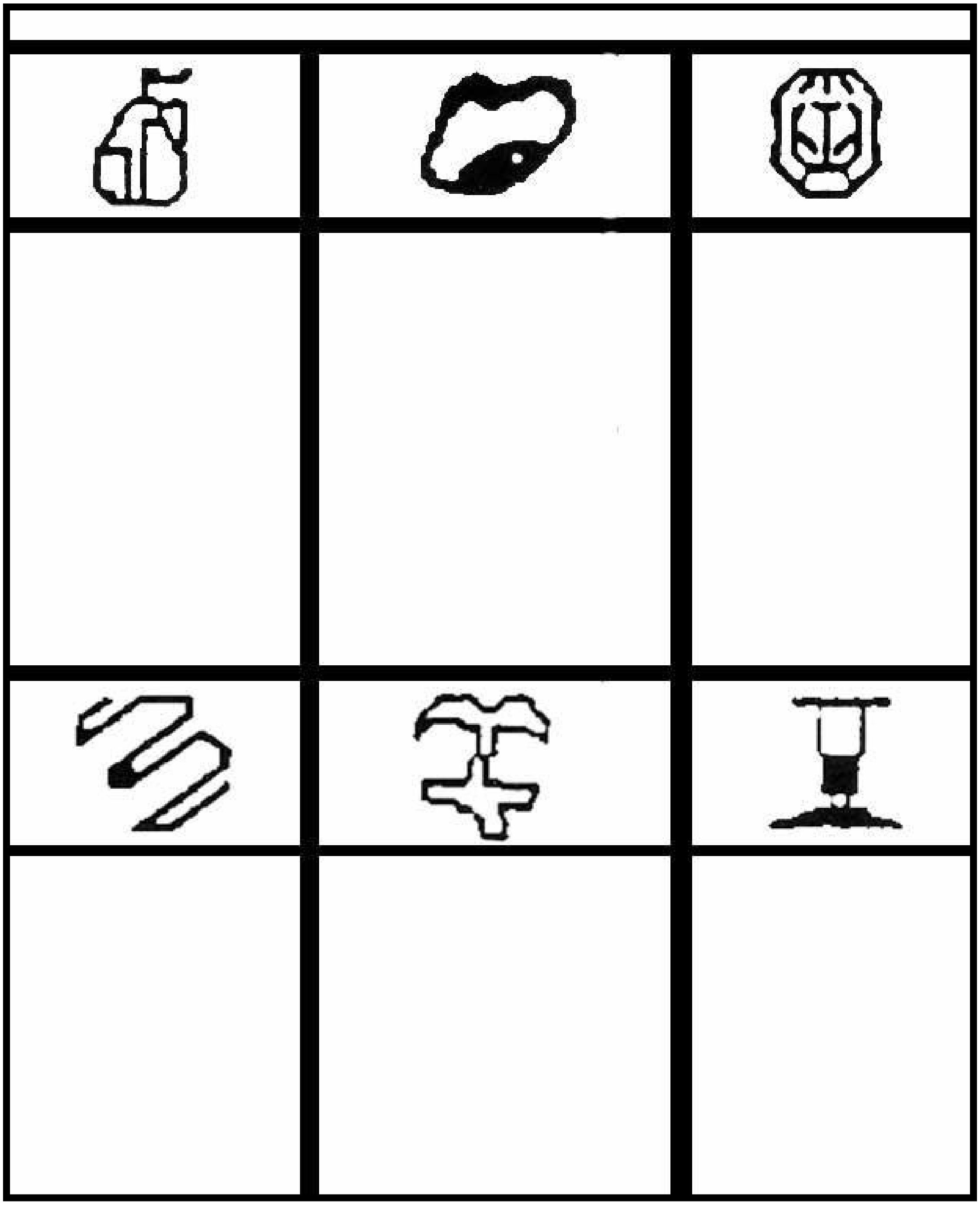


Figure 8. Tally Sheet 2 – Version 2

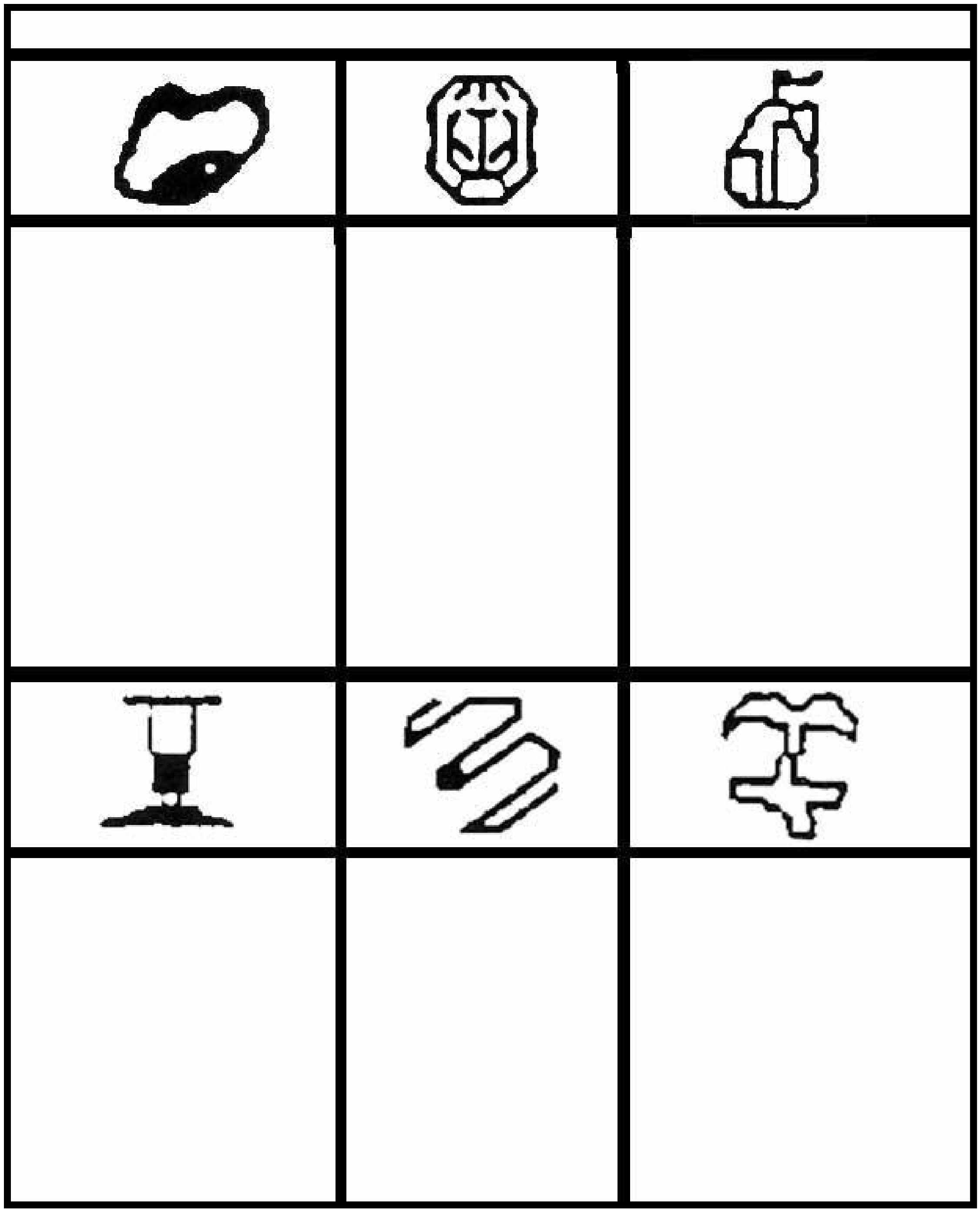


Figure 9. Tally Sheet 2 – Version 3

After the participants met criterion on all of the tally sheet training tests, they were trained to mark the comparison stimuli in the context of the MTS procedure. Once the first session began and the first sample stimulus appeared on the computer screen, the experimenter told the participant, “I want you to place a mark under the one that you see before you click on it.” After they marked the sample and clicked on it with the mouse, the three comparisons were presented on the computer screen. At this point, the experimenter told the participant, “I want you to point to the one that you are going to pick. Now, I want you to place a mark under the one that you picked before you click on it.” These instructions were faded out gradually as the participant consistently placed a mark under the correct sample picture and a mark under the chosen comparison stimulus without any verbal prompts. If the participant demonstrated difficulty marking the samples or the comparisons in this context, reviews of tally sheet training were conducted.

Cards – Training

The six stimulus cards utilized in Tacting Condition 2 and Tally Sheet Condition 2 were also used in card training. When the sample appeared on the screen, the experimenter instructed the participant to, “Point to the one that you see.” When the participant clicked on the sample stimulus, the comparisons were presented on the screen, and the experimenter instructed the participant to, “Point to the one that you are going to pick. Now click on the one that you picked.”

The three sample stimulus cards were either laid out in a row on the table or arranged in different configurations. The three comparison stimulus cards were either laid out in a row on the table, arranged in different configurations, or held in a fan by the experimenter. The way in which the cards were presented was chosen based on the responses of the participant. For example, if a participant was selecting comparison stimuli based on the relative position of the sample stimuli, an alternative method was chosen for the next session to discourage selections based on positioning of the stimuli (See results section for Participant TA and DD).

Naming Test

The six stimulus cards utilized in Tacting Condition 2 and Tally Sheet Condition 2 were also used during the naming test. The stimulus cards were presented to the participant in a random predetermined order. The experimenter began by explaining that she wanted to see if the participant had any names for the stimuli. The experimenter then presented the first stimulus card and asked the participant, “What is its name?” The experimenter presented each of the remaining stimulus cards and asked the participant, “What is its name?” All of the participant’s responses were recorded by the experimenter.

Correction Procedures

Several of the participants demonstrated strong position preferences in this experiment. That is, the participant’s comparison selections were controlled by the position, and not the relation between the sample and comparison stimuli. As mentioned previously, the trials in these sessions were balanced so that the comparisons were never in the same positions more than two times in a row. There were four possible positions for a comparison stimulus presentation: Position 2 (bottom left corner); Position 3 (bottom right corner); Position 4 (top left corner); and Position 5 (top right corner). As an example, a participant might demonstrate a position preference by selecting the stimulus in Position 2 one time, Position 3 two times, Position 4 one time, and Position 5 twenty times. In this example, the participant would be demonstrating a strong position preference for Position 5. If position preferences like this occurred, the participants were exposed to correction procedures. The correction procedures were the same as the original AB conditional discrimination training, but were programmed so that the participant must select the "correct" stimulus on any given trial before proceeding to the next trial. That is, the same trial was repeated if the incorrect response was made, and continued to be repeated until the correct response was made. These procedures were utilized in order to break up the position preferences by requiring the participant to select different positions in order for their selections to be reinforced. The participants were exposed to these correction procedures until they no longer demonstrated a strong position preference for any of the four possible positions.

Data Collection

The percentage of correct responses for each session was recorded by the computer. These data were then transferred to a data sheet and graphed using Sigma Plot 8.0. The graphs were updated after each session and inspected daily. The experimenter determined whether the participants should proceed to another condition based on visual inspection of their graphed results. If the participant's scores were at approximately chance level (i.e., 33%) and there was no upward trend in the scores after at least ten sessions, then the experimenter proceeded with training for the next condition. However, if there was an improving trend in the scores, training continued in the same condition. If there were no further signs of acquisition or upward trends in the scores, training proceeded in the next condition.

Experimental Design

A multiple baseline design across participants was utilized in this experiment. The participants proceeded with one of the two sequences of conditions (See Fig. 5) in a staggered manner, so that the naming or tally sheet interventions were introduced sequentially across participants. For example, in Sequence 1, one participant began Tacting Condition 1 training after approximately 10 sessions in the original arbitrary AB training condition; the next participant began tact training after approximately 12 sessions; the final participant in this sequence began tact training after approximately 14 sessions with no acquisition of the arbitrary AB conditional discrimination. This design was selected in order to provide additional support for the role of the experimental condition in changing performance. For example, if a change in the participant's performance was demonstrated when he or she was exposed to Tacting Condition 1, but there was no change demonstrated by the participant who was still in the AB baseline condition, support would be increased for attributing change to the manipulation involved in Tacting Condition 1.

RESULTS AND DISCUSSION

Participants TA, HC, and DD were randomly assigned to Sequence 1. Participant TA failed to demonstrate acquisition of the arbitrary AB conditional discrimination after 10 sessions (See Fig. 10). Thus, she proceeded to Tacting Condition 1. After five sessions in Tacting Condition 1, Participant TA demonstrated a strong position preference for Position 4 (top left corner). She was exposed to the correction procedure for 14 sessions at which the position preference was no longer evident. Therefore, she proceeded to Tacting Condition 1 again, where there were no trends toward acquisition

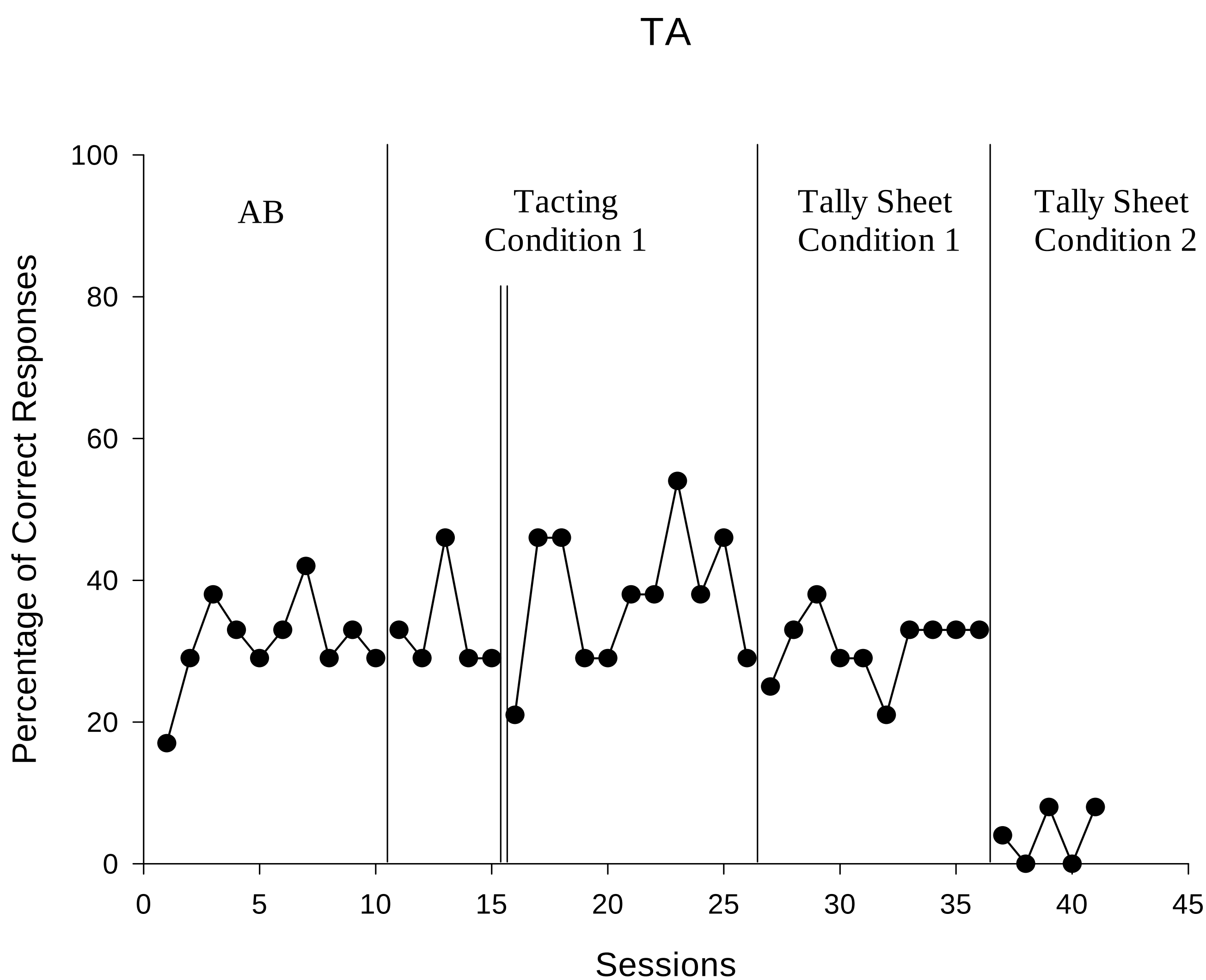


Figure 10. Participant TA

after 11 additional sessions of naming the sample stimuli. She then proceeded to Tally Sheet Condition 1. There was no acquisition after ten sessions of marking the sample stimuli.

She next proceeded to Tally Sheet Condition 2. As described previously, in Tally Sheet Condition 2, the images of the samples and comparisons were arranged so that the image of the correct comparison stimulus was never positioned directly underneath its corresponding sample stimulus. In addition, there were three different versions of these tally sheets. The images were in different arrangements in each version of the tally sheet. The three different versions were used in order to discourage selections based on the arrangement of the stimuli. However, for Participant TA, selections were based almost entirely on the arrangement of the stimuli. That is, she consistently chose the comparison that was aligned directly underneath the sample that was presented. During the first session in this condition Participant TA was given Version 1 of the tally sheet, and her selections were based on the alignment of the stimuli for all but one of the trials. During the second session in this condition Participant TA was given Version 2 of the tally sheet, and her selections were based on the alignment of the stimuli for all of the trials. During the third session in this condition she was given Version 3 of the tally sheet, and her selections were based on the alignment of the stimuli for all but two of the trials. Thus, it was obvious that this participant's selections were controlled by the positioning of the stimuli, and not by the intended sample-comparison relation.

To address this competing source of stimulus control, stimulus cards were substituted for the tally sheets. The sample and comparison stimulus cards were arranged on the table in front of the participant so that all six of the cards were laid out in a row (the three sample cards and then the three comparison cards). When the sample appeared on the screen, the experimenter instructed her to, "Point to the one that you see." When she clicked on the sample stimulus, the comparisons were presented on the screen, and the experimenter instructed her to, "Point to the one that you are going to pick. Now click on the one that you picked." At this point, Participant TA continued to make selections based on the positioning of the stimuli. In the first session using the cards, she chose the comparison stimulus in the same relative position as that of the sample stimulus. For instance, if the sample stimulus presented was the second sample card in the row, she chose the second comparison card in the row. Because none of the "correct" comparisons were aligned in this order, none of her selections were reinforced in this session. In the second session with the cards, the experimenter presented the sample and comparison cards in different configurations, in order to discourage selections based on alignment. The sample cards were arranged in a triangular shape, and the comparison cards were arranged in a straight diagonal line. In this session, the majority of selections were still based on the alignment of the stimuli. Only two selections were reinforced in this session. In the next session, the sample cards were placed on the table in front of the participant, and the experimenter held the comparison cards in a fan. No selections were reinforced during this session. Participant TA left the daycare at this point in the experiment. Thus, she failed to demonstrate acquisition after three sessions of marking and three sessions of touching the sample and the comparison stimuli.

Participant HC showed no signs of acquisition of the arbitrary AB conditional discrimination after 12 sessions of original training (See Fig. 11). She proceeded to Tacting Condition 1, where she again failed to demonstrate acquisition after 14 sessions

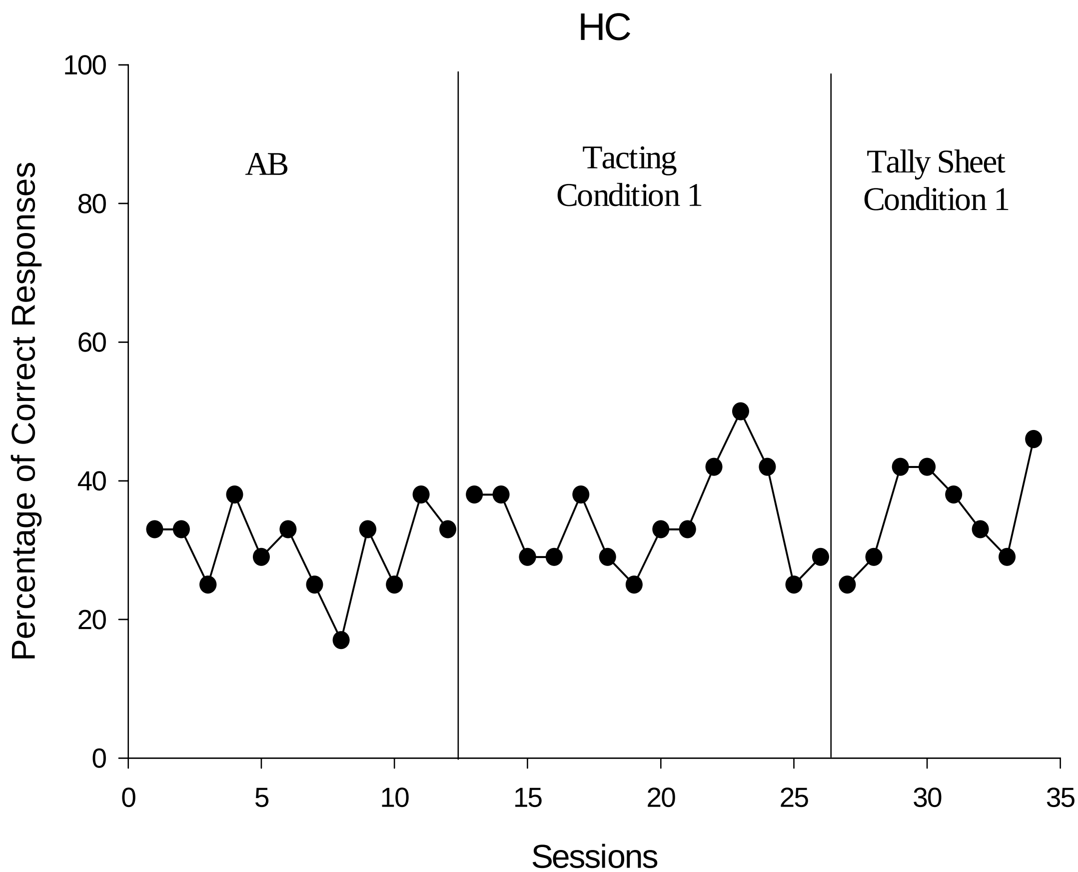


Figure 11. Participant HC

of naming the sample stimuli. She then proceeded to Tally Sheet Condition 1, in which she failed to demonstrate acquisition after eight sessions of marking the sample stimuli. She left the daycare at this point in the experiment.

Participant DD did not demonstrate acquisition of the arbitrary AB conditional discrimination after 18 sessions of original training (See Fig. 12). In Tacting Condition 1, he again failed to demonstrate acquisition after 12 sessions of naming the sample stimuli. In Tally Sheet Condition 1, he failed to demonstrate acquisition after ten sessions of marking the sample stimuli. Therefore, he proceeded to Tally Sheet Condition 2. In the first session in this condition, Participant DD demonstrated the same pattern of selecting stimuli based on alignment that had been demonstrated by Participant TA. So the stimulus cards were introduced with the same instruction described for Participant TA (see above). The sample cards were arranged on the table in front of the participant. The experimenter held the comparison cards in a fan and switched the order in which the comparison cards were presented for every trial. Using this method, the selections gave no indication of control by the arrangement of the stimuli in any way. Participant DD did not demonstrate acquisition after ten sessions of pointing to the samples and comparisons. Thus, he proceeded to Tacting Condition 2. After two sessions in this condition, Participant DD demonstrated acquisition of the conditional discrimination. See Figure 13 for the multiple baseline graph of Participant TA, HC, and DD.

Participants DN, LT, and JE were randomly assigned to Sequence 2. For Participant DN acquisition of the arbitrary AB conditional discrimination had not been demonstrated after 12 sessions of original training (See Fig. 14). After five sessions in Tally Sheet Condition 1, a strong position preference for Position 5 (top right corner) was

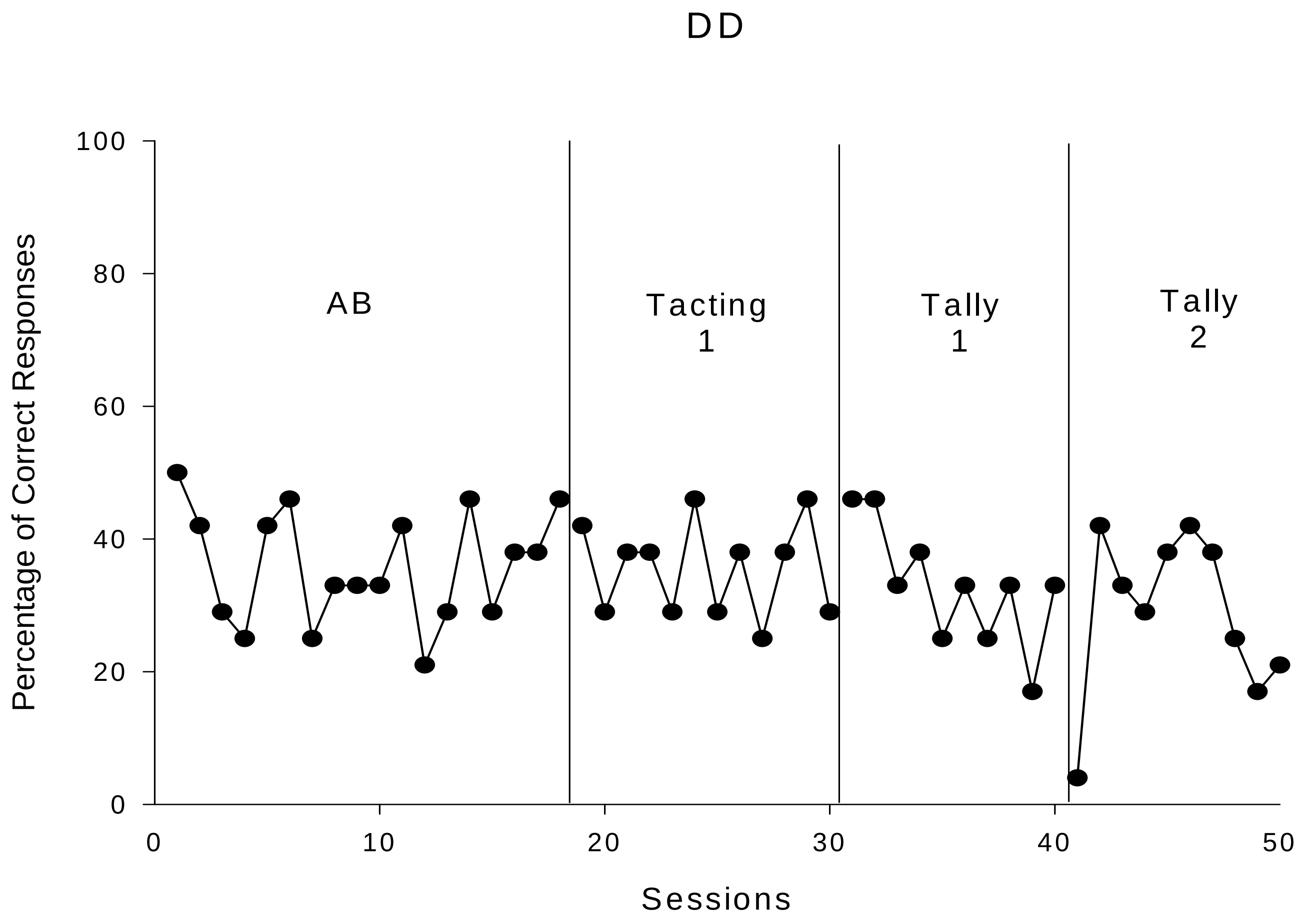


Figure 12. Participant DD

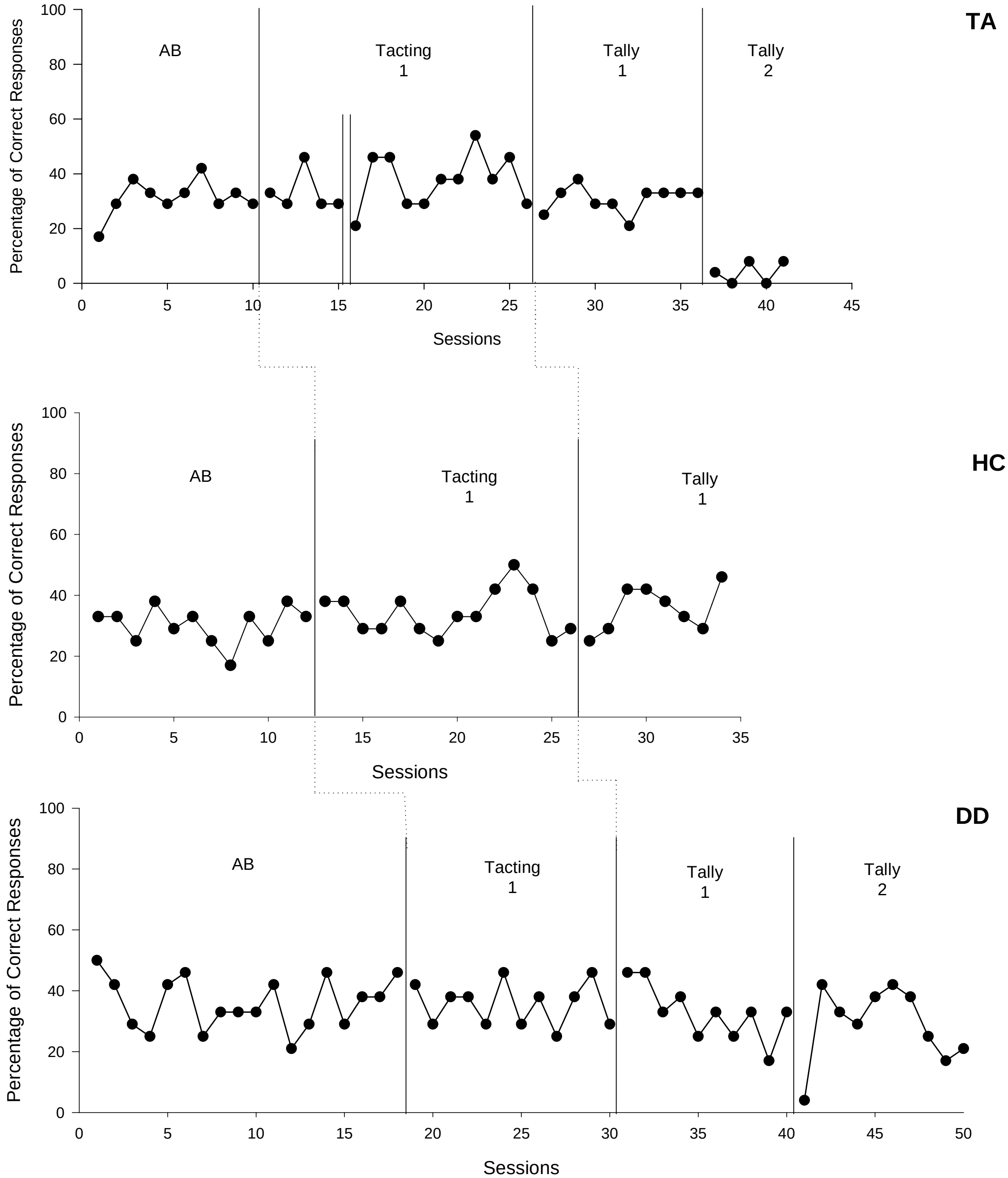


Figure 13. Participants TA, HC, & DD

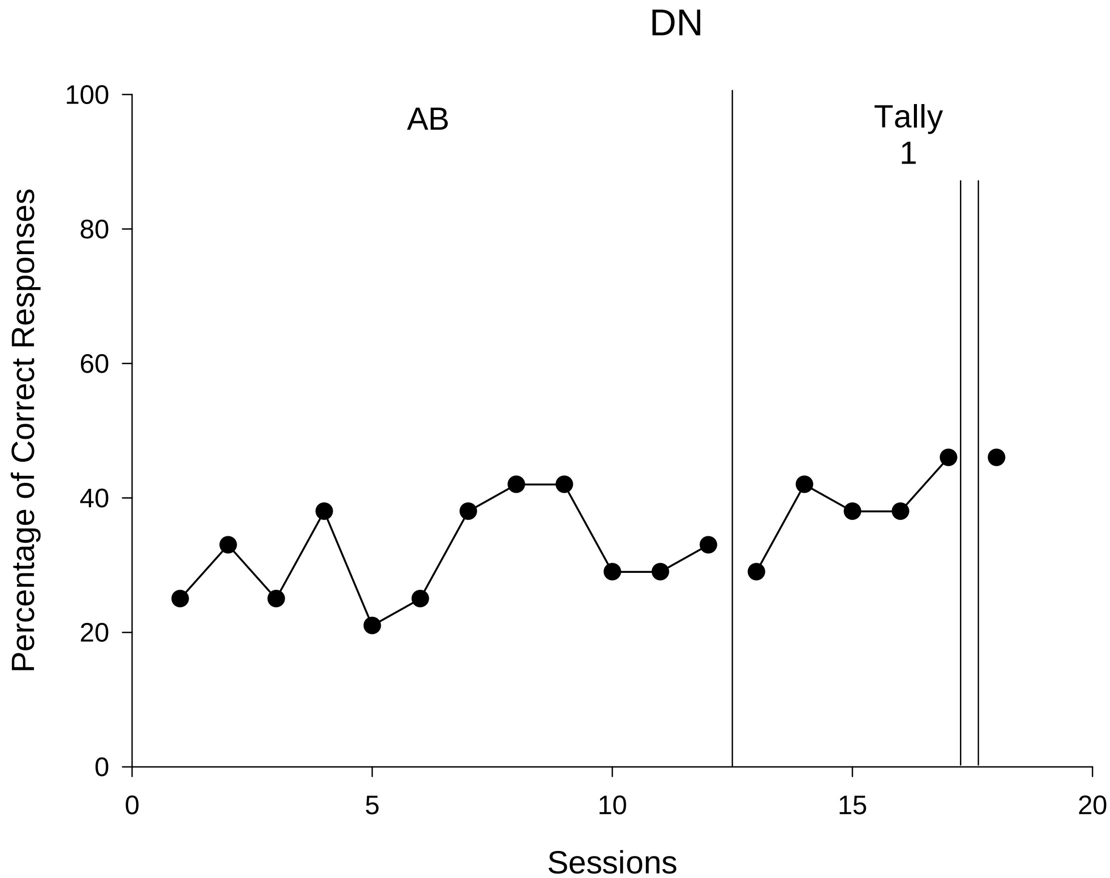


Figure 14. Participant DN

noted. Correction procedures were then implemented for eight sessions, until a strong position preference was no longer exhibited. He left the daycare after one additional session of marking the sample stimuli at chance-level accuracy.

For Participant LT no acquisition of the arbitrary AB conditional discrimination was demonstrated after 14 sessions (See Fig. 15). During the final sessions of her initial training a strong position preference for Position 4 (top left corner) was noted. The correction procedure was implemented for ten sessions, and the position preference ended. In Tally Sheet Condition 1, she again failed to demonstrate acquisition after 10 sessions of marking the sample stimuli. Similarly, in Tacting Condition 1, she failed to demonstrate acquisition after nine sessions of naming the sample stimuli. She left the daycare at this point in the experiment.

Participant JE received 16 sessions of original training with no acquisition (See Fig. 16). After five sessions in Tally Sheet Condition 1, a strong position preference for Position 3 (bottom right corner) was noted and the correction procedure implemented for 16 sessions. Upon return to Tally Sheet Condition 1, she continued chance levels of accuracy for eight additional sessions of marking the sample stimuli. She left the daycare at this point in the experiment. See Figure 17 for the multiple baseline graph of Participant JE, DN, and LT.

Participants ES, NC, and PG left the experiment prior to the introduction of any of the experimental conditions. Participant PG showed chance accuracy levels for 12 sessions while Participants ES and NC showed chance performances for 14 sessions (See Fig. 18, 19, and 20).

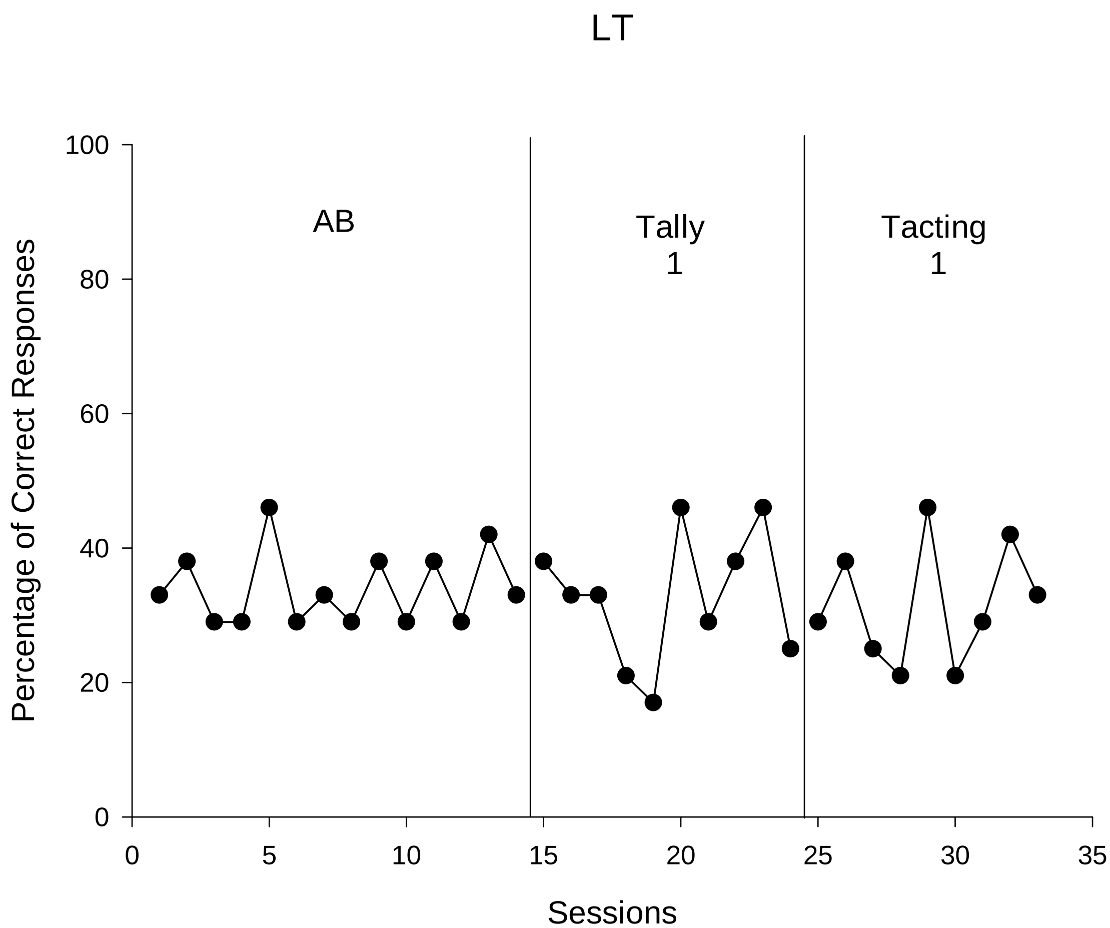


Figure 15. Participant LT

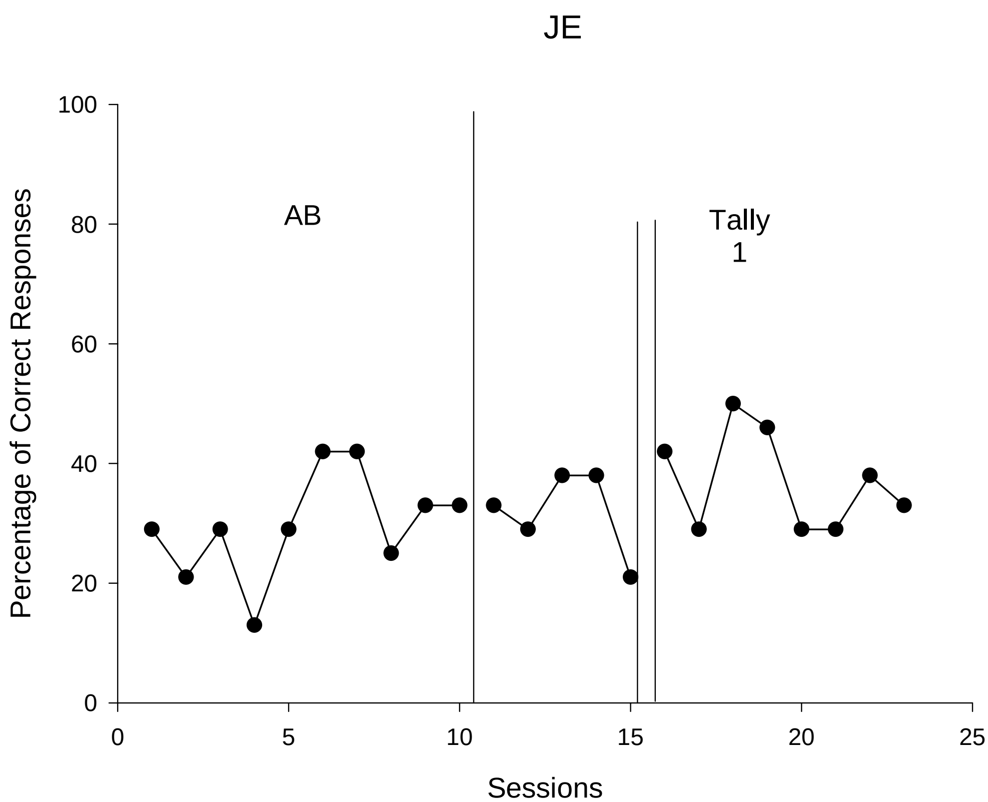


Figure 16. Participant JE

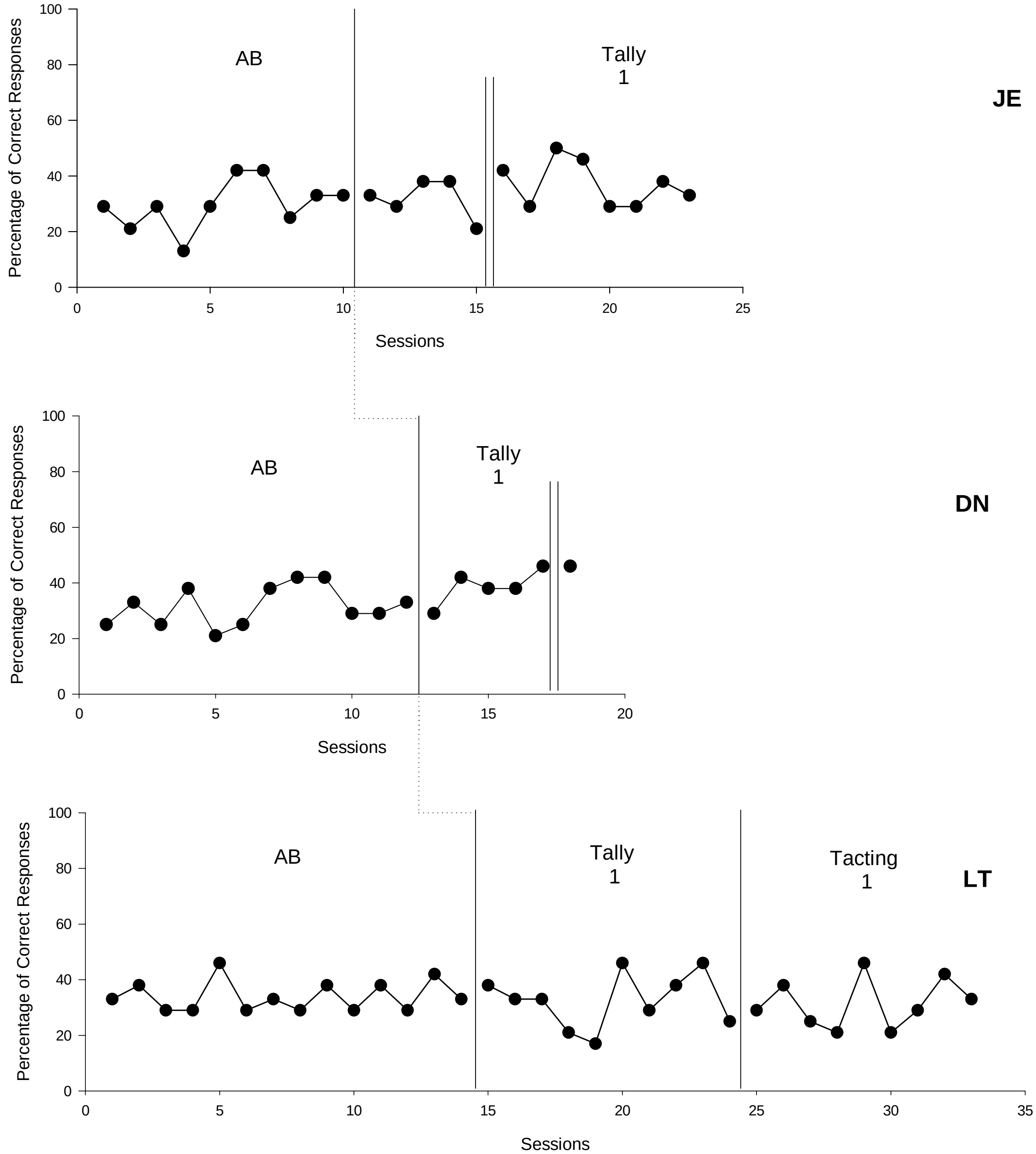


Figure 17. Participants DN, LT, & JE

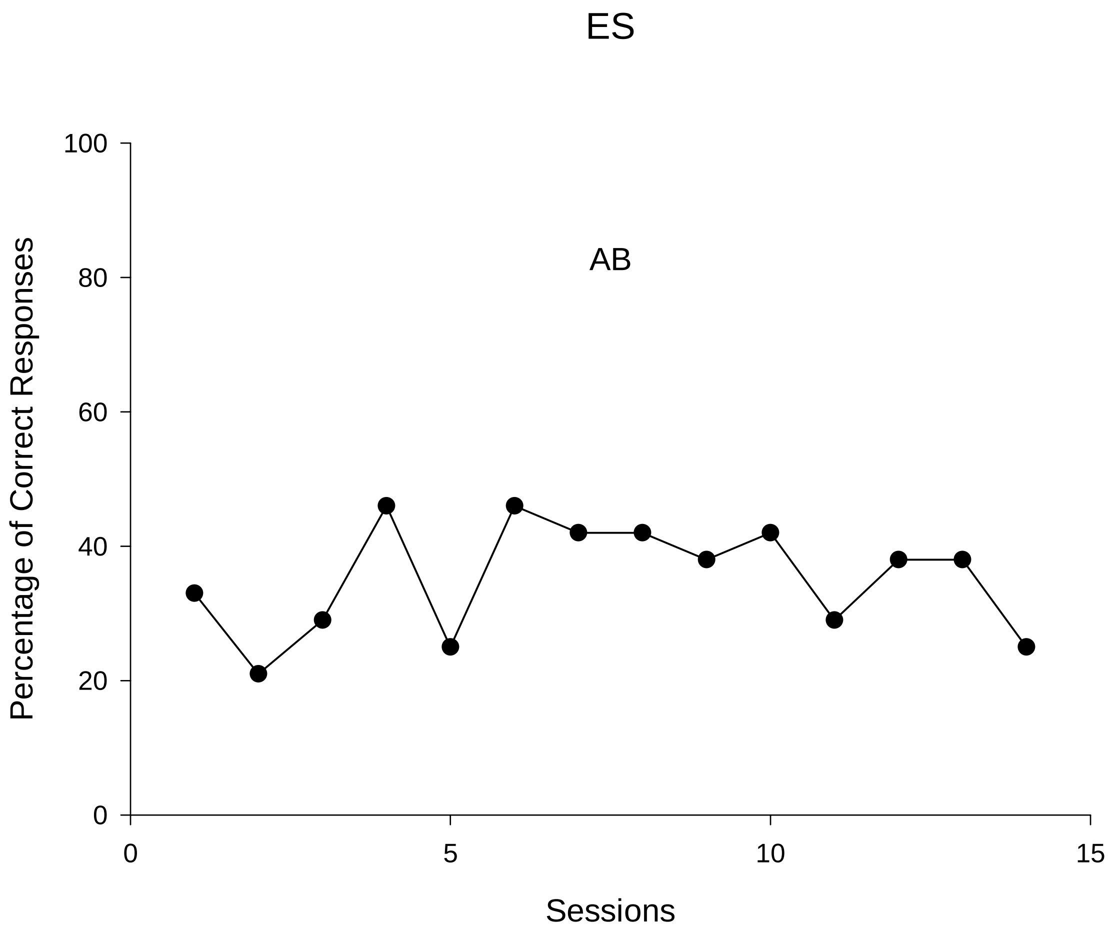


Figure 18. Participant ES

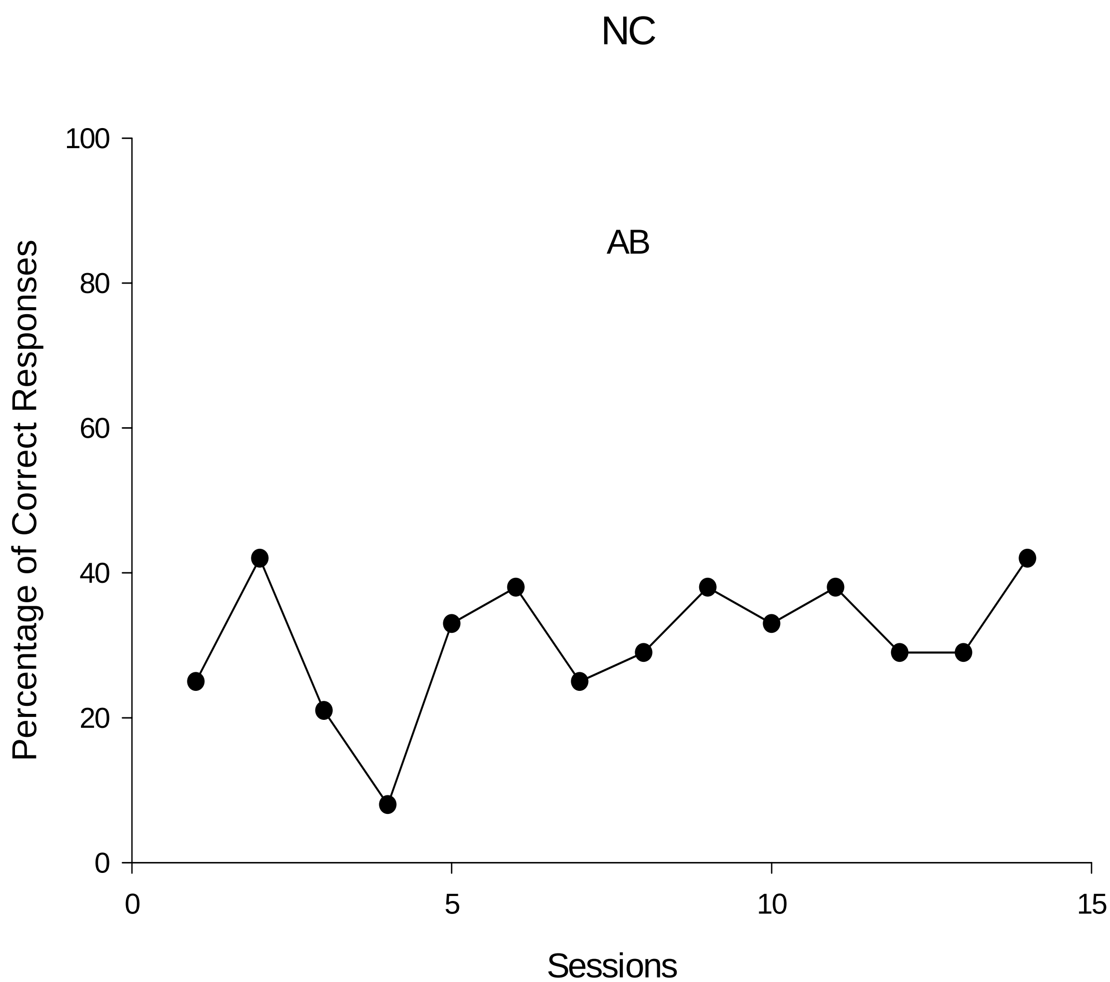


Figure 19. Participant NC

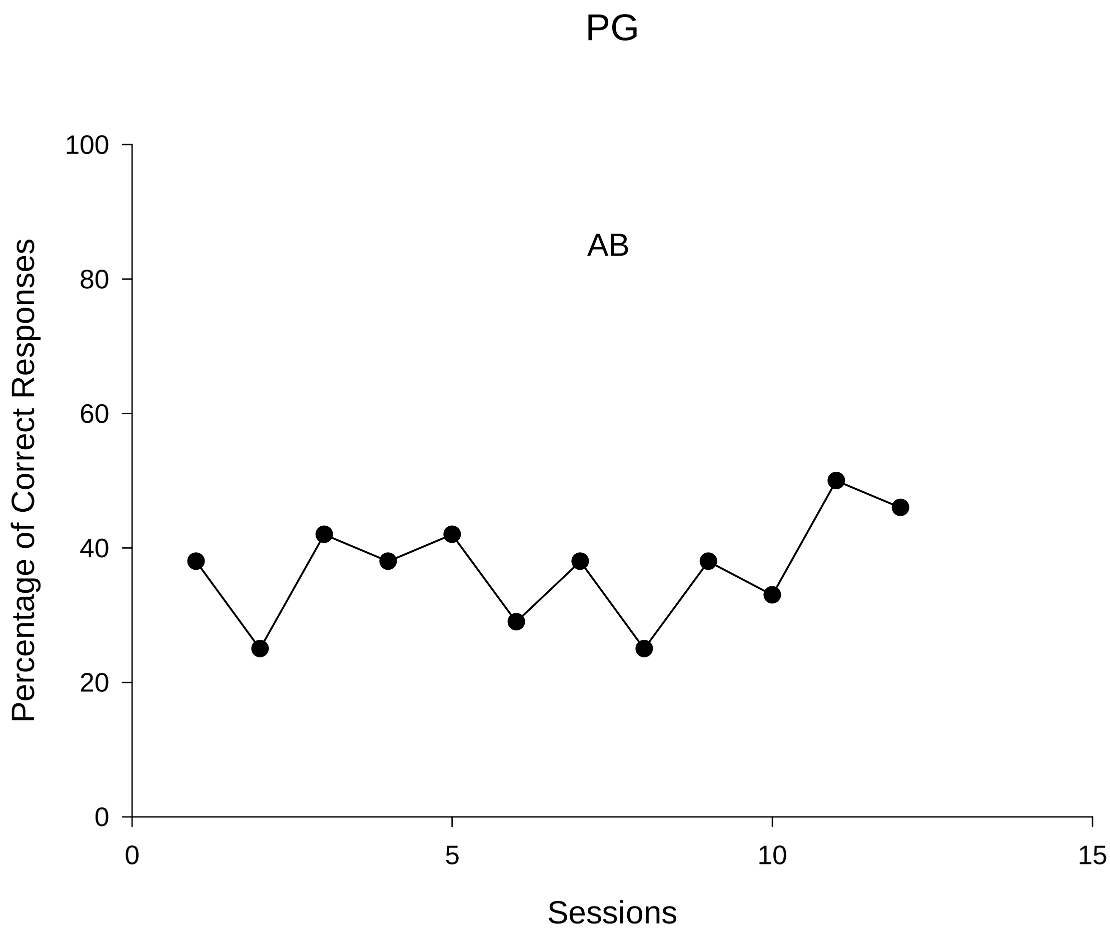


Figure 20. Participant PG

Participant NW received five sessions of original training and reached the mastery criterion (two sessions at 90% accuracy or above) on the fifth session (See Fig. 21). She was then presented with three naming tests to assess whether she had given each of the designated sample-comparison relations (e.g., A1B1, A2B2, A3B3) a common name. The results of these naming tests are presented in Table 1. There was only one trial in which Participant NW applied common names to the sample and comparison stimuli. None of the other naming trials indicated that Participant NW applied common names to the stimuli. This indicates that naming was not necessary for Participant NW to acquire the AB conditional discrimination.

Participant KC received three sessions of original training and reached the mastery criterion on the second session (See Fig. 22). She was then presented with two naming tests. The results of these tests are presented in Table 2. None of the naming trials indicated that Participant KC applied common names to the designated sample-comparison relations. This indicates that naming was not necessary for Participant KC to acquire the AB conditional discrimination.

The results of Experiment 1 demonstrated that nine of the eleven participants failed to acquire the arbitrary AB conditional discrimination in the original training conditions. These results seem indicate that it is difficult for children of this age to acquire conditional discriminations with differential reinforcement alone. These findings are consistent with those reported in previous experiments conducted with young children involving the acquisition of arbitrary conditional discriminations (e.g., Pilgrim, Jackson, & Galizio, 2000; Augustson & Dougher, 1991).

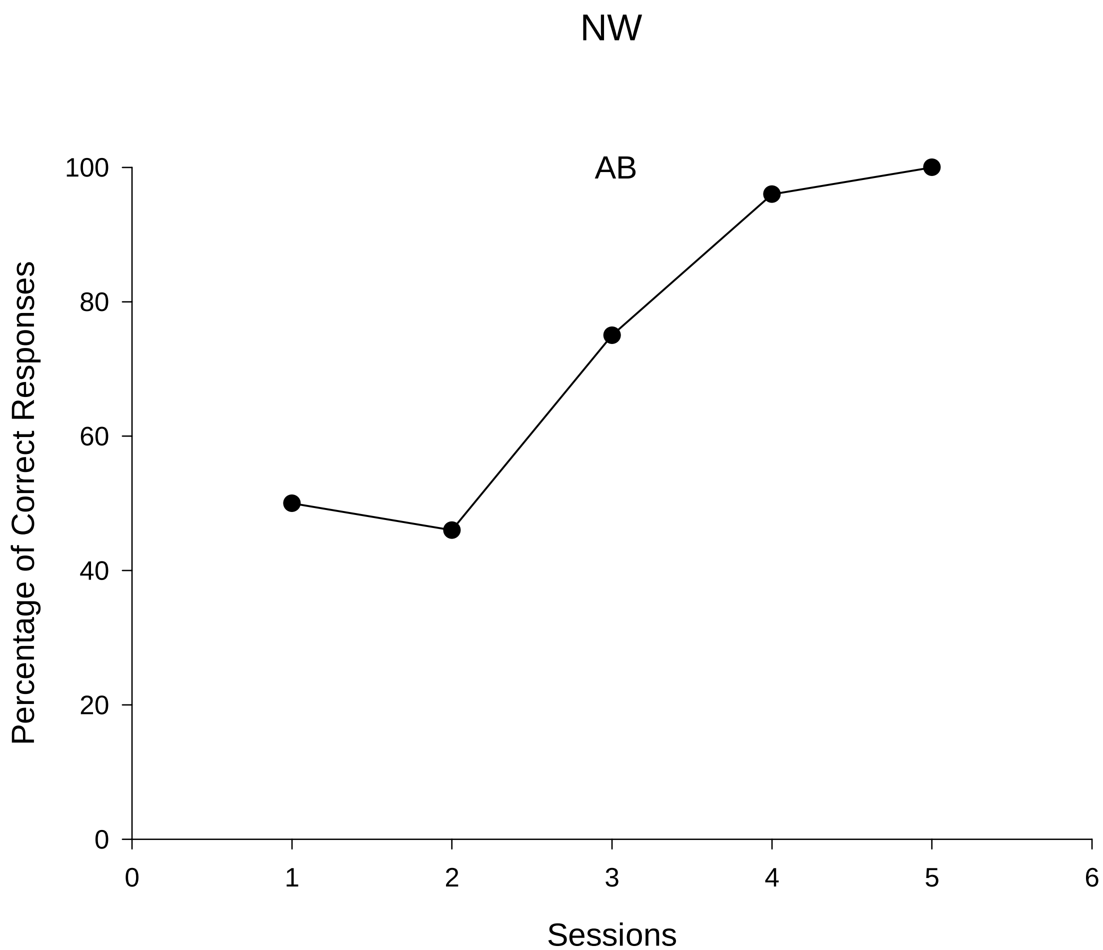


Figure 21. Participant NW

Table 1. Participant NW's Naming Test

	A1	B1	A2	B2	A3	B3
Test 1	#X	T	X	O	X	O
Test 2	#Z	#X	#X	#O	#O	#O
Test 3	#X	#O	#4	#T	#3	#5

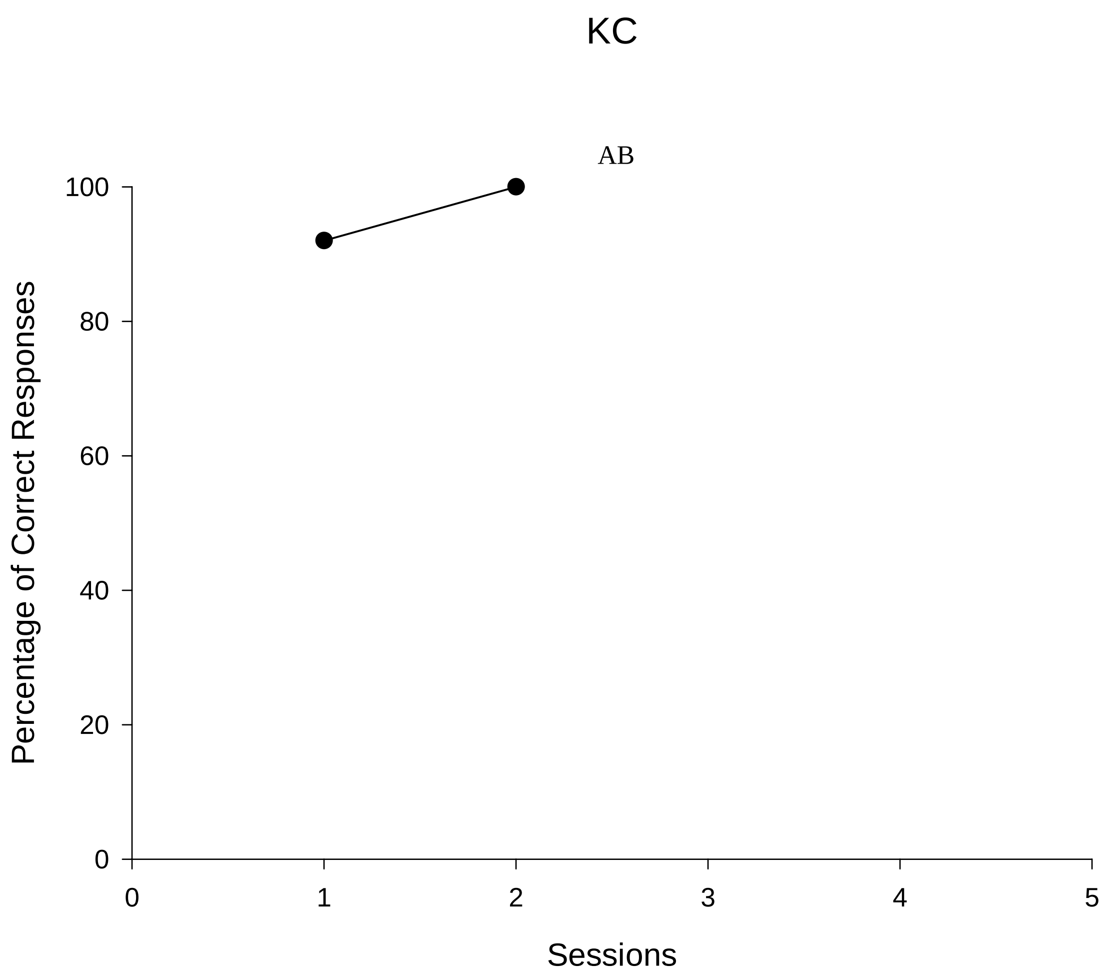


Figure 22. Participant KC

Table 2. Participant KC's Naming Test

	A1	B1	A2	B2	A3	B3
Test 1	kerus	fairst	spherus	pointys	nerfs	fear
Test 2	trufst	fairst	carest	pointys	spherus	whale

In contrast, the results of Experiment 1 demonstrated that two of the eleven participants acquired the arbitrary AB conditional discrimination in the original training conditions. In addition, the naming tests indicated that these two participants did not apply common names to the sample-comparison relations. This indicates that naming was not necessary for acquisition of the conditional discrimination. This is consistent with Sidman's view that naming is not necessary for the acquisition of conditional discriminations or equivalence.

All six of the participants who were exposed to Tally Sheet Condition 1, where discrimination between the sample stimuli was required in order to mark the tally sheets correctly, failed to acquire the arbitrary AB conditional discrimination. This seems to indicate that discrimination between the samples alone is not sufficient to facilitate the acquisition of conditional discriminations. Further, the two participants who were exposed to Tally Sheet Condition 2, where discrimination between the sample and the comparison stimuli was required in order to mark tally sheets or point to stimulus cards correctly, failed to acquire the arbitrary AB conditional discrimination. These two participants demonstrated strong positional control related to the tally sheets, requiring a procedural change to stimulus cards. Even with the stimulus cards, however, these participants failed to demonstrate acquisition. Thus, for these participants, the alternative method of discriminating between the sample and comparison stimuli did not facilitate acquisition of the conditional discrimination. However, conclusions about the facilitative role of this discrimination technique must be tentative because the stimulus control by the alignment of the stimuli was so strong, especially for Participant TA.

All four of the participants who were exposed to Tacting Condition 1, where discrimination between the sample stimuli was required for accurate naming, failed to acquire the arbitrary AB conditional discrimination. This seems to indicate that discrimination between the sample stimuli alone was not sufficient to facilitate the acquisition of conditional discriminations, even when naming was involved. This finding is consistent with those of Saunders and Spradlin (1990), who reported that sample naming alone did not facilitate acquisition of conditional discriminations.

In contrast, the one participant who was exposed to Tacting Condition 2, where discrimination between the sample and the comparison stimuli was required for accurate naming, did acquire the arbitrary AB conditional discrimination. These results indicate that common naming of the samples and comparisons did facilitate acquisition of the conditional discrimination. This is consistent with Horne and Lowe's (1996) argument that one possible way in which naming may lead to equivalence is by giving the stimuli the same name. Thus, proponents of the Naming Theory may suggest that acquisition of the conditional discrimination was facilitated by saying the same name for the samples and comparisons ("zog" for A1 and B1; "vek" for A2 and B2; "kif" for A3 and B3). These results would also provide additional support for Horne and Lowe's (1996) argument that "common naming of arbitrary stimuli is sufficient to establish stimulus classes." Furthermore, these results would be consistent with the findings of Lowe et al. (2002), which demonstrated that "simply training a common tact response to each of a number of arbitrary stimuli established those stimuli as a class or category" (p. 544).

These results are also consistent with the findings of Sidman and colleagues.

Sidman and colleagues argue that naming is not necessary, but it can facilitate the acquisition of conditional discriminations and equivalence. In addition, Sidman notes that naming may serve an instructional function, thereby making it difficult to determine the factors that are responsible for the emergence of conditional discriminations and equivalence.

EXPERIMENT 2

METHOD

Participants

Participants were six typically developing children, ages 4 years 4 months to 4 years 10 months at the beginning of the experiment, who attended a local day care program. See Figure 1 for participant name, sex, and age at start of the experiment. The parents of each of the participants were given information regarding the experiment and gave permission, in writing, for their child to participate prior to beginning this experiment (See Appendix A for permission slip).

Apparatus and Stimuli

The MTS computer program (Dube, 1991) and three desktop MacIntosh computers that were used in Experiment 1 were also used in this experiment. The stimuli were 1in. x 1in. black arbitrary shapes, which were presented on a white background and displayed on the computer screen. The A and B stimuli (See Fig. 2) that were used in Experiment 1 were also used in this experiment. Six new stimuli, the C and D stimuli, were also utilized in this experiment. As in Experiment 1, additional consequences (e.g., stickers for prize chart, stickers for hand, candy) were also presented at the end of each session. The method for obtaining these additional reinforcers was the same as in Experiment 1 (e.g., paying attention/being quiet during task).

General Procedure

The procedures for mouse training and exposure to the initial AB arbitrary conditional discrimination were the same as those discussed in Experiment 1. All of the participants were given the Peabody Picture Vocabulary Test after mouse training. See Figure 1 for Peabody age equivalent scores.

If there was no sign of acquisition of the arbitrary AB conditional discrimination after approximately ten sessions, the participants were exposed to one of the two training approaches, either Tacting Condition 1 or Cards Condition 1, depending on their designated sequence. If there was no sign of acquisition of the AB conditional discrimination after approximately three sessions in Tacting Condition 1, the participants assigned to Sequence 1 proceeded with Tacting Condition 2 training. Likewise, if there was no sign of acquisition of the AB conditional discrimination after approximately three sessions in Cards Condition 1, the participants assigned to Sequence 2 proceeded with Cards Condition 2 training. If there was still no sign of acquisition after completing these two conditions, the participants proceeded with training for the next condition in their designated sequence (See Fig. 23). The participants continued to proceed through each of the conditions in their designated sequence until acquisition of the arbitrary AB conditional discrimination had been demonstrated. The experimenter determined whether the participants should proceed to the next condition based on visual inspection of their graphed results, as described previously in Experiment 1.

Sequence 1	Arb AB	Tacting Condition 1	Tacting Condition 2	Cards Condition 1	Cards Condition 2
Sequence 2	Arb AB	Cards Condition 1	Cards Condition 2	Tacting Condition 1	Tacting Condition 2

Figure 23. Two possible sequences in Experiment 2 – AB conditional discrimination

In this experiment, participants proceeded to the next condition in their designated sequence upon failing to demonstrate acquisition of the AB conditional discrimination in Tacting Condition 1 or Cards Condition 1 after approximately three sessions. This procedural change was based on data obtained in Experiment 1. Of the nine participants exposed to Tacting Condition 1 and Tally Sheet Condition 1, none of the participants demonstrated acquisition of the conditional discrimination after ten or more sessions. Therefore, the experimenter decided to reduce the number of sessions the participants were exposed to the first conditions in each training approach. The participants were still exposed to the second conditions in each training approach (e.g., Tacting Condition 2 and Cards Conditions) for approximately ten sessions before proceeding to the next condition in their designated sequence, unless they demonstrated acquisition of the AB conditional discrimination.

Two training approaches were compared in this experiment (See Fig. 24). One approach involved naming conditions, which consisted of Tacting Condition 1 and Tacting Condition 2. The second approach involved touching stimulus cards, which consisted of Cards Condition 1 and Cards Condition 2. Stimulus cards were used in this experiment instead of tally sheets due to problems associated with the tally sheets in Experiment 1. See results for Participant TA. In order to discourage control by the alignment of the stimuli, this alternative method of requiring discrimination between the sample and comparison stimuli was utilized in Experiment 2. The participants were randomly selected to be in one of two different sequences of these conditions (See Fig. 23). All of the participants were exposed to standard arbitrary MTS training before beginning either of these sequences, as described previously in Experiment 1. Half of the

Condition	Description
Tacting Condition 1	Participants are trained to tact the sample stimulus prior to clicking on the sample stimulus.
Tacting Condition 2	Participants are trained to tact the sample stimulus prior to clicking on the sample stimulus, and to tact the comparison stimulus that they will select prior to clicking on the comparison stimulus.
Cards Condition 1	Three sample stimulus cards are positioned on the table in front of the participant. Participants are trained to point to the correct sample stimulus card prior to clicking on the sample stimulus.
Cards Condition 2	Three sample stimulus cards are positioned on the table in front of the participant. Three comparison stimulus cards are held in front of the participant. The positions of the comparison stimulus cards are rearranged for each trial. Participants are trained to point to the correct sample stimulus cards prior to clicking on the sample stimulus, and to point to the comparison stimulus card that they will select prior to clicking on the comparison stimulus.

Figure 24. Description of conditions in Experiment 2

participants were presented with Sequence 1; the other half were presented with Sequence 2.

Naming Conditions- Training

Tacting Condition 1

This training was conducted in order to teach the participants to name the sample stimuli. The training and the criteria for echoic pretraining and tact training (pairs of stimuli and all three stimuli) were identical to Tacting Condition 1 training described previously in Experiment 1. After the participants met criterion on all of the tact training tests, they were trained to name the sample stimuli in the context of the MTS procedure. The same instructions used during Tacting Condition 1 training in Experiment 1 were given to the participants in this experiment. These instructions were faded out gradually as the participant consistently named the sample correctly without any verbal prompts. If the participant demonstrated difficulty naming the samples in this context, reviews of tact training were conducted.

Tacting Condition 2

This training was conducted in order to teach the participants to name the comparison stimuli. The training and the criteria for tact training (pairs of stimuli and all three stimuli) were identical to Tacting Condition 2 training described previously in Experiment 1. After the participants met criterion on all of the tact training tests, they were trained to name the comparison stimuli in the context of the MTS procedure. The same instructions used in Tacting Condition 2 training in Experiment 1 were given to the participants in this experiment. These instructions were faded out gradually as the participant consistently named the sample correctly without any verbal prompts. If the participant demonstrated difficulty naming the samples in this context, reviews of tact training were conducted.

Cards Conditions - Training

Cards Condition 1

Stimulus cards were used in this condition as an alternative method of requiring discrimination between the sample stimuli. The three laminated sample stimulus cards that were used during Tacting Condition 1 training were also used in this training. Another identical set of sample stimulus cards was used in this training as well. One set of cards was placed on the table in front of the participant. The experimenter held up the other cards one at a time and said, “Look at this. When you see this, which one of these (pointing to the sample stimulus cards) would you pick?” The experimenter presented each sample stimulus card two times in a random, predetermined order. If a participant pointed to the correct sample card, verbal praise was provided by the experimenter. If a participant did not point to any of the cards or pointed to an incorrect sample card, corrective instruction was provided in the form of repeating the initial instructions. The participants were required to respond correctly on all six trials in order to proceed to pointing to the sample stimulus cards in the context of the MTS procedure. Before the session began, the three sample stimulus cards were laid out on the table in front of the participant. Once the first session began and the first sample stimulus appeared on the computer screen, the experimenter told the participant, “I want you to point to the one you see before you click on it.” These instructions were faded out gradually as the participant consistently pointed to the correct sample card without any verbal prompts. If the participant demonstrated difficulty pointing to the correct sample card in this context, reviews of card training were conducted.

Cards Condition 2

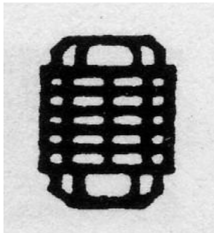
Stimulus cards were used in this condition as an alternative method of requiring discrimination between the sample and comparison stimuli. The three laminated comparison stimulus cards that were used in Tacting Condition 2 training were also used in this training. Another identical set of comparison stimulus cards was used as well. Training to point to the correct comparison stimulus card was conducted in the same manner as it was in Cards Condition 1 training. After the participants met criterion on all of the cards training tests, they were trained to point to the comparison stimulus cards in the context of the MTS procedure. Before the session began, the sample stimulus cards were laid out on the table in front of the participant. The experimenter held the comparison cards in a fan configuration. Once the first session began and the first sample stimulus appeared on the computer screen, the experimenter told the participant, “I want you to point to the one that you see before you click on it.” After they pointed to the sample stimulus card and clicked on the sample with the mouse, the three comparisons were presented on the computer screen. At this point, the experimenter told the participant, “I want you to point to the one you are going to pick. Now click on the one that you picked.” The experimenter rearranged the comparison stimuli after each trial to discourage control of participants’ responses by alignment of the stimuli. The instructions were faded out gradually as the participant consistently pointed to the correct sample stimulus card and pointed to the chosen comparison stimulus card without any verbal prompts. If the participant demonstrated difficulty pointing to the samples or the comparisons in this context, reviews of card training were conducted.

Correction Procedures

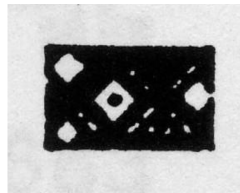
Several of the participants in this experiment also demonstrated strong position preferences at some point during the experiment. That is, the participant's comparison selections were controlled by the comparison position, and not the relation between the sample and comparison stimuli. The correction procedures utilized in this experiment were the same as those used in Experiment 1. The participants were exposed to these correction procedures until they no longer demonstrated a strong position preference for any of the four possible positions.

CD Conditional Discrimination Training

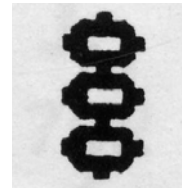
If the participants demonstrated acquisition of the AB conditional discrimination, they were exposed next to CD conditional discrimination training (See Fig. 25). This was done in order to determine whether a second conditional discrimination would be acquired without any additional interventions. However, if there was no sign of acquisition of the arbitrary CD conditional discrimination after approximately ten sessions, the participants were exposed to one of the two training approaches, either Tacting Condition 1 or Cards Condition 1, depending on their designated sequence. The condition sequence assigned for the CD conditional discrimination was the same as the sequence assigned for the AB conditional discrimination. If there was no sign of acquisition of the CD conditional discrimination after approximately three sessions in Tacting Condition 1, the participants assigned to Sequence 1 proceeded with Tacting Condition 2 training. Likewise, if there was no sign of acquisition of the CD conditional



C1

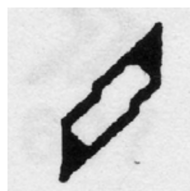


C2

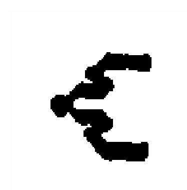


C3

D1



D2



D3

Figure 25. CD arbitrary stimuli

discrimination after approximately three sessions in Cards Condition 1, the participants assigned to Sequence 2 proceeded with Cards Condition 2 training. If there was still no sign of acquisition after completing these two conditions, the participants proceeded with training for the next condition in their designated sequence (See Fig. 26). The training for both Tacting Conditions and Cards Conditions was the same as described previously. The participants continued to proceed through each of the conditions in their designated sequence until acquisition of the arbitrary CD conditional discrimination had been demonstrated. The experimenter determined whether the participants should proceed to the next condition based on visual inspection of their graphed results, as described previously.

BC Conditional Discrimination Training

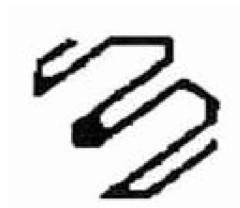
If the participants demonstrated acquisition of the CD conditional discrimination, they were exposed next to BC conditional discrimination training (See Fig. 27). If the participants demonstrated acquisition of the BC conditional discrimination, they were given a naming test for the C and D stimuli. This was done in order to determine whether the common names would transfer to other members in the same class.

CE Conditional Discrimination Training

If the participants demonstrated acquisition of the CD conditional discrimination after being trained to name the stimuli, they were exposed next to CE conditional discrimination training (See Fig. 28). If the participants demonstrated acquisition of the CE conditional discrimination, they were given a naming test for the E stimuli. This was done in order to determine whether the common names would transfer to other members in the same class.

Sequence 1	Arb CD	Tacting Condition 1	Tacting Condition 2	Cards Condition 1	Cards Condition 2
Sequence 2	Arb CD	Cards Condition 1	Cards Condition 2	Tacting Condition 1	Tacting Condition 2

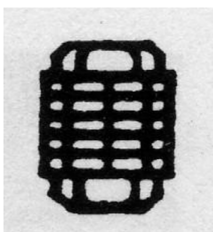
Figure 26. Two possible sequences in Experiment 2 – CD conditional discrimination



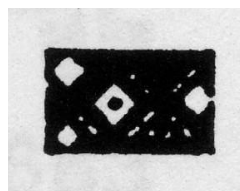
B1

B2

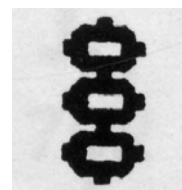
B3



C1

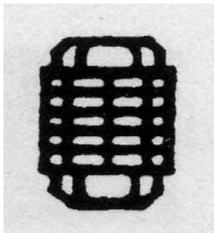


C2

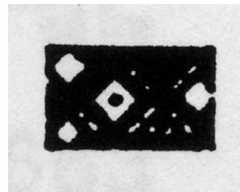


C3

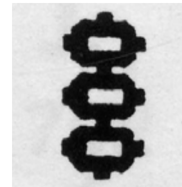
Figure 27. BC arbitrary stimuli



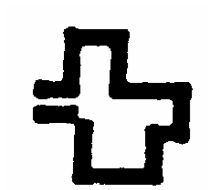
C1



C2



C3



E1

E2

E3

Figure 28. CE arbitrary stimuli

Naming Tests

C and D Stimuli

Six laminated stimulus cards with images of the C and D stimuli (i.e., C1, C2, C3, D1, D2, D3) were used during the naming test. The stimulus cards were presented to the participant in a random predetermined order. The experimenter began by explaining that she wanted to see if the participant had any names for the stimuli. The experimenter then presented the first stimulus card and asked the participant, “What is its name?” The experimenter presented each of the remaining stimulus cards and asked the participant, “What is its name?” All of the participant’s responses were recorded by the experimenter.

E Stimuli

Three laminated stimulus cards with the images of the E stimuli (i.e., E1, E2, E3) were used during the naming test. This naming test was conducted in the same manner as the naming test described previously with the C and D stimuli.

Data Collection

The percentage of correct responses for each session was recorded by the computer. These data were then transferred to a data sheet and graphed using Sigma Plot 8.0. The graphs were updated after each session and inspected daily. The experimenter determined whether the participants should proceed to another condition based on visual inspection of their graphed results. If the participant’s scores were at approximately chance level (i.e., 33%) and there was no upward trend in the scores after at least ten sessions, then the experimenter proceeded with training for the next condition. However, if there was an improving trend in the scores, training continued in the same condition. If there were no further signs of acquisition or upward trends in the scores, training proceeded in the next condition.

Experimental Design

A multiple baseline design across participants was utilized in this experiment. The participants proceeded with one of the two sequences of conditions in a staggered manner, so that the naming or card interventions were introduced sequentially across participants. This design was selected in order to provide additional support for the role of the experimental condition in changing performance.

RESULTS AND DISCUSSION

Participants MD, MM, and DD were randomly assigned to Sequence 1. Participant MD failed to acquire the arbitrary AB conditional discrimination after 10 sessions (See Fig. 29). In Tacting Condition 1, Participant MD demonstrated no trends toward acquisition after three sessions of naming the sample stimuli. In Tacting Condition 2, Participant MD demonstrated mastery of the arbitrary AB conditional discrimination after three sessions of naming the sample and comparison stimuli. He then received training for the arbitrary CD conditional discrimination. After four sessions of exposure to CD training, without any additional manipulations, Participant MD mastered the arbitrary CD conditional discrimination. Finally, he received training for the arbitrary BC conditional discrimination. Participant MD mastered the arbitrary BC conditional discrimination after three sessions of exposure to BC training, without any additional manipulations.

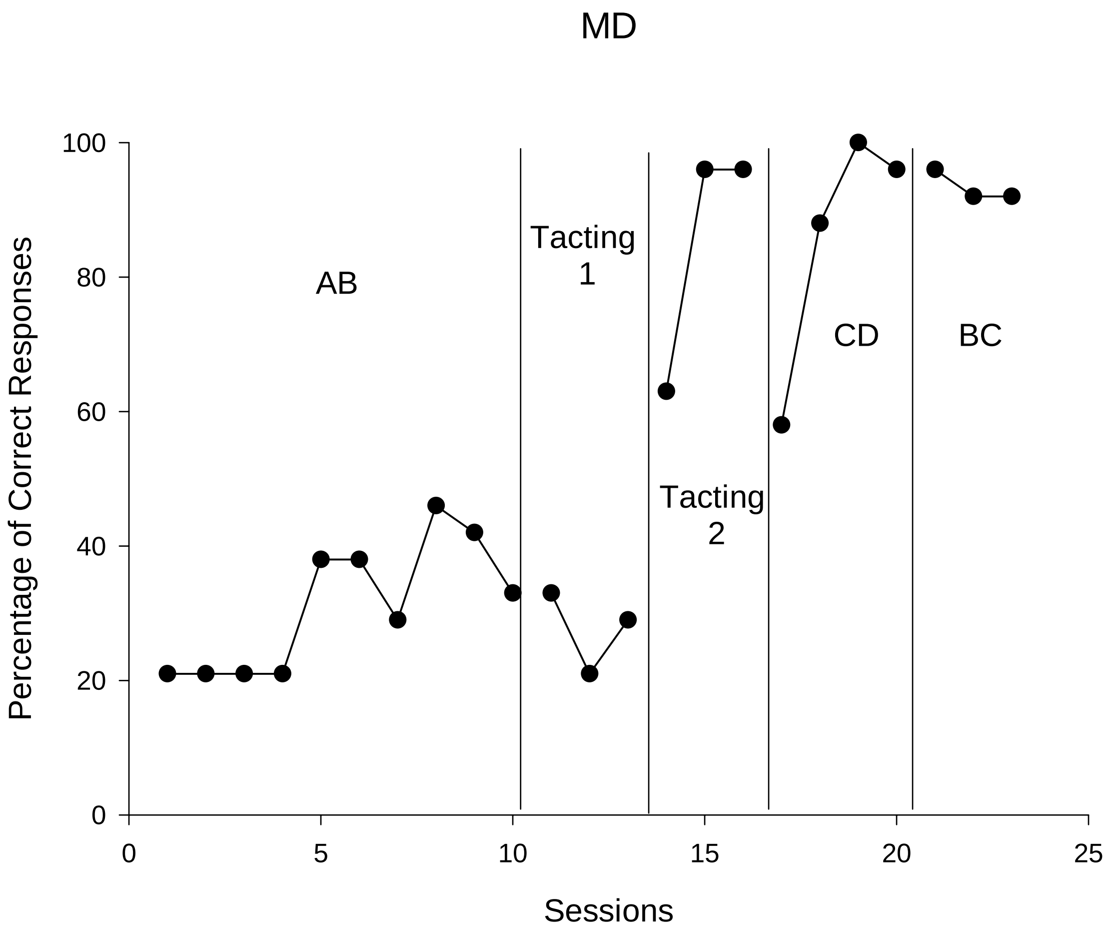


Figure 29. Participant MD

Participant MD was next given a naming test with the C and D stimuli to determine if the nonsense names had transferred to other stimuli within the same class (See Table 3). The results of this naming test demonstrated that the nonsense names had indeed transferred to the C and D stimuli, although Participant MD had never been explicitly trained to name these stimuli. There was one exception in Test 2 where he responded by saying "kif" in the presence of D2. Otherwise, all of the names given were consistent with other members within the same class.

Participant MM demonstrated no signs of acquiring the arbitrary AB conditional discrimination after 14 sessions of original training (See Figure 30). She also demonstrated no trends toward acquisition after three sessions of naming the sample stimuli in Tacting Condition 1. After five sessions of naming the sample and comparison stimuli in Tacting Condition 2, Participant MM mastered the arbitrary AB conditional discrimination. She then received training for the arbitrary CD conditional discrimination. After six sessions of exposure to CD training, without any additional manipulations, Participant MM mastered the arbitrary CD conditional discrimination. Finally, she received training for the arbitrary BC conditional discrimination, where she failed to acquire the conditional discrimination after 10 sessions. See Figure 31 for the multiple baseline graph of Participants MD and MM.

Participant DD was the only participant in Experiment 2 who also participated in Experiment 1. In Experiment 1, he failed to demonstrate acquisition of the arbitrary AB conditional discrimination after 18 sessions in original training, 12 sessions in Tacting Condition 1, 10 sessions in Tally Sheet Condition 1, and 10 sessions in Tally Sheet

Table 3. Participant MD's Naming Test

	C1	D1	C2	D2	C3	D3
Test 1	Zog	Zog	Vek	Vek	Kif	Kif
Test 2	Zog	Zog	Vek	Kif	Kif	Kif

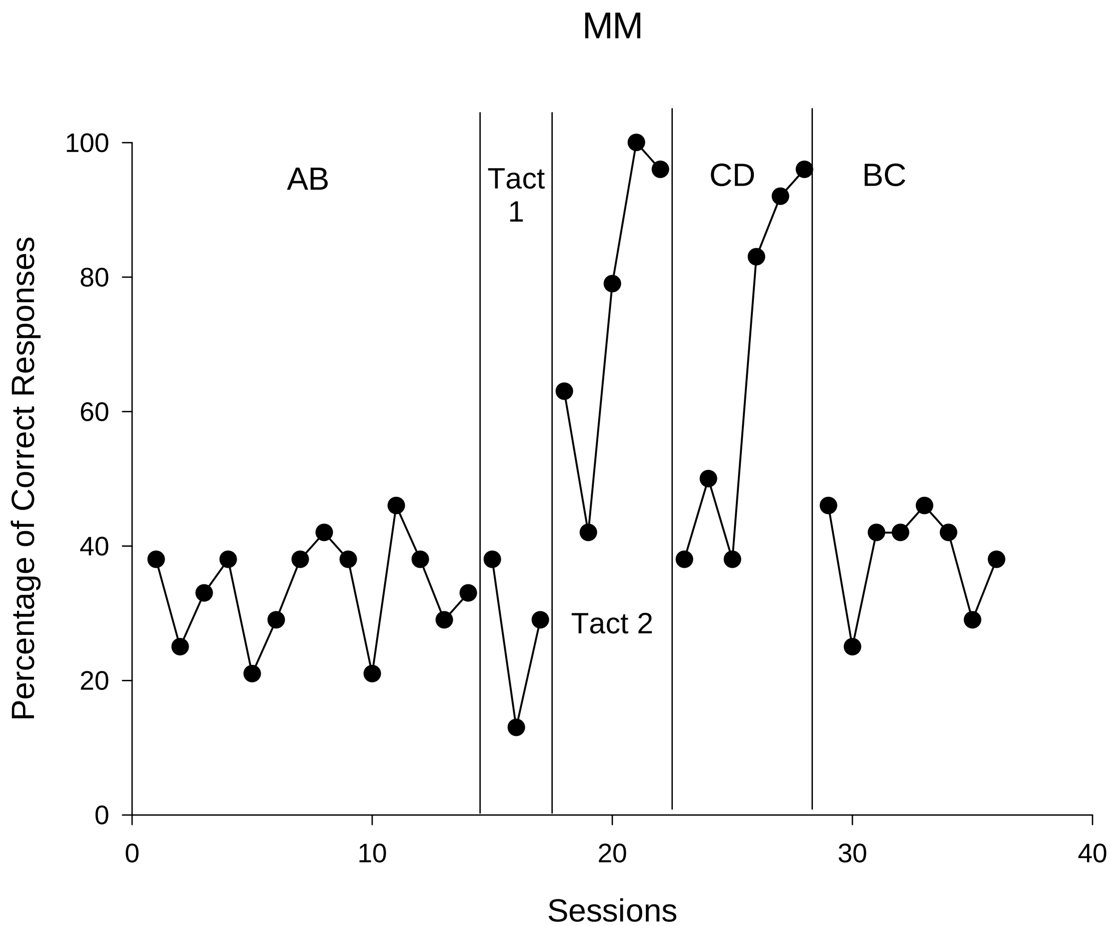


Figure 30. Participant MM

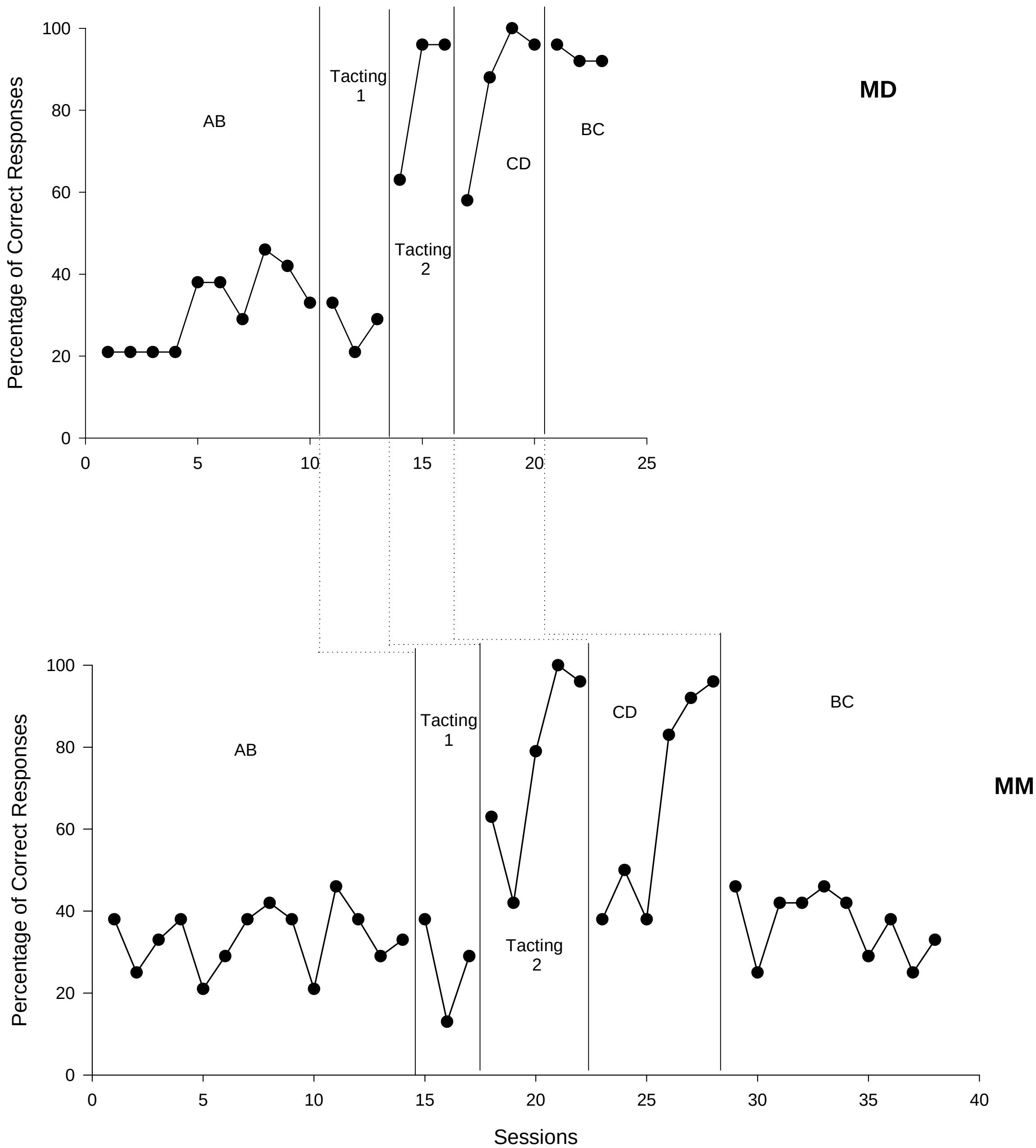


Figure 31. Participants MD & MM

Condition 2 (See Figure 12). In Experiment 2, he proceeded to Tacting Condition 2. After only three sessions of naming the sample and comparison stimuli, Participant DD mastered the arbitrary AB conditional discrimination (See Fig. 32). He then received training for the arbitrary CD conditional discrimination. Participant DD demonstrated no signs of acquisition of the CD conditional discrimination after 10 sessions of training without any additional manipulations. Therefore, he proceeded to Cards Condition 1. Participant DD demonstrated no trends toward acquisition after three sessions of touching the sample stimulus cards. In Cards Condition 2, he also failed to demonstrate acquisition of the CD conditional discrimination after 11 sessions. He was next exposed to Tacting Condition 1 for three sessions of naming the sample stimuli, and still no trends toward acquisition were demonstrated. In Tacting Condition 2, after two sessions of naming the sample and comparison stimuli, Participant DD mastered the arbitrary CD conditional discrimination.

Because Participant DD had been explicitly trained to name the C and D stimuli, he did not receive training for the arbitrary BC conditional discrimination and the follow-up naming test for the C and D stimuli. Instead, an arbitrary CE conditional discrimination was trained and a naming test was given to determine whether the nonsense names had transferred to the E stimuli. After four sessions of training for the CE conditional discrimination, Participant DD mastered the conditional discrimination without any additional manipulations. He was then given a naming test with the E stimuli (See Table 4). The results of this naming test indicated that the nonsense names had transferred to the E stimuli, although Participant DD had never been explicitly trained to

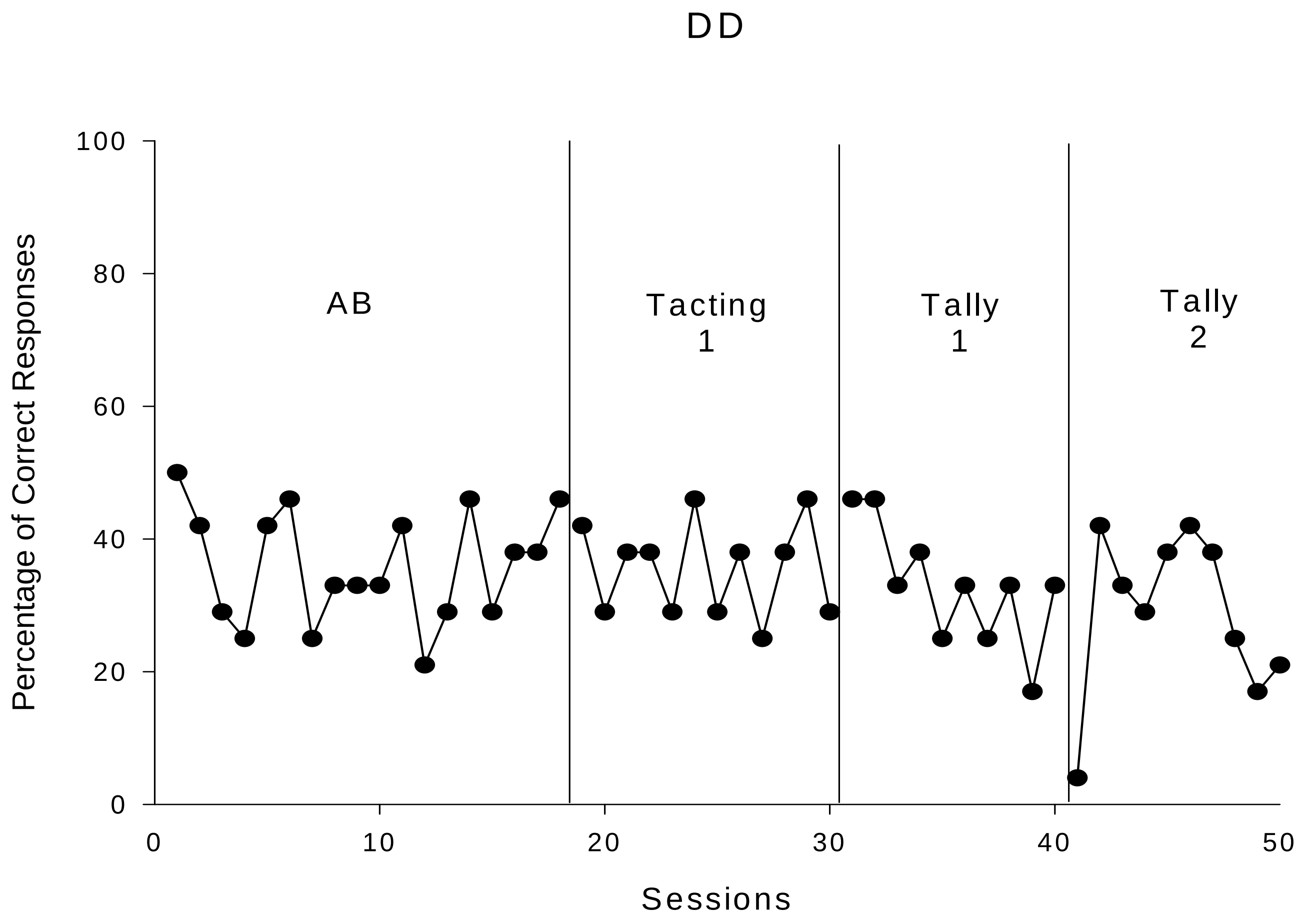


Figure 12. Participant DD

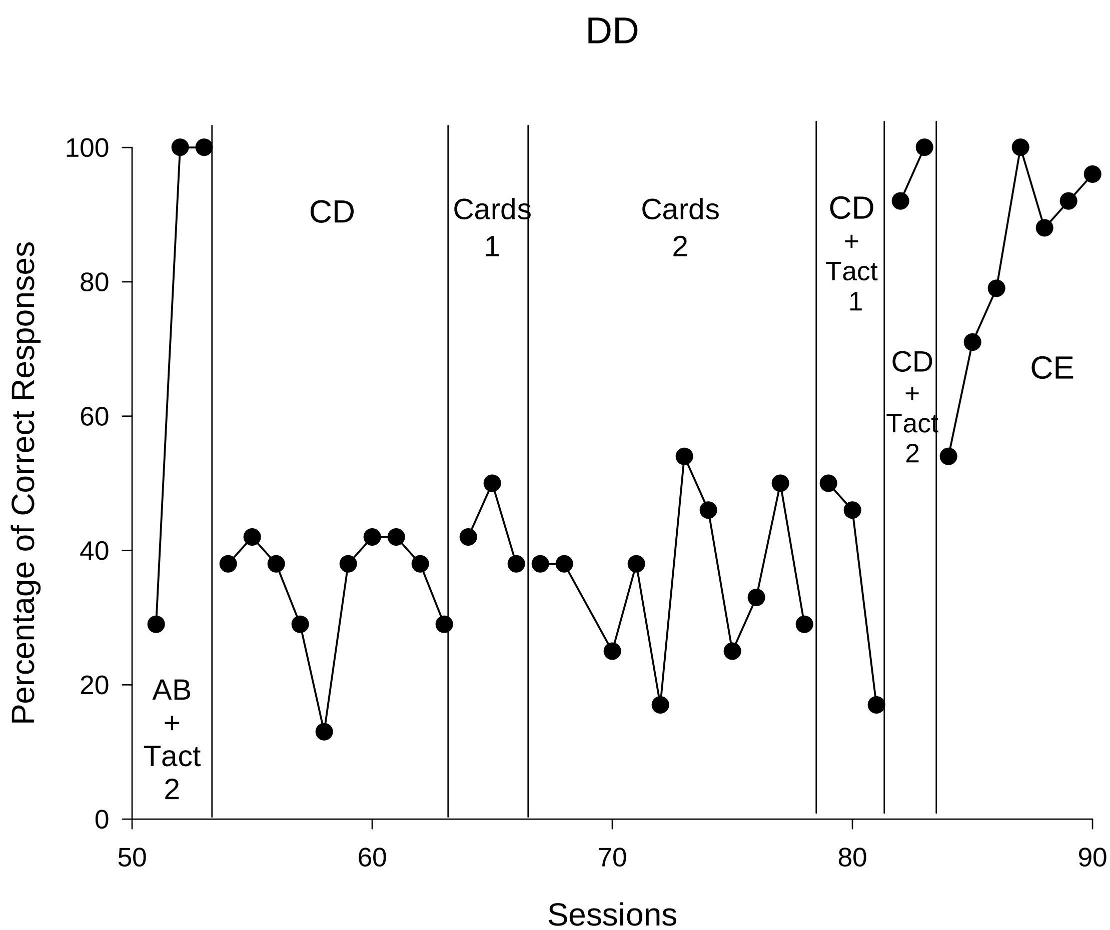


Figure 32. Participant DD

Table 4. Participant DD's Naming Test

	E1	E2	E3
Test 1	Zog	Vek	Kif
Test 2	Zog	Vek	Kif

name these stimuli. Thus, all of the names given were consistent with other members within the same class.

Participants AH, BB, and LM were randomly assigned to Sequence 2. Participant AH failed to acquire the arbitrary AB conditional discrimination after 10 sessions of original training (See Fig. 33). In Cards Condition 1, no trends towards acquisition were demonstrated after four sessions. In Cards Condition 2, after 14 sessions of touching the sample and comparison stimuli, she again failed to demonstrate acquisition. Participant AH proceeded to Tacting Condition 1 for three sessions where no trends towards acquisition were demonstrated. Finally, after naming the sample and comparison stimuli for 10 sessions in Tacting Condition 2, she failed to demonstrate the acquisition of the arbitrary AB conditional discrimination. Because Participant AH was the only participant who completed all of the conditions without demonstrated acquisition of the conditional discrimination, she was exposed to several additional procedures to determine whether the effectiveness of the reinforcer was contributing to this failure. Participant AH was first exposed to identity training with familiar stimuli (e.g., hearts, flowers), where after seven sessions she demonstrated mastery of the conditional discrimination. She was then exposed to two different thematic matching programs. These programs consisted of familiar stimuli that belong in the same class (e.g., cake and ice cream; chair and table; sun and moon). After five sessions in the first thematic matching training and three sessions in the second, she demonstrated mastery of the conditional discriminations. Since the same reinforcer was used in the identity training, thematic training, and AB conditional discrimination training, mastery of these three conditional discriminations

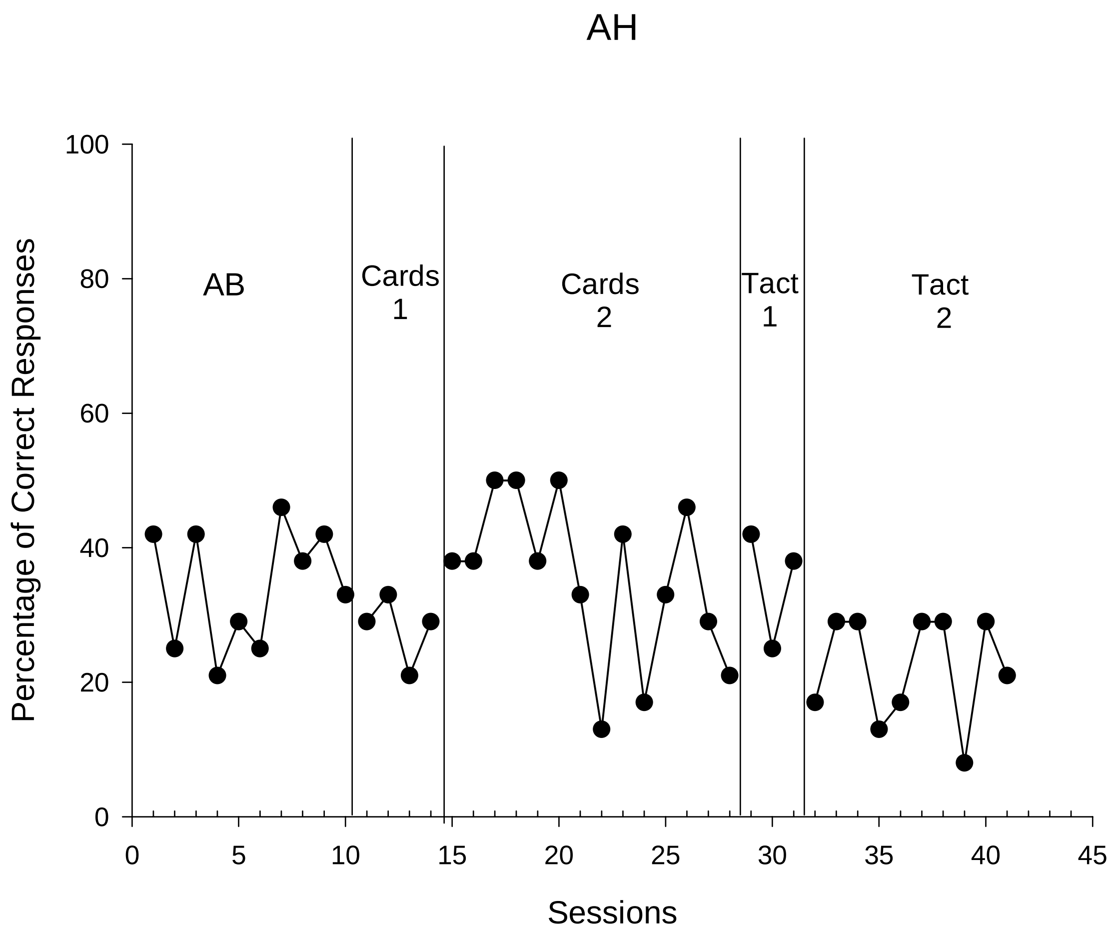


Figure 33. Participant AH

indicates that the reinforcer was effective. Therefore, it does not seem that her failure to acquire the AB conditional discrimination was due to the lack of an effective reinforcer.

Participant BB failed to acquire the arbitrary AB conditional discrimination after 14 sessions of original training (See Fig. 34). Similarly, there were no trends towards acquisition after five Sessions in Cards Condition 1. After five sessions in Cards Condition 2, Participant BB demonstrated a strong preference for selecting B3 in the presence of both A1 and A2. This did not seem to be an overall preference for the B3 comparison stimulus because B3 was not selected in the presence of A3 (the experimenter-designated relation). To address this preference, correction procedures were programmed next for Participant BB. After six sessions with the correction procedures, the preference was no longer demonstrated. Participant BB completed seven additional sessions in Cards Condition 2 (12 sessions total), and failed to acquire the arbitrary AB conditional discrimination.

Participant LM failed to learn the arbitrary AB conditional discrimination after 18 sessions of original training (See Fig. 35). There were also no trends towards acquisition in the three sessions of Cards Condition 1. After 10 sessions in Cards Condition 2, Participant LM failed to acquire the AB conditional discrimination. See Figure 36 for the multiple baseline graph of Participants AH, BB, and LM.

To summarize, in Experiment 2 none of the six participants acquired the arbitrary AB conditional discrimination in the original training conditions. As mentioned for Experiment 1, these results indicate that it is often difficult for children of this age to master conditional discriminations with differential reinforcement alone. These findings are consistent with those reported in previous experiments conducted with young children

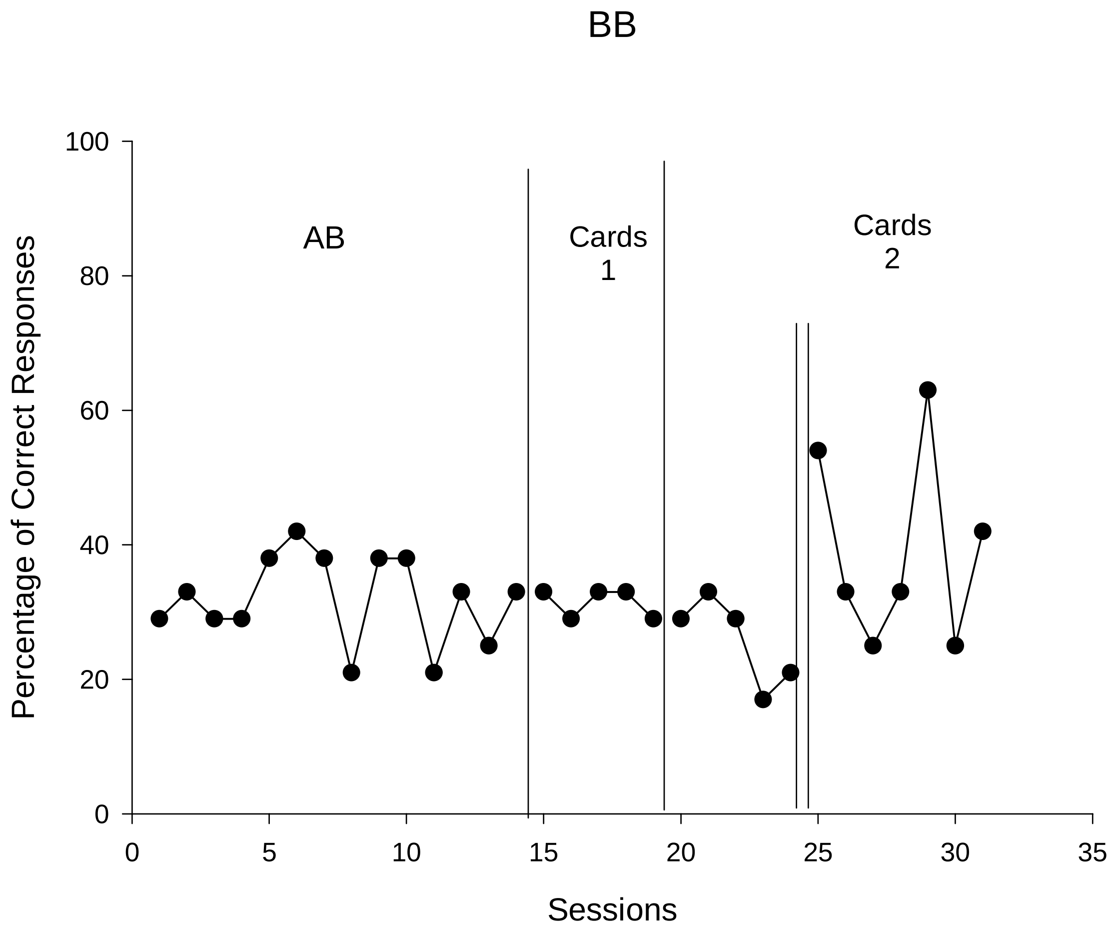


Figure 34. Participant BB

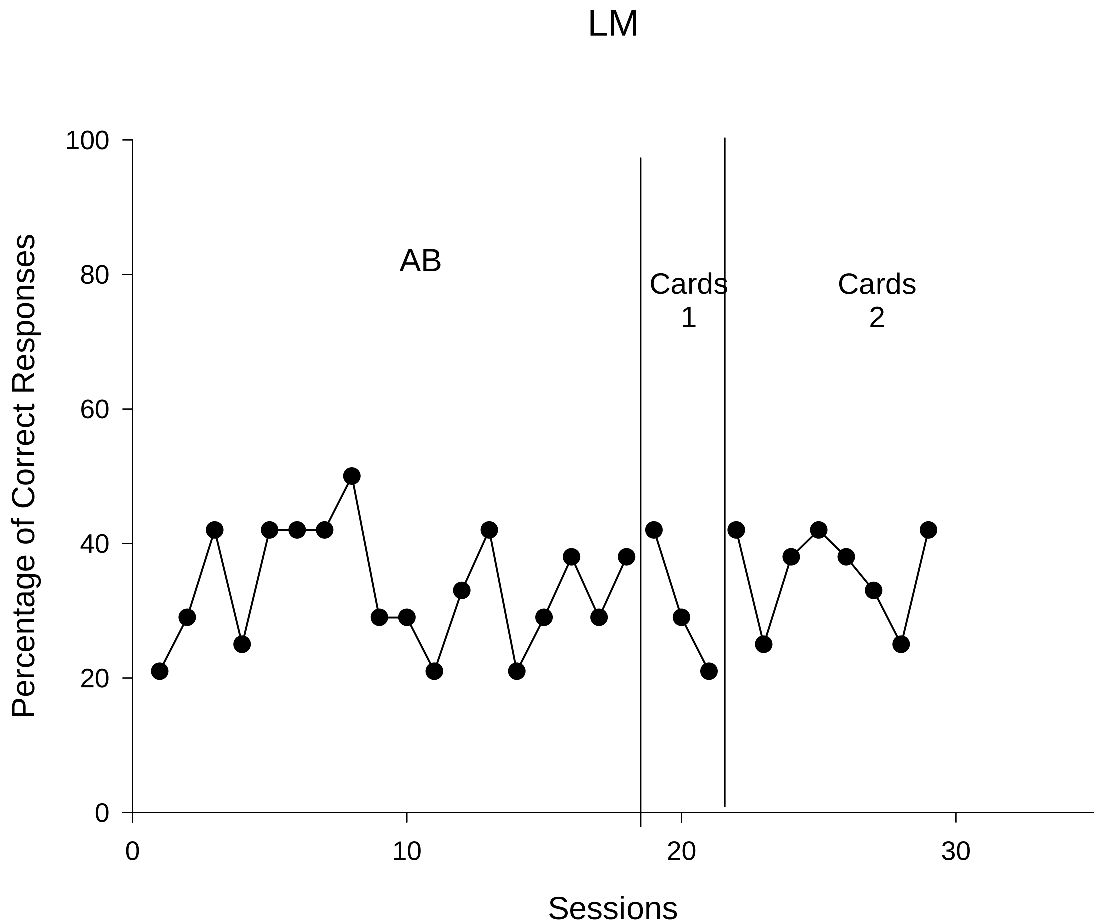


Figure 35. Participant LM

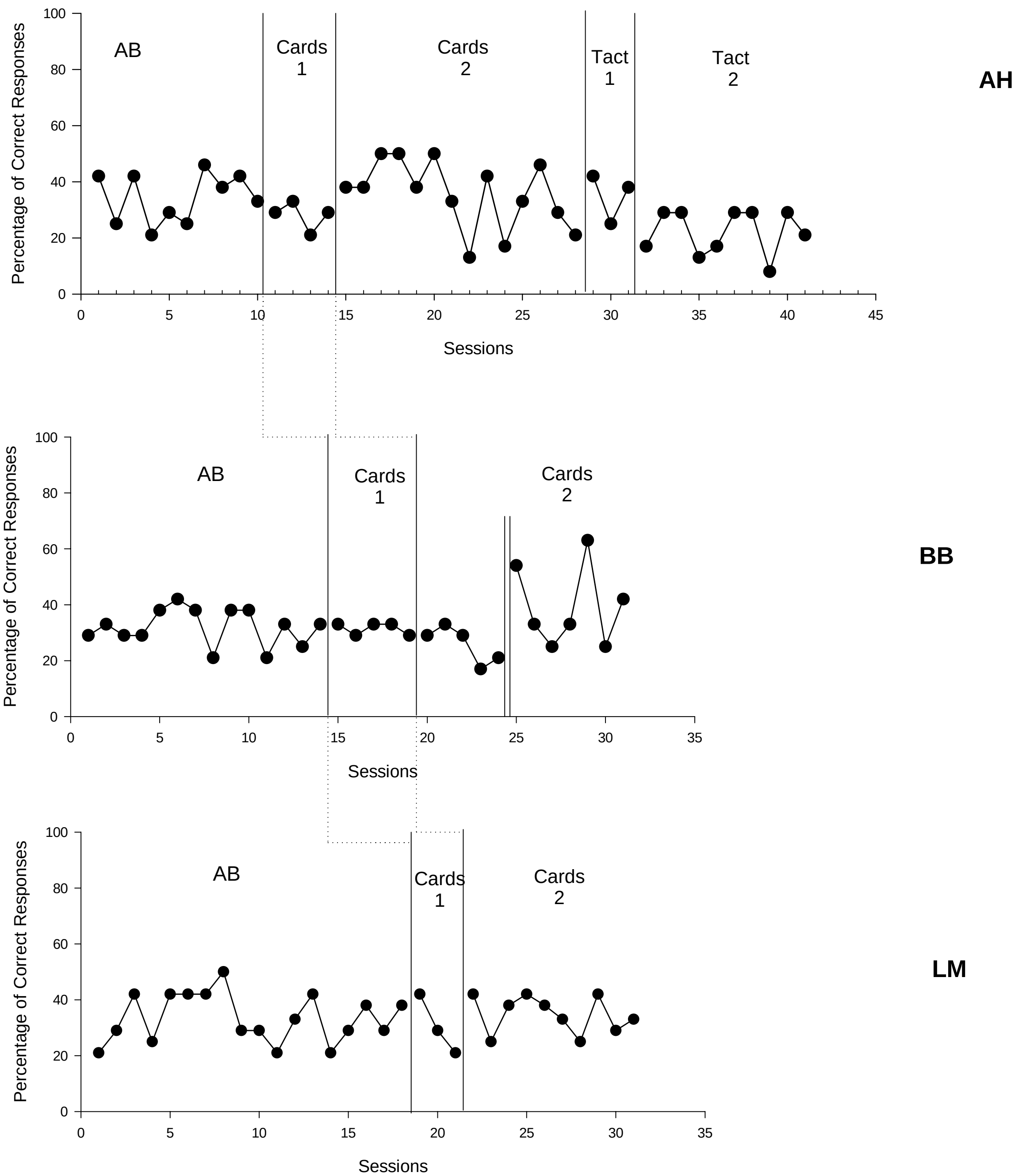


Figure 36. Participants AH, BB, & LM

involving the acquisition of arbitrary conditional discriminations (e.g., Pilgrim, Jackson, & Galizio, 2000; Augustson & Dougher, 1991).

None of the four participants who were exposed to Cards Condition 1, where discrimination between the sample stimuli was required in order to touch the correct sample stimulus card, acquired the arbitrary AB conditional discrimination. This seems to indicate that discrimination between the samples alone was not sufficient to facilitate conditional discrimination acquisition. Further, of the four participants exposed to Cards Condition 2, where discrimination between the sample and the comparison stimuli was required in order to point to stimulus cards correctly, none acquired the arbitrary AB conditional discrimination. Thus, for these participants, the alternative method of requiring discrimination between the sample and comparison stimuli did not facilitate conditional discrimination acquisition.

Four participants were exposed to Tacting Condition 1, where discrimination between the sample stimuli was required for accurate naming, none of the four acquired the arbitrary AB conditional discrimination. This seems to indicate that discrimination between the sample stimuli alone was not sufficient to facilitate the acquisition of conditional discriminations, even when naming was involved. This finding is consistent with those of Saunders and Spradlin (1990), who reported that sample naming alone did not facilitate acquisition of conditional discriminations.

Three of the four participants who were exposed to Tacting Condition 2, where discrimination between the sample and the comparison stimuli was required for accurate naming, did acquire the arbitrary AB conditional discrimination. For these three participants, these results indicate that common naming of the samples and comparisons was effective in facilitating acquisition of the conditional discrimination. This is consistent with Horne and Lowe's (1996) argument that one possible way in which naming may lead to equivalence is by giving the stimuli the same name. Thus, proponents of the Naming Theory might suggest that acquisition of the conditional discrimination was facilitated by saying the same name for the samples and comparisons ("zog" for A1, B1, C1, and D1; "vek" for A2, B2, C2, and D2; "kif" for A3, B3, 3, and D3). These results would also provide additional support for Horne and Lowe's (1996) argument that "common naming of arbitrary stimuli is sufficient to establish stimulus classes." Furthermore, these results would be consistent with the findings of Lowe et al. (2002), which demonstrated that "simply training a common tact response to each of a number of arbitrary stimuli established those stimuli as a class or category" (p. 544).

These results are also consistent with the findings of Sidman and colleagues, however (Sidman, Willson-Morris, & Kirk, 1986). Sidman and colleagues argue that naming is not necessary, but that it can facilitate the acquisition of conditional discriminations and equivalence. In addition, Sidman notes that naming may serve an instructional function, thereby making it difficult to determine the factors that are responsible for the emergence of conditional discriminations and equivalence.

One of the four participants, Participant AH, did not acquire the arbitrary conditional discrimination after common naming was trained for the stimuli. This participant demonstrated 100% accuracy in naming during the sessions. This indicates that naming was not sufficient in facilitating the acquisition of the conditional discrimination. This is consistent with the findings of Sidman, Willson-Morris, & Kirk

(1986), who argue that naming is neither necessary, nor sufficient in facilitating the acquisition of conditional discriminations and equivalence.

All three of the participants who acquired the AB conditional discrimination also demonstrated the acquisition of the CD conditional discrimination. Two of these three participants demonstrated rapid acquisition of the second conditional discrimination without any additional manipulations. The third participant, Participant DD, required additional manipulations before he demonstrated acquisition of the CD conditional discrimination. He proceeded through his designated sequence of training conditions, but did not demonstrate acquisition until exposure to Tacting Condition 2. That is, he did not acquire the conditional discrimination until common names were trained for the sample and comparison stimuli.

The two participants who acquired the CD conditional discrimination also demonstrated rapid acquisition of the BC conditional discrimination. Participant DD demonstrated the acquisition of the CE conditional discrimination without any additional manipulations. Therefore, all three participants who acquired the initial AB conditional discrimination also demonstrated the acquisition of two additional conditional discriminations.

GENERAL DISCUSSION

One of the important findings from these experiments is that acquisition of conditional discriminations through differential reinforcement alone, and in the absence of additional training manipulations, is difficult for young children. Fourteen of the 16 participants in these experiments did not acquire the arbitrary AB conditional discrimination with differential reinforcement alone. A number of studies have yielded similar results for individuals with developmental disabilities (e.g., Saunders & Spradlin, 1989, 1990, 1993; Eikeseth & Smith, 1992); however, this finding has not been emphasized as much with typically developing children. Several studies have found similar results with this population (Pilgrim, Jackson, & Galizio, 2000; Auguston & Dougher, 1991). Results from the present study contribute additional evidence to the finding that conditional discrimination acquisition is difficult for children with differential reinforcement alone.

Furthermore, eight of the 16 participants in these experiments failed to acquire the AB conditional discrimination with interventions that required discrimination between the sample stimuli alone or that required discrimination between both the sample and comparison stimuli (i.e., naming, marking tally sheets, or pointing to stimulus cards). In addition, of the 11 participants who were trained to discriminate between the sample stimuli alone (i.e., Tacting Condition 1, Tally Sheet Condition 1, Cards Condition 1) none of them acquired the conditional discrimination. This finding has been demonstrated previously in other experiments as well (See Saunders & Spradlin, 1989, 1990, & 1993). Previous research indicates that interventions designed to enhance discrimination between the sample stimuli alone can sometimes be useful (See Pilgrim, Jackson, Galizio, 2000). However, the majority of studies indicate that discrimination between the samples alone is frequently insufficient.

Three of the seven participants for whom discriminations were required between the sample and the comparison stimuli acquired the conditional discrimination. All three of these participants acquired the conditional discrimination when discriminations were required via naming (i.e., Tacting Condition 2). Of the five participants who were trained to use alternative methods for sample and comparison stimulus discrimination (i.e., marking tally sheets or pointing to stimulus cards), none demonstrated acquisition of the conditional discrimination. These results suggest that the alternative methods chosen for this experiment did not facilitate the acquisition of the conditional discrimination.

Five of the 16 participants in this experiment did acquire the arbitrary AB conditional discrimination. Of these five participants, two participants (Participants NW and KC) demonstrated acquisition without exposure to naming and without evidence of common naming. Naming tests conducted with Participant NW indicated that there was only one instance in which common names were applied to stimuli within the same class (See Table 1). Naming tests conducted with Participant KC indicated that no common names were applied to stimuli within the same class (See Table 2). These results are consistent with previous research which suggests that naming is not a necessary component in the acquisition of conditional discriminations. For example, Lazar, Davis-Lang, and Sanchez (1984) found that none of the participants in their study applied a common name to stimuli within the same class, but all of the participants demonstrated the formation of equivalence relations. Likewise, Sidman, Willson-Morris, and Kirk (1986) found that during naming tests for visual-visual conditional discriminations, only one of six participants applied common names to stimuli within the same class, but all of the participants demonstrated the formation of equivalence relations. These results contradict the Naming Theory, which suggests that naming is necessary for the acquisition of conditional discriminations, and therefore, that acquisition should not be demonstrated in the absence of naming.

Participant AH was exposed to common naming and naming performance during the sessions indicated that common names had been established for the stimuli. However, she did not acquire the AB conditional discrimination. Results from this participant contradict the Naming Theory in that training common names for the stimuli did not facilitate the acquisition of the conditional discrimination. More specifically, these results contradict Horne and Lowe's (1996) argument that "common naming of arbitrary stimuli is sufficient to establish stimulus classes."

The other three participants (Participants MD, MM, and DD) demonstrated acquisition with the addition of common naming. These results are consistent with the Naming Theory, which suggests that training participants to name stimuli in a matching-to-sample procedure can lead to acquisition of conditional discriminations, even if the participants have failed to demonstrate acquisition prior to the naming intervention. Research conducted by Dugdale and Lowe (1990) demonstrated that applying common names to the stimuli did facilitate the acquisition of conditional discriminations. These results are also consistent with Horne, Lowe, and Randle's (2004) study, in which they argue that "naming may be necessary for the categorization of arbitrary stimuli" (p. 281). These results are also consistent with Sidman's Theory because, although he does not view naming as necessary, he does suggest that naming may facilitate the acquisition of conditional discriminations by enhancing discrimination between the sample and comparison stimuli, which is a necessary component. Furthermore, these results are consistent with Sidman's suggestion that names can become class members.

The three participants who acquired the AB conditional discrimination with the addition of common naming were exposed to additional conditional discriminations. Two of these three participants (Participants MD and DD) demonstrated acquisition of two additional conditional discriminations. Participant MD demonstrated acquisition of the CD and BC conditional discrimination without the addition of naming. Participant DD demonstrated acquisition of the CD conditional discrimination with the addition of common naming. However, he did demonstrate acquisition of a third conditional discrimination (CE) without exposure to naming. These results are consistent with previous research which indicates that once one conditional discrimination is mastered, participants demonstrate acquisition of new conditional discriminations more quickly (Pilgrim, Jackson, & Galizio, 2000; Saunders & Spradlin, 1990).

Participant MD's naming tests indicated that the nonsense names had transferred to the new C and D stimuli within the same class. This test indicated that common names were applied to all stimuli within the same class, with only one exception (See Table 3). Participant DD's naming tests indicated that the nonsense names had transferred to the new E stimuli within the same class. This test indicated that common names were consistently applied to stimuli within the same class (See Table 4).

Overall, these results suggest that naming was neither necessary nor sufficient in facilitating the acquisition of the conditional discrimination for some of the participants. That is, naming was not necessary for Participants NW and KC to acquire the conditional discrimination, and naming was not sufficient for Participant AH to acquire the conditional discrimination. However, it seems that naming did help facilitate acquisition of the conditional discrimination for Participants MD, MM, and DD.

The purpose of these experiments was to investigate whether the facilitative effect of naming is due to enhancing discrimination between the sample and comparison stimuli or if naming serves additional functions that contribute to this facilitative effect. If the facilitative effect of naming is due to enhanced discrimination of the sample and comparison stimuli, then alternative methods requiring discrimination of the sample and comparison stimuli should also facilitate the acquisition of conditional discriminations. As mentioned previously, the results of this experiment suggest that naming was neither necessary nor sufficient for the acquisition of conditional discriminations. However, the results suggest that naming did serve a facilitative effect for some of the participants. Based on the results of this experiment, it is difficult to determine whether naming served any additional functions besides enhancing the discrimination of the sample and comparison stimuli. The alternative methods of discrimination did not seem to serve a facilitative effect, so it is possible that naming does serve additional functions. Although the results of this experiment demonstrate that the alternative methods of marking tally sheets and pointing to stimulus cards did not facilitate the acquisition of conditional discriminations, other methods should be investigated. For example, Saunders and Spradlin (1989, 1990) found that a combination of differential responding to sample stimuli and blocked-trial procedures facilitated acquisition of conditional discriminations. In the study conducted in 1989, differential responding to sample stimuli was trained by requiring button presses on DRL and FR schedules, whereas in the study conducted in 1989 differential responding to sample stimuli was trained via naming. These techniques represent alternative ways to investigate the experimental question of the present experiment. It may be that a more complex response, such as pressing buttons on different sample schedules, would enhance attention to the stimuli more effectively. In addition, the alternative methods utilized to enhance discrimination between the stimuli in the present experiment involved identity matching (marking/pointing to the identical stimulus that was displayed on the screen). It may be that requiring discrimination between stimuli via arbitrary relations (e.g., A1 occasions FR 3) would enhance the arbitrary learning that is necessary for mastery of the AB conditional discrimination. Thus, alternative methods that address this possible problem should be investigated further.

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Appendix A

Dear Parent,

Drs. Carol Pilgrim and Mark Galizio of UNCW are currently conducting research to study children's learning patterns, and in particular, to evaluate strategies designed to facilitate children's learning via computers. Computerized instruction is becoming more and more important in today's educational systems and in order to facilitate this, it is important to study the ways in which educational software can take advantage of basic learning and developmental principles. Our work was begun with a grant from the National Institute of Child Health and Human Development.

One goal of this work has been to develop a group of standard tasks or games that can be used to study learning with children of a wide range of ages. Another goal is to identify the ways in which young children's learning patterns differ from those of older children or adults. Because we are comparing the learning and memory patterns shown by children of different ages, it can be especially useful to work with individual children over an extended period of time, to see if their patterns change. A third goal will be to examine features of the teaching programs that can improve student interest in learning.

We feel very fortunate to have been able to conduct some of this project at Wilmington area preschools and after-school child care programs. Drs. Pilgrim and Galizio have more than 15 years of experience studying children's learning. Over the years, a number of parents from our local schools have been most helpful in giving permission for their child to participate. Currently, we are looking for approximately 30 children from 3 to 7 years of age to take part in the study. This letter comes as a request for your permission to include your child in this important study of how children learn.

The specifics of your child's participation would be as follows. All study sessions will be held at your child's school or after-school program at times that do not interfere with planned activities for the children. Your child would work with one or two of our advanced undergraduate or graduate students for about 15 minutes a day over a period of time as short as one week or as long as several months, depending on your child's age, interest and learning level.

We tell each child that we are going to play a game with a computer. The kinds of games vary according the child's age and the particular study from simple picture recognition to problem solving, to language and math games. We would be happy to demonstrate these games to parents before their child participates. One of our students sits with the child on one side of a small table facing the computer screen. This student teacher then will instruct and monitor the child's use of either a computer mouse or touchscreen. Learning these basic computer skills should be of lasting value to your child. With your permission, we will sometimes give the children fruit treats or small toy prizes (but never enough to spoil the appetite).

These learning games are fun for children. Each day's lesson is short, so they don't get bored. Further, your child is free to decline to participate on any given day, or to withdraw from the study at any time, with absolutely no repercussion. The only possible risk of participation is that for the 15-minute lesson time, your child will not be engaging in other activities (e.g., playing with friends, watching videos). Benefits of participation include the fact that children seem to enjoy the attention that comes from interacting with our students, and they get some experience working at a structured task. Importantly, your child will benefit from learning basic computer skills as well as the concepts developed by the instructional software itself. In addition, your child will be contributing to important findings on how learning styles change with age, with possible implications for improving educational practices in the future.

We would like to point out that this project has been approved by the National Institute of Child Health and Human Development and the UNCW Institutional Review Board for research with human participants, and by the directors of your child's school or after-school program. Your child's performance will not be compared with that of any other individual child. Instead, we are seeking to find the range of learning patterns that may be shown in specific age groups. At no time will a child's name be used to identify his or her performance. At the end of the project, we will be very happy to send you a summary of our findings.

If you have any questions at all about this research, what it means, or how it is handled, please feel free to call us at the University at 962-3288 (Dr. Pilgrim) or 962-3813 (Dr. Galizio). If you have questions about the University's procedures for ensuring the rights of volunteer research participants, please call Dr. Candace Gauthier, Chair of the UNCW Institutional Review Board (962-3558). Your child's school or after-school program director is also familiar with the project and could answer questions about its operation. If you would allow your child to participate, please sign the attached permission slip and return it to your child's teacher as soon as is convenient. We appreciate your consideration of this project.

Thank you for your support,

Carol Pilgrim, Ph.D.
Professor of Psychology

Mark Galizio, Ph.D.
Professor of Psychology

Permission for Participation

I give my permission for my child to participate in the Computer Learning Project being conducted at their school.

Parent’s Name…............................ Date…...........

Phone Number…..

Child’s Name…................... Child’s Birth Date….........

Does your child have access to a computer at home? ___ Yes ___ No

If yes, does your child use a joystick? ___ Yes ____ No

a mouse? ___ Yes ____ No

Are there software programs that your child uses frequently? ___ Yes ___ No

If yes, please list the names of those you know: