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Functional audience classes and stimulus equivalence

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Functional Audience Classes and Stimulus Equivalence

A Thesis Presented

by

Tiffany Dubuc

The Department of Counseling and Applied Educational Psychology

In partial fulfillment of the requirements

for the degree of

Master of Science

in the field of

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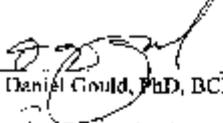
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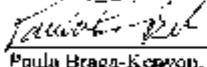
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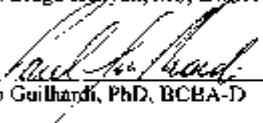
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Abstract

The phenomenon of audience control (Skinner, 1957) can be interpreted as a form of second-order conditional control, in which the audience functions as the second-order conditional stimulus. Such an interpretation allows for a detailed, systematic analysis of the stimulus relations involved in language repertoire selection (as with bilingualism). Furthermore, the use of equivalence technology to teach equivalent audience class membership may provide an efficient methodology for maximizing the potential of teaching the complex stimulus-stimulus relations involved in bilingualism. Despite this, relatively little research has been conducted which investigates this potential. The purpose of the current study was three-fold: (a) to extend the literature on second-order conditional control via audience class membership, (b) to examine whether equivalence technology could be utilized to teach functional equivalence class membership using arbitrary auditory and visual stimuli, and (c) to determine whether emergent class-consistent responding would occur.

Four typically-developing adult participants were taught to relate a series of visual-visual and auditory-visual stimuli, and later demonstrated emergent equivalence of two three-member classes that included one common member per class. Participants also demonstrated the emergence of a 5-member stimulus class, that is, the two three-member classes with a common member had merged into a single five-member class. In addition, responding was brought under the control of a second-order conditional stimulus for all participants. Finally, all participants successfully generalized the second-order conditional control to a novel audience class member. These findings support previous research by demonstrating that match-to-sample procedures can be utilized to effectively teach equivalence relations among arbitrary stimuli to typically-developing adults. The study extends the literature by demonstrating that these performances can be brought under second-order conditional control, and that this contextual control can be generalized to a novel class member.

Key words: bilingualism, stimulus equivalence, audience control, verbal behavior

Functional Audience Classes and Stimulus Equivalence

Bilingualism (or multilingualism) is common to much of the world's population. Previous studies cite 60-75% of the world as bilingual (Global bilingualism. ND). Although a great deal of research has been conducted on bilingualism and bilingual education with typically developed children, very little research has been conducted on bilingualism in children diagnosed with an Autism Spectrum Disorder (ASD) and related disorders. Since language impairment is a diagnostic criterion for children diagnosed with ASD, behavior analysts should bring special attention to bear on the issue of bilingual language development in this population.

Much of the available literature on bilingualism – and indeed, language development in general – has its theoretical grounding in structural, linguistic, or cognitive perspectives. In contrast, Skinner's *Verbal Behavior* (1957) analyzes language and communication from a functional perspective. With respect to bilingualism, Skinner introduces the concept of "audience" as a controlling, environmental variable that selects a subdivision of the speaker's repertoire.

Audience control may be conceptualized as a form of conditional stimulus control (specifically, second-order conditional control; Sidman, 1986). Few behavior-analytic studies have actually investigated the phenomenon of "audience control" over verbal repertoires, and fewer still have considered this phenomenon in individuals diagnosed with an ASD and related disabilities.

Therefore, the purpose of the current paper was to: (a) to extend the literature on second-order conditional control via audience class membership, (b) to examine whether equivalence technology could be utilized to teach functional equivalence class membership using arbitrary auditory and visual stimuli, and (c) to determine whether emergent class-consistent responding would occur.

Verbal Behavior

Introduction and Definition

Skinner (1957) defined verbal behavior as operant behavior that is mediated through the behavior of another person, the listener (or in some cases by speakers who function as their own listener). In his analysis, Skinner described six basic verbal operants under varying sources of control.

The mand is described in plain English as a request. It is under the control of a current motivating operation, thus the mand is reinforced by access to a specific stimulus. Conversely, the tact (also known as the naming of things) is under the control of a nonverbal discriminative stimulus, and it produces generalized conditioned reinforcement, often social in nature. Thirdly, the echoic is a response that occurs when there is point-to-point correspondence and formal similarity between the stimulus and the response product. Point-to-point correspondence is evident when a stimulus, such as a teacher saying “shoe” is followed by a response that is matched in sound from the beginning to the end of the word, such as when a student responds by saying “shoe”. Formal similarity is evident when the antecedent stimulus and the response share the same sense mode and physically resemble each other. The intraverbal is a verbal operant in which the speaker differentially responds to the verbal behavior of others. It occurs

when a verbal discriminative stimulus evokes a response that does not have point-to-point correspondence with the verbal stimulus. Intraverbals produce generalized conditioned reinforcers. For example, a student may respond to the childhood song Old MacDonald by offering a multitude of potential farm animals that live on the farm. The textual verbal operant can more simply be described as reading, without any implications that the reader understands what is being read. The textual operant has point-to-point correspondence but no formal similarity between the stimulus and the response product. Transcription consists of writing and spelling words that are spoken. As with the textual operant, there is point-to-point correspondence between the stimulus and response product, and no formal similarity.

Audience control. In Skinner's analysis, the listener was seen as a stimulus in the environment that would occasion, and possibly reinforce, a particular verbal response. To this end, Skinner described the phenomenon of audience control, in which particular forms of verbal behavior (including language selection, content, vocabulary, and tone, among other variables) are reinforced in the presence of a particular listener or group of listeners (known as the audience). The audience thus acts as a type of discriminative stimulus that selects a large portion of the speaker's verbal repertoire. The audience does not serve as a discriminative stimulus for specific verbal responses; rather, the audience works in conjunction with a specific discriminative stimulus in order to determine the specific verbal responses that the speaker produces. Skinner suggested that the verbal community was necessary in the shaping of verbal behavior.

Membership in a verbal community may be determined biologically, and culturally. Verbal communities can include members of different languages,

political groups, and economic communities. Therefore, any particular individual is likely a member of many independent and overlapping communities. The relation between verbal responding and the presence of these communities is the variable of interest to those who wish to study the effects of audience control.

Clinical Applications

Countless studies have utilized Skinner's analysis of verbal behavior to approach clinically significant issues. For example, the field of Applied Behavior Analysis (ABA) has adopted verbal behavior theory to tackle communication deficits apparent in those diagnosed with an ASD and other developmental disabilities.

A large portion of the literature pertaining to the clinical application of verbal behavior theory has been devoted to mand training (Hall & Sundberg, 1987; Sundberg, Loeb, Hale, & Eigenheer, 2002; Duker, Dortmans, & Lodder, 1993; Hung, 1980; Singafoos, Doss, & Reichle, 1989; Simic & Bucher, 1980, Yamamoto & Mochizuki, 1988). In fact, in a review of the empirical literature on verbal behavior, Sautter and LeBlanc (2006) report that 72% of the literature has involved the development, assessment, or analysis of a mand repertoire. Although the majority of studies focused on the development of mands, behavior analysts have also studied the establishment of tacts and intraverbals in those with developmental disabilities.

The premise of mand training is that teachers can arrange the environment in a way that maximizes the effects of current establishing operations, increasing the likelihood that said environment will occasion a request from a student.

Functional Communication Training (FCT) is one example of mand training. In

the FCT procedure, teachers utilize differential reinforcement and response shaping techniques to teach the student to emit a functional request such as a vocalization or a sign. The goal of FCT is to establish appropriate, functional behavior (mands) that allow the individual to access the same reinforcers accessed by the challenging behavior. Carr and Durand (1985) presented the first application of FCT. The authors were successful in teaching appropriate, functional verbal responses to four developmentally delayed children, effectively decreasing their rates of challenging behavior. FCT has since been validated as an effective means of teaching functional replacement behaviors to a wide range of individuals with developmental delays whose challenging behavior is maintained by social variables such as positive reinforcement via social attention, or negative reinforcement via escape from a demand (Durand, 1990; Durand & Carr, 1991; Durand & Carr, 1992).

For example, Yi, Christian, Vittimberga, and Lowenkron (2006) used a mand training procedure to teach three children diagnosed with an ASD the functional communication response, “No” (“no thanks” or “no don’t do that”) when presented with non-preferred items or activities. The authors noted that the acquisition of functional ‘escape’ responses had a direct inverse effect on rates of challenging behavior.

In addition, children with developmental disabilities have been taught to tact or label things present in their environment (Sundberg, Endicot, & Eigenheer, 2000; Carroll & Hesse, 1987). Sundberg et al. used intraverbal prompts to teach two boys diagnosed with an ASD to sign (tact) common objects in the environment (such as scissors, table, and shoe). Although both participants had acquired some functional mands, both had previously failed to use signs to tact

common objects. The authors hypothesized that the students' extensive error history with traditional tact training procedures was due to the weak control exhibited by the S^D "What is it?" and the correct response (the appropriate tact). Therefore, the authors used an intraverbal prompting strategy (pairing the spoken name of the object with presentation of the object) to evoke the correct sign (tact). The authors note that for all participants, the intraverbal prompt was successfully faded.

In another example, Carroll and Hesse (1987) found that using a mand-tact training in which children were required to request the pieces necessary to complete a construct was more effective (required fewer trials to criterion) at teaching six preschool children to tact the names of pieces than a tact-training only procedures in which the children were simply asked to name the pieces. The authors speculated that this may be due to the stronger controlling variables associated with mands, suggesting that a combination of mand-tact training could facilitate the acquisition of a tact repertoire. That is, because mands are under the functional control of motivating operations and specific reinforcement, the contingencies under which they are acquired may be stronger than the controlling contingencies of tact responses.

Finally, those with developmental disabilities have also been taught to respond to more complex social interactions by emitting intraverbal responses (Partington & Bailey, 1993; Finkel & Williams, 2001; Watkins, Pack-Teixeira, & Howard, 1989, Braam & Poling, 1983; Luciano, 1986). In a recent review of the literature on training intraverbal repertoires, Cihon (2007) distinguished teaching procedures as peer-mediated, transfer of stimulus control, video modeling, discrete trial training, direct instruction, or precision teaching. The relative

strengths and limitations of these procedures are discussed, and the author suggested that although there exists a wide range of effective procedures for establishing an intraverbal repertoire, more research is necessary to clarify best practices.

While there is a multitude of applied literature utilizing verbal behavior theory, there is very limited applied research pertaining specifically to the phenomenon of audience control. This is likely due to Skinner's original emphasis on the behavior of the speaker, rather than the listener. However, there is much to be gained by analyzing the role of the listener, or verbal community (audience) as a discriminative stimulus for particular forms of language.

Second-Order Conditional Control and Stimulus Equivalence

Introduction and Definition

To understand second-order conditional control, it is first necessary to understand the units of analysis within various environmental contingencies, and specifically, the discriminated operant. Sidman (1986) provides an excellent discussion of the levels of analysis within simple and complex environmental contingencies which will be summarized below.

A simple discrimination involves a response that can be described by a three-term contingency such that a discriminative stimulus (S^D) occasions the response and is followed by a consequence. For example, a red box is presented, which is the S^D for touching the red box, and doing so produces reinforcement. On every occasion in which the red box is present, and it is touched, the response

is reinforced. If the subject touches a green box, or does anything else, the response is not reinforced.

Conditional discrimination can be described by a four-term contingency in such that a conditional stimulus is present in addition to a discriminative stimulus. Expanding the example mentioned above, if a child is presented with the auditory stimulus “red” (the conditional stimulus), and the visual stimuli red box (the S^D or S^+ in this example) and green box (the S^A or S^-), touching the red box produces reinforcement. Touching the green box or emitting any other response does not result in reinforcement. When presented with the conditional stimulus of the spoken word “green”, the functions of the discriminative stimuli red box and green box are reversed, that is the red box assumes the function of S^A and the green box assumes the function of S^D . Conditional stimuli (unlike discriminative stimuli) do not control responses directly, but determine the control that other stimuli exert over responses. Essentially, the three-term contingency itself is placed under the stimulus control of the conditional stimulus. This is also known as contextual control.

To explain the phenomenon of second-order conditional control and the five-term contingency, the above example will be further expanded. If the conditional discrimination (four-term contingency) is *hear “red”, touch circle*, *hear “green”, touch square*, it could be said that two functionally equivalent classes are generated, such that *red goes with circle* and *green goes with square*. Red and circle become members of one stimulus class, and green and square become members of another stimulus class.

However, this contingency can also be placed under further conditional control. A fifth element such as an auditory tone could modify the above contingency so that one responds according to the contingency of “see red light, touch circle” and “see green light, touch square” *only in the presence of one tone, but not in the presence of a second tone*. In the presence of a second tone, the contingencies would be reversed (“see red, touch square” and “see green, touch circle”). Responding would then be said to be under second-order conditional control, that is, responding would be under the control of the second-order conditional stimulus (the tone), the conditional stimulus (the light), and the discriminative stimulus (the shape). Therefore, the functionally equivalent relations “red goes with circle” and “green goes with square” would be true only in the presence of the first tone, and the relations “red goes with square, green goes with circle” would be true in the presence of the second tone.

Although the relations presented within this five-term contingency demonstrate the emergence of two *functionally* equivalent classes involving the shapes (circle, square) and colors (red, green), dependent on the second-order conditional stimulus (the tone), these relations could also be tested for *formal* equivalence. Sidman, Rauzin, Lazar, Cunnigman, Tailby, & Carrigan (1982) present a definition of formal equivalence, based on mathematical logic. The definition of stimulus equivalence includes the three required properties of mathematical equivalence: reflexivity, symmetry and transitivity. Reflexivity refers to a relation in which a stimulus is equal to itself, such that $a=a$, $b=b$, $c=c$, etc. Symmetry defines a relation in which stimuli in a class are substitutable for each other, i.e., if $a=b$ then $b=a$. The final requirement (transitivity) describes a property which must hold for the relation among three stimuli, that is, if $a=b$, and

$b=c$, then $a=c$. Sidman and colleagues present a methodology for testing these properties using a basic matching-to-sample (MTS) procedure.

Clinical Applications

Equivalence theory has provided an efficient and effective teaching paradigm which has been utilized to teach a wide variety of skills to a large variety of populations (from typically developing children and adults, to children and adults with various developmental disabilities, and individuals with acquired brain injury). Some of these skills include reading (Sidman, 1971; Sidman & Cresson, 1973), math skills (Maydak, Stromer, Mackay, & Stoddard, 1995; Lynch & Cuvo, 1995), geography skills (LeBlanc, Miguel, Cummings, Goldsmith, & Carr, 2003), money skills (Stoddard, Brown, Hurlbert, Manoli, & McIlvane, 1989), emotion recognition (Guerico, Podolska-Schroeder, & Rehfeldt, 2004), language arts tasks (Lane & Critchfield, 1998), and manding (Rosales & Rehfeldt, 2007).

In what would become a pivotal study, Sidman (1971) taught a 17-year-old male with severe mental retardation to match a spoken word to its corresponding written text. Prior to training, the subject could match pictures to their spoken name and could name pictures aloud, but could not match pictures to text or name printed words. Following the training, the subject was able to accurately name the words presented as text, to accurately match the text with its corresponding pictures, and to match pictures to their corresponding text without training of these specific relations. In other words, after having been directly taught one relation (auditory sample – text matching), three relations emerged without any direct training (naming of text, text-picture matching, and picture-text matching).

These results were replicated by Sidman and Cresson (1973) who expanded on the previous study by showing that the existing relations demonstrated by the first participant (1971) could be trained, without any adverse effect on the emergence of reading comprehension.

Sidman and Tailby (1982) were successful in modifying procedures to expand the equivalence classes from three members to four-members. This study demonstrated a teaching efficiency increase (a factor of 2.5) with the addition of a fourth member to each stimulus class. Sidman (1994) commented on the “potentially explosive nature of the process” (p. 219), that is, the startling efficiency with which the procedure established new relations among stimuli.

Sidman, Kirk and Willson-Morris (1985) further demonstrated the power of the stimulus-equivalence technology, by expanding the classes of equivalent stimuli to six members. The results of this study were unparalleled: that is, having explicitly taught 15 relations, an additional 60 relations emerged without any direct training. This was hailed as an “extraordinary theoretical triumph” (Sidman, 1994, p. 266).

In more recent literature, Guerico et al. (2004) examined whether stimulus equivalence technology would be effective in teaching individuals with acquired brain injury (ABI) to recognize and label the emotions depicted in several photographs. Three male participants (aged 17 to 19 years old) with ABI resulting in severe cognitive impairments were taught to expressively label two sets of photographs depicting different emotions. After training, all participants matched both of these sets of pictures by corresponding emotion represented in each, and named the emotion depicted in each set of pictures. Therefore, MTS was effective at establishing equivalence relations between pictured emotions and their spoken

labels for three participants with ABI. Furthermore, anecdotal evidence suggested an increase in appropriate social skills while in group sessions and on community outings for these participants.

Lane and Critchfield (1998) used educationally related stimuli in an identity-based training procedure involving compound stimuli to teach two adolescent females with Down syndrome to accurately classify printed letters as either vowels or consonants. Following training, data indicated that both participants performed nearly perfectly in classifying letters as vowels or consonants. Furthermore, one participant categorized all letters perfectly during follow-up tests which occurred one-month after testing. In addition, the authors assessed the generalization of vowel/consonant identification of letters within words. Posttest data indicated that both participants achieved 100% accuracy on this task, with the exception of one letter for one participant (who made two errors in eight trials). At follow-up, one participant made only four errors in 64 trials, and the other participant made no errors on this task.

Rosales and Rehfeldt (2007) taught two adults (aged 34-58 years) with severe developmental disabilities to mand for inaccessible items needed to complete chained tasks by exchanging pictures of those items. They were then taught to conditionally relate the dictated names of those items to the corresponding pictures and to the corresponding printed words. Finally, participants were tested for their ability to exchange the correct text when in need of an item to complete a task as well as for the emergence of derived stimulus relations among the stimuli. Following training, both participants demonstrated the ability to mand for items using corresponding text labels on 60-90% of opportunities. Furthermore, derived relations were maintained for both participants upon follow-up at one month.

The authors noted that a synthesis of verbal behavior and derived stimulus relations may prove useful.

Hall and Chase (1991) presented an interesting description that defines Skinner's (1957) analysis of verbal behavior according to the stimulus equivalence terminology outlined by Sidman and colleagues (Sidman & Tailby, 1982). For instance, the echoic relation is presented as synonymous with an A-A, B-B, C-C relation, such as described by the property of reflexivity. That is, a subject produces the spoken word "cat" in the presence of the spoken word "cat" (A=A), the subject produces the spoken word "gato" in the presence of the spoken word "gato" (B=B), and the subject produces the spoken word "chat" in the presence of the spoken word "chat" (C=C). Similarly, intraverbal relations are shown to display the properties of symmetry (A=B & B=A; B=C & C=B) such that a subject produces the Spanish word "gato" in the presence of "cat" and produces the English word "cat" in the presence of the word "gato". Transitivity is evident in the intraverbal response of "chat" in the presence of the spoken word "cat" (A=B, B=C, & A=C). Thus, Hall and Chase present a convincing example of verbal behavior being often (though not without exception) understandable in terms of stimulus equivalence. This presentation has implications for research in both the study of verbal behavior and stimulus equivalence, and also accounts for a functional explanation of the development of vast amounts of "emergent" language in humans.

Audience Control as an Example of Second-Order Conditional Control

The phenomenon of audience control can be interpreted as a form of second-order conditional control, in which the audience functions as the second-

order conditional stimulus. For instance, a participant is likely to respond differently to a French audience than an English audience when asked to identify a color of light as either red or green, by selecting the corresponding color name “rouge” or “vert” when in the presence of the French audience, and by selecting the color name “red” or “green” when in the presence of an English audience. Selection of the English or French spoken color name is more likely in the presence of the relevant audience, as a result of a history of differential reinforcement of the speaker’s repertoire, that is, the English-speaking audience reinforces the speaker’s use of English repertoire and does not reinforce the use of French; and vice versa for the French-speaking audience. In this example, the audience member serves as the second-order conditional stimulus, the light functions as the conditional stimulus, and the spoken color names function as the S^D and S^A for the selection response. It is through this process of differential reinforcement that the listener, or audience, may establish second-order conditional control over the verbal behavior of the speaker.

Applications of Audience Control

There is very limited research on the application of audience control and the utilization of second-order conditional control to teach functional audience classes. In one example, Silverman, Anderson, Marshall and Baer (1986) established two audience classes and specific repertoires under the control of each class, and then evaluated generalization of the audience control to additional audience class members. In this study, the authors taught participants that one puppet ‘went with’ another, and that a third puppet ‘went with’ a fourth, thus establishing two audience classes. Then one member of each class taught the

subjects to respond differentially to verbal questions of opposites. For instance, if Puppet A taught subjects to respond with “evil” to the question “what is the opposite of good”, Puppet B then taught the students to respond with “bad” to the same question. Then the authors probed the questions using the other member of the previously-taught audience class who had never participated in the training phases. In this manner, Silverman et al. were able to demonstrate that responding came under the functional control of the audience classes that were trained at the beginning of the study.

Vassar (2010) replicated the Silverman et al. (1986) study using only nonverbal stimuli and visual-visual MTS procedures to establish both audience class members and response repertoires. Audience class members were photos of individuals wearing culture specific clothing (Middle Eastern or Western). The participants learned to respond differentially in the presence of pictorial stimuli, conditional on the audience class member (Arabic or English) that was present on each trial. Then, as with Silverman et al., a second member of each class probed to determine if class-consistent responding occurred, that is, whether or not functional audience control generalized to the other class member. Following the initial probes, a reversal was conducted in which the previously taught “Arabic” stimuli became the correct selection in the presence of the English audience class member (and vice versa with the previously-taught “English” stimuli). Once reversal trainings were mastered, additional probe trials were conducted with the other member of each audience class. Results indicated that the word-picture relations and directly-taught audience class relations were acquired by a typically-developing adult and by an 8-year-old boy diagnosed with an Autism Spectrum

Disorder, however only the adult generalized the audience control relation.

Unfortunately, the results were potentially confounded by the fact that stimuli were non-arbitrary, thus responding could have been biased by the participants' learning histories.

Purpose and Research Question

The interpretation of audience control as an example of second-order conditional control allows for a more detailed, systematic analysis of the stimulus relations involved in the process. Furthermore, the use of equivalence technology to teach equivalent audience class membership provides an efficient methodology for maximizing the potential of teaching complex stimulus-stimulus relations, such as those involved in the control of language repertoires in bilingual individuals. Despite this, relatively little research has been conducted which investigates this potential. Therefore, the purpose of the current project was to extend the literature on second-order conditional control via audience class membership, to examine whether equivalence technology could be utilized to teach functional equivalence class membership using arbitrary auditory and visual stimuli, and to determine whether emergent class-consistent responding would occur.

Method

Participants

Participants were 4 typically developing adults. Selection was limited to those with no formal training in stimulus equivalence or verbal behavior theory, and with no previous knowledge regarding the purpose of the study. In addition, all participants were monolingual (that is, fluent in only one language). This

criterion was included to account for any potential confounds in the learning strategies used by those with existing audience control over language/stimulus selection.

Setting and Materials

Discrimination trainings were presented to the participants using a laptop computer equipped with automated, interactive PowerPoint© slide shows. The participants interacted exclusively with the computer program which presented visual or auditory samples and visual comparison stimuli in a three-choice or six-choice array, depending on the phase of the study. Differential consequences were provided by the computer program based on responding. Correct responses were followed by a screen which displayed “Great Job!” and played an audio clip of applause. Incorrect responses were followed by a black screen which was present for 2 s prior to the presentation of the next trial. No error correction procedure was implemented. The experimenter collected data on the participants’ selection manually using a data sheet that reflected the trials presented to the participant. Appendix A presents the stimuli that were utilized.

Dependent Variable

Selection was defined as the participant moving the mouse over one of the comparison stimuli and clicking on it. Responses were recorded as correct, correct prompted, incorrect, or incorrect prompted. The percentage correct unprompted responses was the primary dependent measure.

Experimental Phases

The experiment consisted of four or five phases (depending upon participant results). An outline of these phases is presented in Appendix B. In Phase 1, two three-member classes were established, with the classes having a

common member. One class consisted of the visual stimuli A and B and the auditory stimulus D (forming the 3-member class ABD) and the second class consisted of the visual stimuli A and C and the auditory stimulus E (forming the 3-member class ACE). The AB and DB relations were established first, followed by a test for untrained DA relations. Subsequently, the AC and EC relations were established and followed by a test for the untrained EA relations. Phase 1 also included probe sessions assessing the emergence of EB, DC, BC and CB relations. This assessed the emergence of a 5-member class (ABCDE).

Phase 2 consisted of a MTS procedure in which two 2-member classes (which would become the ‘audience classes’) were established. Classes consisted of colored shape figures (Class 1 consisted of a blue square and an orange star, and Class 2 consisted of a red triangle and a yellow circle). These images are presented in Appendix C.

In Phase 3, trials of the previously-learned relations AB and AC were presented. However, prior to the presentation of the sample (and comparison) stimuli, one member of one of the audience classes was presented (e.g., blue square or red triangle). Participants were taught to differentially respond to the comparison stimuli (by selecting either the correct B stimulus or C stimulus), conditionally on which audience class member was presented. For instance, in the presence of the square (audience Class 1), selection of the corresponding B stimulus was correct. However, in the presence of the triangle (audience Class 2), selection of the corresponding C stimulus was correct. In this way, the AB and AC performances came under the second-order conditional control of the audience class member (Class 1: square or Class 2: triangle).

Phase 4 consisted of a test for the generalization of audience control. One session was conducted, identical to Phase 3 sessions, with the exception that the novel audience class member (that is, the audience class member that had not been present during Phase 3 training) from each audience class was presented.

Phase 5 was a replication of the BC/CB probe session presented in Phase 1. It was presented following Phase 4 only if positive results were not obtained on the first presentation of the probe (in Phase 1).

Procedure

All phases involved the same matching-to-sample procedures. In addition, all sessions were presented in the same format, utilizing an automated PowerPoint© slideshow. Sessions began with the presentation of the sample stimulus (or the second-order conditional stimulus in Phases 3 and 4). On the first trial of each session, participants were instructed (by on-screen text) to “Click on image to begin”. In Phases 1, 2 and 5 clicking on the image (the conditional stimulus) resulted in the presentation of the sample stimuli. In Phases 3 and 4 (second-order conditional discrimination training and test sessions), the second-order conditional stimulus (audience class member) was presented first. Clicking on the image resulted in the presentation of the conditional stimulus, which, when clicked, was then followed by the comparison stimuli. In Phases 1, 2 and 5 three comparison stimuli were presented; in Phases 3 and 4 six comparisons were presented. In sessions for which the sample was auditory, clicking on the image of an audio-speaker played a recording of the auditory sample and displayed the comparison stimuli.

A progressive-delayed visual cue was used in training sessions. On Step 0, the comparison stimuli were presented simultaneously with a green box outlining the correct selection. On Step 1, the visual prompt (green box) was presented after either 1 s (for visual-visual matching trials with a 3-choice array), 1.5 s (for visual-visual matching trials with a 6-choice array), or 2 s (for auditory-visual matching trials). The additional delays were included to allow additional scanning time for the 6-stimulus array and to account for the time required for the auditory sample to play. Step 2 included no visual prompt.

Correct responses (prompted or independent) were followed by a screen which displayed “Great job!” and played an audio clip of applause. In order to proceed to the next trial, the participant was required to click on a large green arrow in the bottom-right corner of the screen (the only active link on the slide). Incorrect responses were followed by a black screen and an inter-trial interval of 2 s before an automated presentation of the next trial.

Session lengths varied in order to account for counter-balancing of stimuli. Phase 1 training sessions were run in 27-trial blocks (with the exception of Participant 1 who ran 3 blocks of 9 trials for each trial type). Probe sessions in Phase 1 were 27 trials, with the exception of the BC/CB test which included 54 trials. Phase 2 consisted of 16-trial blocks, and Phase 3 consisted of 18-trial blocks. Phase 4 included 54 trials, presented in a single block. Typically participants completed Phase 1 in one session (which took 40 to 60 min to complete) and Phases 2-5 in a second session (which took approximately 25 to 45 min to complete).

Criterion to advance to the next prompting step was a minimum of 89% accuracy (either prompted or independent). Criterion to mastery during training phases was a minimum of 89% accurate and independent responding.

Probe sessions included reinforced maintenance trials and unreinforced probe trials (at a minimum ratio of 2:1) in each session. The consequences for maintenance trials were the same as during training. There were no programmed consequences for correct or incorrect responding on probe trials, with one exception: if a participant failed to meet mastery criteria on either DA or EA probe sessions, the session was re-run *with* reinforcement. This was done to ensure establishment of the 3-member classes prior to advancing to Phases 2-4.

Results

Data are presented on percentage of correct independent responding across Phases 1-5 in Figures 1-4. Figures show training and probe trials. Training sessions are indicated by line graphs, and probe sessions are indicated by bar graphs. In addition, probe sessions that are indicated with an asterisk (*) are those in which reinforcement was delivered for correct responses. Maintenance-trial data are shown separately in Table 1.

Maintenance-trial accuracy was high for all participants, across all probe sessions ($m=98.2\%$; range 78-100%). Participant 1 scored poorly on maintenance trials during the first presentation of the EA probe session (78%) but demonstrated no further errors on maintenance trials across subsequent sessions.

Phase 1

Participants required four or five training sessions (per 3-member class) to acquire the relations AB, DB, AC, and EC. All participants met mastery criteria on all trained and emergent relations prior to advancing to Phase 2.

Figure 1 represents the results obtained for Participant 1. Participant 1 required five sessions to master the ABD relations and five sessions to master the ACE relations. Participant 1 did not immediately demonstrate the emergent performances, scoring 55.6% correct independent on the DA probe and 67.7% independent on the EA probe. Upon re-training of the AB, DB, AC and EC relations, the probe sessions were re-presented. The participant successfully demonstrated both emergent performances upon re-testing (100% correct independent on both tests). When tested for the emergence of the 5-member class (BC and CB probes), Participant 1 scored 72.2% correct independent. When tested for the emergence of DC and EB relations, she scored 67.7% and 89% correct independent, respectively. Prior to advancing to Phase 2, these tests (DC, EB and BC/BC) were re-presented *with reinforcement*. The participant scored 100%, 100% and 94.4% correct independent with reinforcement on the re-presentation of these tests.

Figure 2 represents the results obtained for Participant 2. Participant 2 required five sessions to master the ABD relations and four sessions to master the ACE relations. Participant 2 demonstrated all emergent relations (at 100% accuracy) involving the 3-member classes upon the first presentation of testing (DA, EA, DC, and EB). However she did not demonstrate reliable emergence of the BC/CB relations (scoring 77.7% correct independent), thus not demonstrating

the 5-member class. The 5-member class was reassessed for Participant 2 in Phase 5.

Figure 3 represents the results obtained for Participant 3. Participant 3 required five sessions to master the ABD relations and five sessions to master the ACE relations. Participant 3 demonstrated all emergent relations upon the first presentation of testing, including the BC/CB relations, scoring 100% correct independent on the DA, EA and BC/CB tests and scoring 89% correct independent on both the DC and EB probe tests, thus demonstrating both the 3-member classes and the merged 5-member class.

Figure 4 represents the results obtained for Participant 4. Participant 4 required five sessions to master the ABD relations and five sessions to master the ACE relations. Participant 4 performed poorly on the test for the DA emergent relation (scoring 33.3% correct independent). The DA test was then re-presented *with reinforcement*, and on second presentation his performance improved significantly (to 77.8% correct independent), however he still did not demonstrate mastery of the relation, so the test was re-presented for a second time *with reinforcement*. Upon this third presentation, the DA relation was demonstrated with 100% accuracy. Following acquisition of the AC and EC relations, Participant 4 was assessed for the emergence of the EA relations. He scored 100% correct independent on the first presentation of this test. In addition he demonstrated the emergent performances of DC and EB. Participant 4 did not demonstrate reliable emergence of the BC/CB relations (scoring 77.8%). The 5-member class was reassessed for Participant 4 in Phase 5.

Phase 2

Participant 1 met mastery criteria for establishment of the audience classes in four sessions; Participants 2 and 3 required two sessions; Participant 4 required 3 sessions. All participants successfully acquired the two 2-member audience classes before going on to Phase 3.

Phase 3

Participants met mastery criteria for Phase 3 within 3 to 6 sessions. That is, responding successfully came under the second-order conditional control of the audience class member for all participants. Participant 1 required six sessions to meet mastery criteria. Due to a programming error, in this phase Participant 1 was initially presented with a training that included the audience class member, the sample, and a 3-stimulus comparison array from *either* the B or C stimulus classes. This did not require control of responding by the second-order conditional stimulus, since correct responses could be made solely on the basis of the 4-term conditional discrimination; that is, the participant could respond correctly on these trials even while ignoring the audience class member. Therefore, the procedure was revised to include six comparison stimuli (three B stimuli and three C stimuli) and the revised procedure was presented to Participant 1 and was utilized for all remaining participants. Utilizing this revised procedure, Participants 2-4 required three sessions each to meet mastery criteria.

Phase 4

All participants successfully generalized their class-consistent responding to the novel audience class member (each participant scored 100% correct

independent). Due to a programming error, Participant 1 was initially presented with a generalization test that contained only a 3-choice comparison array. Subsequently, she was presented with a revised Phase 4 test (as described above) which was then utilized with all other participants. She demonstrated generalization of audience control with 100% correct independent responding upon presentation of this test.

Phase 5

Participants 2 and 4 completed Phase 5 to re-assess their performance on the BC and CB relations. Both participants demonstrated the emergence of the 5-member class (both scoring 94.4% correct independent on this probe session).

Discussion

The present study demonstrated the establishment and generalization of audience control relations in four participants. Procedures derived from Sidman's (1986) analysis of second-order conditional stimulus control were successfully used to establish two, 3-member classes sharing a common member. The individual classes were then brought under the control of a second-order conditional stimulus (the "audience"), and this control generalized to another member of each audience class. The results are consistent with Silverman et al. (1986) and expand the literature on audience control.

The present study had some limitations. For two participants, emergent performances did not immediately occur. For Participant 1, additional training sessions were required, and for Participant 4, reinforcement on probe trials was required on one probe type (DA). This is inconsistent with previous studies in

which such types of emergent performances have been demonstrated with typical adults in tests conducted in extinction. It is unclear what component of the training procedures resulted in these difficulties.

Another limitation of this study was the programming error in Phase 3 for Participant 1. Because second-order conditional control was not required, training was repeated with the correct procedure. It is not possible to identify what effect this error and retraining might have had on the participant's subsequent performance. However, this participant did demonstrate generalization of audience control relations when tested in Phase 4.

Future research should investigate the utilization of these types of automated MTS procedures to establish equivalence classes with learning delays. In addition, a comparison of the rates of acquisition on such types of tasks of unilingual and bilingual individuals would be interesting.

Finally, it was anecdotally noted by the author that all participants described clear (and widely varied) methods of associating the stimuli, and completing the matching tasks. While some participants seemed to note physical resemblances between the stimuli, others focused on the associated auditory stimuli, creating names or even descriptive verbal stories which related the stimuli. Future research should investigate these learning techniques, with the possible outcome of developing effective teaching strategies.

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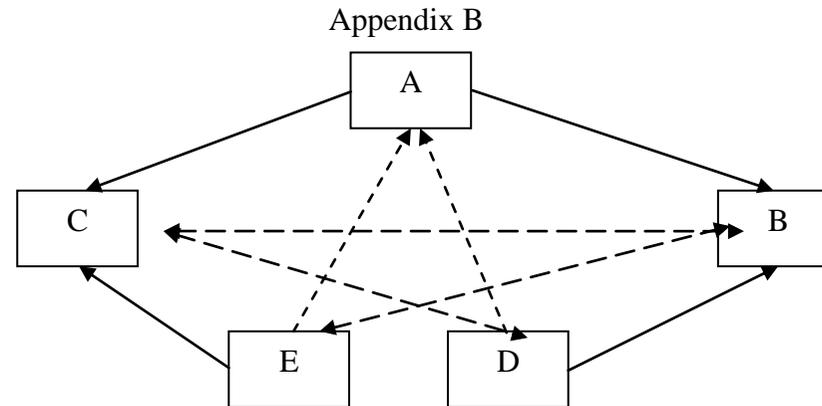
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Appendix A

Visual Representation of Stimuli and Class Membership

		
A1	A2	A3
		
B1	B2	B3
		
C1	C2	C3
“Deeble”	“Rimoy”	“Tacka”
D1	D2	D3
“Terpay”	“Surchi”	“Elnaw”
E1	E2	E3



Phase	Purpose	Procedure
1	Establish ACE and ABD classes; test for emergent 3-member equivalence classes; test for emergent 5-member equivalence class	<ol style="list-style-type: none"> 1. Teach AB and DB relations 2. Test DA. Assess for emergent equivalence; test in EXT embedded within SR+ Maintenance trials (AB/DB) 3. Teach AC and EC relations 4. Test EA. Assess for emergent equivalence; test in EXT embedded within SR+ Maintenance trials (AC/EC) 5. Test BC/CB. Assess for emergent equivalence; test in EXT embedded within SR+ Maintenance trials (AB/DB/AC/EC) 6. Test DC. Assess for emergent equivalence; test in EXT embedded within SR+ Maintenance trials (DB/EC) 7. Test EB. Assess for emergent equivalence; test in EXT embedded within SR+ Maintenance trials (AB/AC)
2	Establish “audience” membership (functional equivalence)	<ol style="list-style-type: none"> 1. Teach Class 1 Member 1- Class 1 Member 2 2. Teach Class 2 Member 1- Class 2 Member 2
3	Establish audience control over stimulus selection	<ol style="list-style-type: none"> 1. Class Member 1 teaches AB (reinforces selection of B stimuli from mixed array of C and B stimuli) 2. Class Member 1 teaches AC (reinforces selection of C stimuli from mixed array of C and B stimuli)
4	Test for generalization of audience control (critical test)	<ol style="list-style-type: none"> 1. Class Member 2 tests AB (in extinction; from mixed array of C and B stimuli) 2. Class Member 2 tests AC (in extinction; from mixed array of C and B stimuli)
5	Test for 5-member classes (ABCDE)	<ol style="list-style-type: none"> 1. Test CB and BC in extinction, embedded within SR+ Maintenance trials (AB/DB/AC/EC)

Appendix C:

“Audience” Class Members

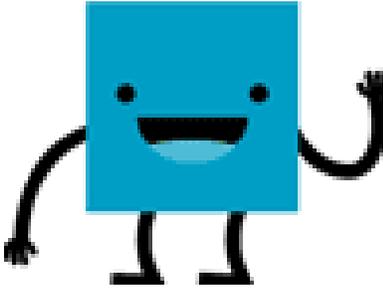
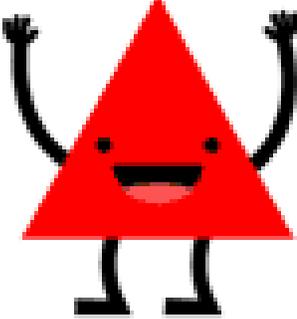
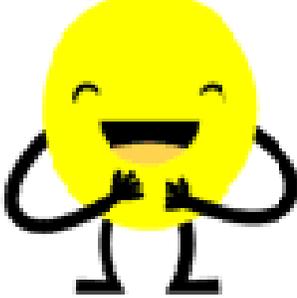
	Class 1	Class 2
Train		
Probe		

Table 1

Percent Correct on Maintenance Trials

Participant	Percent Correct Across Session									
	DA	EA	DA	EA	BC/CB	DC	EB	DC	EB	BC/CB
1	100	78	100	100	100	100	100	100	100	100
2	100	100			100	100	100			
3	100, 94, 94 ^a	89			97	100	100			
4	100	100			100	100	100			

Note. Sessions are presented in the order in which they were run. Shaded cells indicate that a session type was not completed with a participant.

^aParticipant 3 completed 3 consecutive sessions of the DA test.

Figure Captions

Figure 1. Participant 1 percent correct independent responding across Phases 1-4.

Figure 2. Participant 2 percent correct independent responding across Phases 1-5.

Figure 3. Participant 3 percent correct independent responding across Phases 1-4.

Figure 4. Participant 4 percent correct independent responding across Phases 1-5.

Figure 5. Participants 1-4 percentage of errors on maintenance trials across probe sessions.

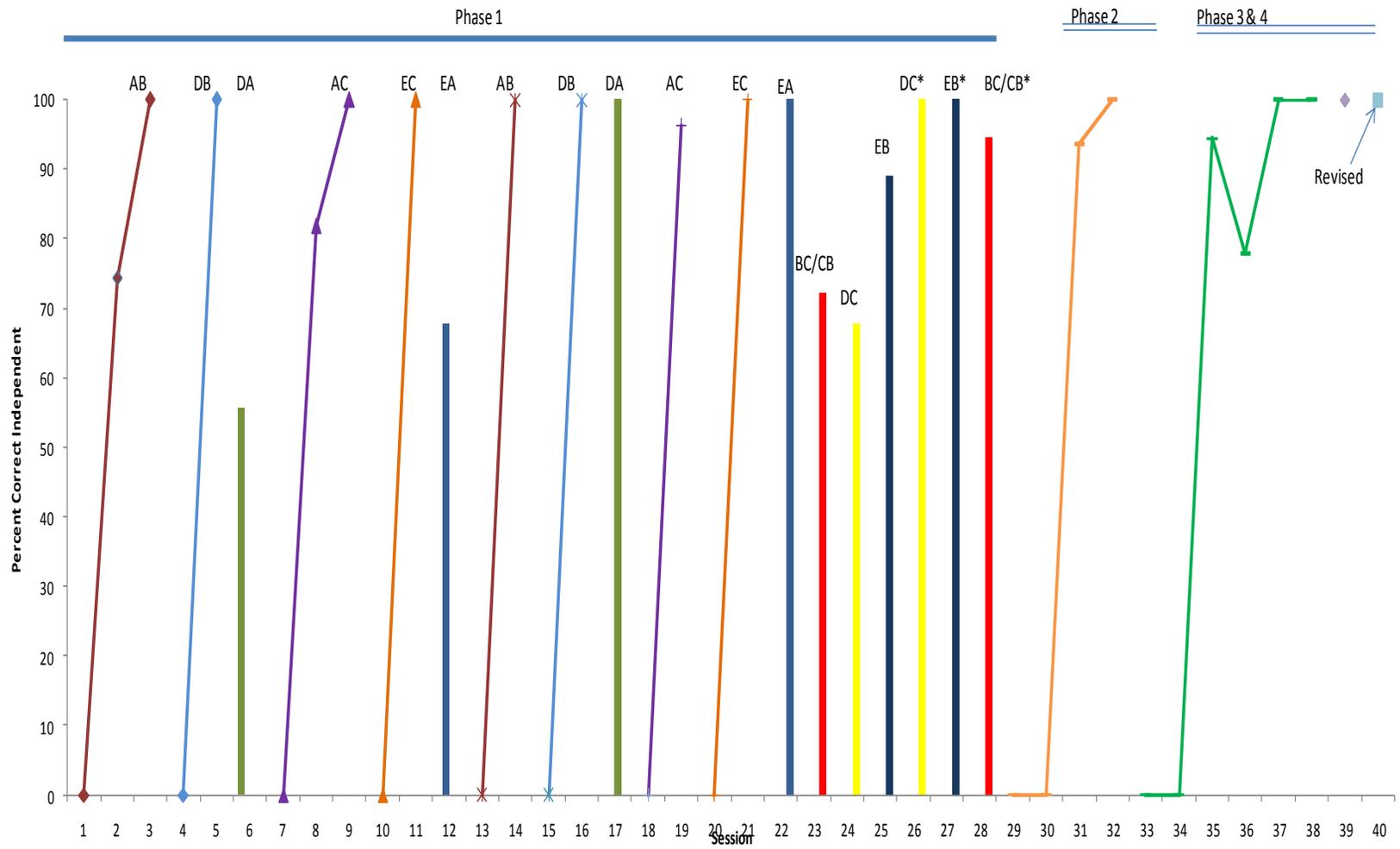


Figure 1

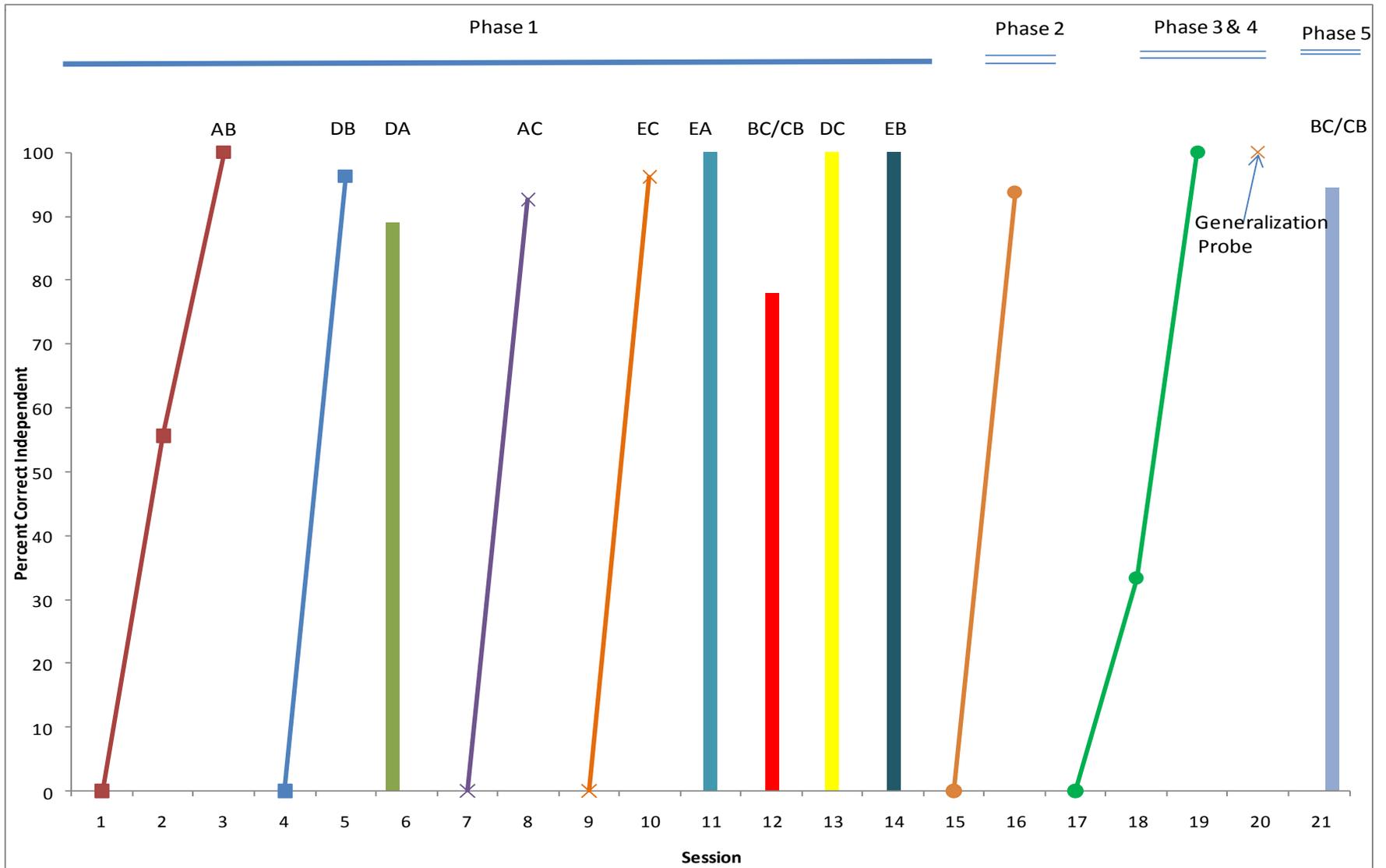


Figure 2

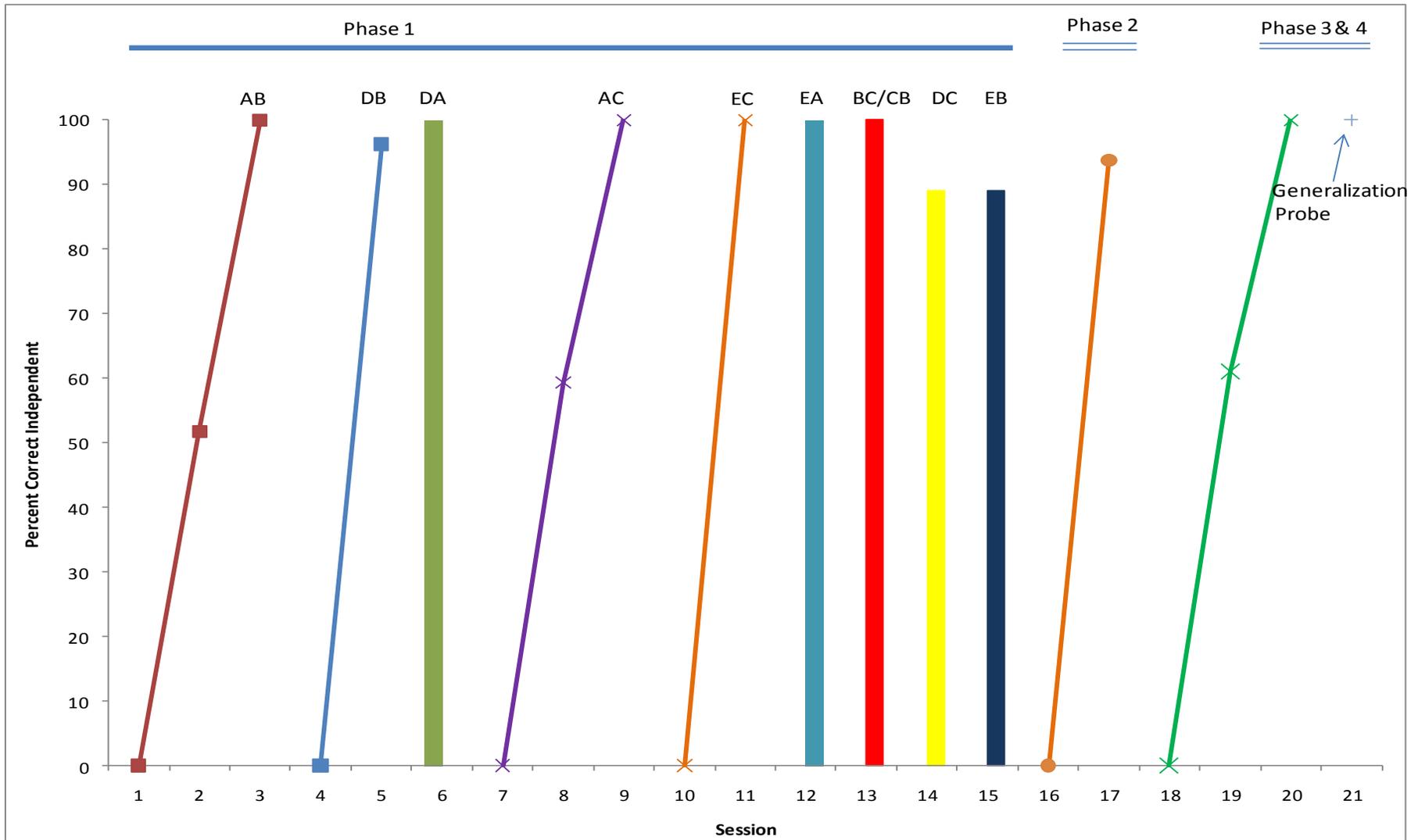


Figure 3

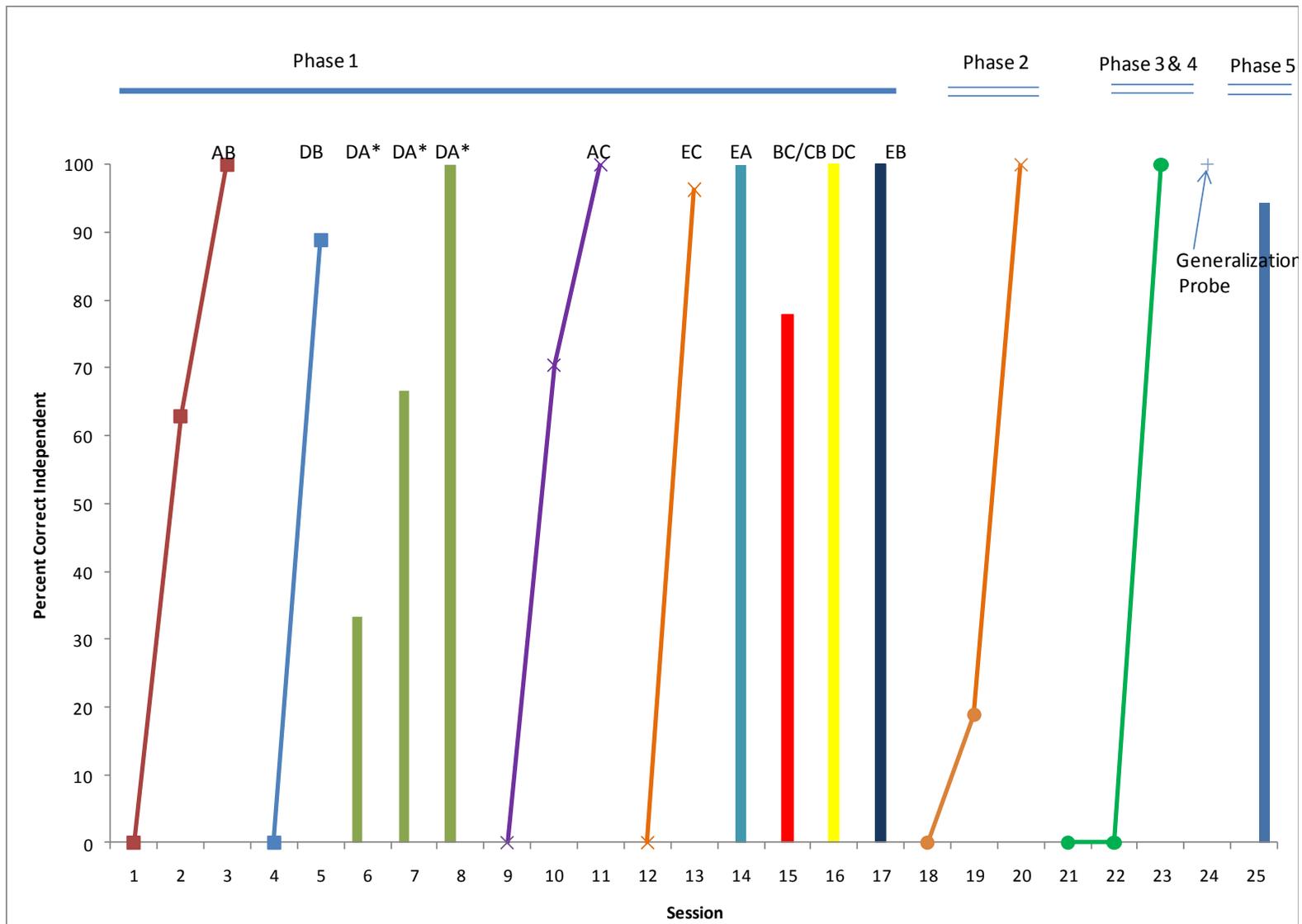


Figure 4