DEVELOPING COMPOUND STIMULUS CONTROL OVER VOCAL TACTS

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Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by persistent impairments in verbal and non-verbal communication, social interactions, development and maintenance of interpersonal relationships, and repetitive behavior patterns or restricted interests (American Psychiatric Association, 2013). The prevalence of ASD has been estimated as high as 1 in 68 children as of 2010 (Centers for Disease Control and Prevention [CDC], 2014). Applied behavior analysis (ABA) is highlighted as an effective treatment option because all interventions which have been shown to produce long-term positive benefits have been based on principles of ABA (for a review, see Foxx, 2008). Early intervention programs based on ABA emphasize efforts to teach communication skills. For children whose language impairments are severe, intervention initially focuses on the elementary building blocks of language, which include relations between words and nonverbal referents. Such relations may be taught either receptively or expressively. In receptive programs that target word-referent relations (often referred to as receptive identification), a child is taught to respond to spoken words by selecting corresponding objects or pictures from an array (e.g., Lovaas, 2003; Sundberg & Partington, 1998). Conversely, expressive programs target saying the spoken word (or making an equivalent non-vocal communication response) in the presence of the object or picture. To distinguish them from other expressive programs that target, for example, conversation and question-answering, expressive programs that teach word-referent relations are often referred to within applied behavior analysis as *tact* instruction. A tact is one of the verbal operants described by Skinner (1957). The term ”tact” is taken from the word “contact”, so that it might serve as a reminder that the verbal behavior makes contact with the environment. According to Skinner (1957), a tact occurs when “…a response of a given form is evoked (or at

least strengthened) by a particular object or event or property of an object or event" (p. 82). For example, the sigh of an airplane in the sky might evoke responses like "airplane" or "fly" as tacts. Whereas receptive identification targets conditional discriminations, tact instruction targets simple discriminations (Green, 2001).

A great deal of research has focused on procedures for teaching receptive identification (for a review, see Grow & LeBlanc, 2013), including research on remedial strategies to address acquisition failures or slow acquisition (e.g., Carp, Peterson, Petursdottir, Arkel, & Ingvarsson, 2012; Fisher, Kodak, & Moore, 2007; Grow, Carr, Kodak, Jostad, & Kisamore, 2011; Kodak, Fisher, Clements, Paden, & Dickes, 2011; Perez-Gonzalez & Williams, 2002; Williams, Perez-Gonzalez, & Queiroz, 2005). By contrast, procedures for teaching tacts have not received much attention in the literature, even though it may be argued that tact instruction is more important, as it often renders receptive identification instruction unnecessary (Petursdottir & Carr, 2011). It might be speculated that lack of research on tact instruction procedures reflects that tacts are more easily acquired than receptive identification. However, this is not necessarily the case, as comparison studies have not consistently reported either faster or slower acquisition of tacts relative to receptive identification (e.g., Cuvo & Riva, 1980; Delfs, Conine, Dickman, & Shillingsburg, 2014; Keller & Bucher, 1980; Watters, Wheeler, & Watters, 1981). In addition, failures to acquire tacts under standard instructional procedures have been reported in the literature (e.g., Partington, Sundberg, Newhouse, & Spengler, 1994; Sundberg, Endicott, & Eigenheer, 2000). The present study examined whether failures to acquire tacts of compound stimuli could be remediated by adding a potential attention-enhancing response to instructional trials.

Prior Research on Procedures for Establishing Tacts

Although numerous studies have addressed various aspects of tact instruction procedures, relatively few studies have investigated the specific components of a single tact trial. The majority of research on tact instruction can be divided into three main categories; (a) experiments that have investigated the arrangement of the entire tact instruction program, (b) experiments that have investigated the arrangement of tact instruction sessions, and (c) experiments that have manipulated specific variables with in a single tact trial. Of interest to the present study is category (c); experiments that have examined individual tact trial procedures. However, the procedures of a single trial are important within the context of an entire session and tact instruction program as well.

Research on Arrangement of the Instructional Program

Research on the overall arrangement of the instructional program has focused primarily on the simultaneous versus successive introduction of instructional targets, or stimulus exemplars related to each instructional target. Two representative examples will be described here. Cuvo, Klevans, Borakove, Borakove, Landuyt, and Lutzker (1980) conducted three between-subject design experiments in which they investigated successive and simultaneous introduction of instructional targets. During the successive instruction condition, one tact was taught at a time, until the participant had acquired five tacts. In the simultaneous instruction condition, five tacts were taught simultaneously, such that each block of five trials contained one trial for each of five stimuli that were present in all of the trials. In a combined instruction condition, stimuli were first presented successively until a low mastery criterion was met, and then stimuli were presented simultaneously until a more stringent mastery criterion was met. Results suggested that the simultaneous and combined procedures required slightly more trials in order for participants

to reach the mastery criterion, but produced superior post-test performance for typically developing college students, children with intellectual disability, and typically developing pre-school children. The authors concluded that teaching tacts by presenting stimuli simultaneously, or combining successive and simultaneous presentation and discrimination requirements, produced more academically meaningful outcomes for only slightly more work.

Along similar lines, Wunderlich, Vollmer, Donaldson, and Phillips (2014) taught five preschool children with developmental delays to tact letter names or letter sounds using serial and concurrent methods of instruction to assess effects on generalization. An alternating-treatment design was embedded within a nonconcurrent multiple-baseline design and multiple probes were used to assess generalization to novel exemplars of the target stimuli. Each letter or letter sound was taught using three exemplars (different fonts). In both conditions, participants were taught two letters at a time. In the serial condition, the participants were exposed to the same exemplar form of each letter until mastery was achieved, followed by instruction with the next set of exemplars if needed. Conversely, the concurrent instruction sessions involved presentation of all three exemplars of each letter in a random fashion. Results indicated that the concurrent method required less sessions to mastery and produced greater generalization for all participants. Overall, these studies illustrate the impact that variations of an entire instructional program may have on acquisition. Equally important to this level of analysis of instruction is that of individual sessions and the variables which can be manipulated therein.

Research on Arrangement of Instructional Sessions

Research on the arrangement of instructional sessions has primarily focused on the effects of interspersing tact trials with either maintenance trials for previously mastered targets (tact or others) or instructional trials for unmastered targets other than tacts. These studies

comprise a subset of a larger literature on the effects of task interspersal on the acquisition of various types of instructional targets.

Rowan and Pear (1985) examined interspersal techniques when teaching three children with developmental disabilities to tact pictures. During interspersal, trials with non-acquired tacts were mixed with trials with previously mastered tacts. Interspersal produced faster acquisition of tacts relative to presenting only trials for non-mastered tacts, but there were no differences in retention or generalization. By contrast, other studies have failed to find a benefit of task interspersal. Majdalany, Wilder, Greif, Mathisen, and Saini (2014) evaluated the contribution of trial-spacing to tact interspersal effects. Six participants with developmental delays were each exposed to four conditions; (a) massed-trial instruction, (b) distributed-trial instruction, (c) task interspersal, and (d) extended baseline, while learning to tact outline maps of countries. During massed-trial instruction, all five countries were taught simultaneously with a 1- to 2-s interval between trials, and no trials from other programs were interspersed. In the distributed-trial instruction, trials were separated by a 10-s interval. Trials in the task-interspersal instruction were also separated by a 10-s interval, and three previously mastered tact targets were delivered within that interval. Five of the six participants reached the mastery criterion fastest in the massed-trial condition, and sessions were approximately 60% shorter than in either the distributed or task interspersal conditions. Similarly, Volkert, Lerman, Trosclair, and Kodak (2008) found no benefit of task interspersal compared to a massed-trial condition, when teaching object labels to children with ASD. In this study, high-quality reinforcers were used as consequences of correct responding and delivered on a thinner schedule for maintenance tasks (previously mastered targets) relative to non-mastered tacts. Acquisition in the massed-trial

condition was superior to two interspersal conditions that included either mastered tacts or mastered motor tasks.

Three studies with typically developing children and children with ASD have evaluated the effects of interspersing tact instructional trials with opportunities to request the items that the children were learning to tact. Arntzen and Almas (2002) conducted an extension of Carroll and Hesse (1987) who compared the effect of these two techniques on acquisition and follow up. During tact-only sessions, the experimenter presented the object in front of the participant, asked "What is this?" and delivered praise and a token for correct responding. During a request trial in the request-tact sessions, each participant was required to complete some task and the last piece of the object to do the task was hidden, resulting in the need for the participant to ask for this missing piece. A correct request for the missing piece resulted in delivery of the piece and ultimate completion of the task. This was always followed by a tact trial performed just as in the tact-only condition. These two trial types were alternated in a 1:1 manner and sessions always began with a request trial. Both studies found that a request-tact condition produced superior acquisition over the tact-only condition. By contrast, Sidener et al. (2010) found no advantage of the request-tact condition over the tact only condition. Overall, these studies have not demonstrated consistent effects of task interspersal on tact acquisition.

Research on the Arrangement of Instructional Trials

Only three studies appear to have investigated the effects of trial arrangement on the acquisition of tacts. Partington, Sundberg, Newhouse, and Spengler (1994) investigated the use of supplemental prompts during tact trials with a six-year-old girl with ASD. She had failed to acquire signed tacts of objects despite being able to request items and answer questions using signs. It was hypothesized that the use of the supplemental question "What is that?" had blocked

the establishment of stimulus control by the objects. During Phase 1 of the experiment, the phrase "What is that?" resulted in the participant signing "ball" immediately and without looking at the nonverbal stimulus that was presented to her. When the experimenters changed the supplemental prompt to calling her name and pointing to the item to be tacted, prompting and prompt-fading procedures that had previously been unsuccessful, produced acquisition. Later, the question "What is that?" was successfully re-introduced. One year after the study, the participant had acquired over 200 signed tacts.

Similarly, Sundberg et al. (2000) worked with two boys with ASD who communicated in sign and had long histories of failure to acquire tacts. Acquisition rates produced by standard tact instruction trials which involved the use of the supplemental question "What is that?" were compared to those produced by an intraverbal condition in which the experimenter showed the item and signed an instruction (i.e. "sign bed"). Both participants showed faster acquisition in the latter condition, and when items that were not successfully taught using the standard instruction method were then taught using the intraverbal prompt method, the participants acquired them rapidly. The use of this specific procedure for conducting tact trials, however, is limited to teaching children who use signing for communication.

Because the studies by Partington et al. (1994) and Sundberg et al. (2000) suggested potentially adverse effects of including of supplemental questions in tact trials, Marchese, Carr, LeBlanc, Rosati, and Conroy (2012) compared the rate of acquisition and maintenance of tacts with four school-aged children diagnosed with ASD in (a) tact-only trials, and (b) tact plus supplemental question trials. Marchese et al. (2012) found idiosyncratic results in that each method produced faster acquisition of tacts for two of the four participants. There were no clear or reliable differences in performance during maintenance tasks.

No other published studies appear to have addressed the specific arrangement of individual trials in tact instruction for children. However, the procedural manipulation in the present study is similar to manipulations that have been shown to enhance acquisition or remediate acquisition failures in matching-to-sample (MTS) tasks.

Matching to Sample

MTS procedures have been used across a variety of populations to study learning, memory, and concept formation (Saunders & Williams, 1998). Often, the MTS procedures employed with human participants are similar to the original procedure developed by Cumming and Berryman (1961) for pigeons. In a standard MTS task for pigeons, three or more keys are presented. The pigeon is required to peck at the sample key (usually presented first) and then the comparison keys (which correspond to the sample in some way as determined by the experimenter). If the pigeon pecks at the comparison key that matches the sample key, the behavior is followed by reward delivery. If, however, the pigeon pecks at the other comparison key, no reward is delivered and the next trial is presented after an interval. A few different types of MTS tasks have been described in the literature. In an identity MTS task, one of the two comparison keys is physically identical to the sample key. This is different from an oddity MTS task in that the correct comparison does not match the sample comparison in physical appearance; in fact it mismatches the sample while the other comparisons do match the sample. In a symbolic MTS task, the correspondence between the sample and comparisons is not based on physical correspondence. Another adaptation of this procedure is known as delayed MTS (DMTS) because there is a delay between the offset of the sample stimulus and the onset of the comparison stimuli.

Observing Responses and Differential Observing Responses

In MTS procedures, an OR is defined as a response to the sample stimulus (e.g., a key peck for a pigeon, or touching or clicking the stimulus for a human) that produces access to the comparison stimuli, in turn permitting an opportunity for the reinforcement of correct stimulus selection (Saunders & Williams, 1998). The OR in an MTS procedure differs from that used by Wyckoff (1952) in several ways. In MTS, it is not possible for a response to be reinforced until an OR has produced the comparison stimuli, so the OR is a necessary condition for reinforcement. In addition, the comparison stimuli that the OR produces are not by themselves correlated with differential probabilities or schedules of reinforcement, as the reinforcement of each comparison selection is conditional upon the prior presentation of a particular sample. Thus, although the consequence of the OR is to contact comparison stimuli, it has been proposed that its primary function is to get the subject to look at the *sample* stimulus immediately before selecting a comparison (Skinner, 1950; Saunders & Williams, 1998).

Dube and McIlvane (1999) suggested that a procedural modification that could improve discrimination is one in which participants are required to engage in differential observing responses (DOR), that is, perform a different response to each sample stimulus. For example, a person learning to match novel arbitrary symbols in a DMTS task could give each a name based on something familiar that they may resemble. Assuming that each of the symbols looks different than the other, this person would be responding differentially across the stimuli.

Differential Observing Responses in MTS tasks

Previous studies have shown enhanced performance in MTS tasks when participants are required to make a DOR to the sample stimulus. As an early example, Constantine and Sidman (1975) taught four men with intellectual disabilities to use pre-existing verbal skills to enhance

identity DMTS performance. During visual-visual matching, participants were shown black line drawings of common objects and were required to match a sample to its identical comparison in the absence of the sample stimulus. The naming condition required that participants state the name of the sample stimulus when it was presented. Although the dependent variable of interest was performance on DMTS, it was ensured that participants could perform these discriminations in a simultaneous discrimination format prior to testing (the sample stimulus was available for the duration of the trial). Additionally, they could all give verbal labels when shown the stimuli, and could also select the stimulus when told the verbal label. Three participants from Experiment 1 were successful in simultaneous matching, but not DMTS. In Experiment 2, these three participants were instructed to name each sample picture before responding to the comparisons. The performance of every participant improved in the DMTS task when they followed the instructions to name the sample stimuli; however accuracy declined when the instruction was removed.

In a replication of Constantine and Sidman's (1975) experiment, Gutowski, Geren, Stromer, and Mackay (1995) investigated the effects of a DOR on performance in an identity DMTS task for five adults with intellectual disabilities. Experimenters tested simultaneous and delayed matching using a touch sensitive computer. The tasks involved both 1 picture (simple) and 2 picture (compound) sample stimuli displayed in the center box of the screen and surrounded by four white boxes (one in each corner). The comparisons were displayed in these surrounding boxes and consisted of simple stimuli (one of which was identical to the simple sample, or was identical to one feature of the compound sample stimulus). In Phase 1, comparison stimuli were displayed either simultaneously with the sample, or just after the participant touched the sample which made it disappear (0 s delay). Prior to testing matching

performance, participants were given a naming test in which they were asked to name both types of sample stimuli and received no feedback or consequences based on responding. During the matching tasks, correct responses were followed by auditory and visual feedback as well as the delivery of a penny. Incorrect responses were followed by a 3-s blackout. Simultaneous and 0-s delay matching trials were alternated every six blocks, and within each of these blocks the simple and compound stimuli were randomly presented. Results showed that matching accuracy was high during the simultaneous matching trials with both types of sample stimuli. Matching accuracy was also high during 0-s delayed matching trials involving the simple sample stimulus, but performance deteriorated significantly when compound sample stimuli were presented. The experimenters noted that the decrease in matching performance for one participant in this condition occurred despite his ability to accurately name all of the sample stimuli during the initial testing. Thus, Phase 2 investigated the effects of oral naming on matching performance under the 0-s delay condition with compound sample stimuli. In the No Instruction condition, the sessions were conducted just as in Phase 1. In the Instruction condition, experimenters told the participants to name the stimuli before choosing a comparison. Results demonstrate that all participants could correctly name the sample stimuli when instructed to, but typically did not do so in the No Instruction condition. Generally speaking, matching scores were higher in the Instruction condition, and remained high for two of the participants in the following No Instruction condition. Given the positive effects that the naming DOR had on matching performance at a 0 s delay, Phase 3 examined matching performance at longer delays (5 or 10 s) and with novel stimuli, for the two participants whose gains in matching performance seemed to have generalized to the No Instruction condition in Phase 2. Prior to the final delay condition (10 s + new stimuli), a naming test was given just as in Phase 1 and both participants could name all

of the new sample stimuli. Results show that matching performance remained high during 0 s matching with both simple and compound stimuli, however decreased at 5 and 10 s delays for both participants. With respect to the novel stimuli, matching remained high at the 0 s delay for both participants (suggesting possible generalization to these stimuli), and decreased after the 10 s delay, however not below levels of matching in that condition with the familiar stimuli. In conclusion, the naming DOR appeared to provide some benefit in the DMTS tasks.

One possible interpretation of these data is that participants may have repeated the name of the stimulus during the delay period; thus, bridging the temporal gap between the sample and comparison stimuli. However, other studies have shown similar effects with DORs that did not involve naming the sample stimuli, which may support Sidman and Constantine's (1975) suggestion that naming functioned as a DOR rather than a verbal mediator.

Dube and McIllvane (1999) investigated a different type of DOR with adolescents with intellectual disabilities. Many individuals with developmental disabilities are unable to make verbal responses, thus, the experimenters embedded a compound simultaneous matching trial which required no vocal ability within the sample observation period of DMTS trials. In the DMTS task, participants were presented with compound sample stimuli, each consisting of two shapes. The comparison stimuli consisted of single shapes, and a correct response consisted of selecting the shape that had appeared as part of the previously displayed sample stimulus. All participants performed poorly or with intermediate accuracy on this task in the absence of a DOR requirement, despite performing highly accurately in a simultaneous matching version of the task. During the DOR condition, the first touch to the sample stimuli resulted in the presentation of three compound comparison stimuli, one of which was exactly identical to the sample. A touch to the correct comparison stimulus produced the sample stimulus alone in the center of the

screen again, and the next touch to the screen produced the single-shape comparisons. All participants performed with high accuracy in this condition, although the effect dissipated when the DOR requirement was removed.

Walpole, Roscoe & Dube (2007) showed that use of a DOR could also remediate atypically restricted stimulus control in a teenaged girl with ASD who was learning to match identical printed words. During baseline, the participant was shown a page in a binder with a sample stimulus visible and three comparison stimuli covered by a flap of paper. Once the participant pointed the sample stimulus (e.g., *cat*), the experimenter lifted the flap to present the comparison stimuli (*car, can, cat*). The only difference between the correct and incorrect comparisons was the last letter of each word. During the DOR intervention, she was required to match the distinguishing letters of the overlapping words prior to matching the whole words. For instance, she was shown the letter *t* from *cat* as the sample, and the letters *t, r, c* as comparison stimuli. This was immediately followed by the whole word matching task just as in baseline. Accuracy scores improved significantly and remained high when the DOR requirements were withdrawn, suggesting that she may have learned a broader range of observing behaviors.

Differential observing responses in acquisition tasks. The previously reviewed studies all investigated the effects of DORs on the performance of previously acquired skills, but under conditions of added difficulty (e.g., delayed vs. simultaneous matching). To date, only two studies have examined the effects of DORs when teaching new discriminations, and mixed results have been found. As such, it is yet unknown if a DOR requirement could be indicated when acquisition of new discriminations is impaired due to failure to attend to relevant features of the instructional stimuli.

Reed, Altweck, Broomfield, Simpson, and McHugh (2012), in Experiment 3, investigated the effects of a naming DOR in a simple discrimination task involving compound stimuli. Eighteen individuals with ASD were presented with two cards in a table-top format. Each card displayed two separate stimulus elements (such as a hand and a teacup). Participants were rewarded for pointing to whichever card was designated AB+ by the experimenter, and received negative feedback ("no") for pointing to the CD- card. Participants in one group were required to name the stimuli on the card prior to pointing to it, whereas participants in the other group were not. Although the experimental group had slightly fewer trials to criterion, the difference was not statistically significant.

By contrast, Kisamore, Karsten, Mann, and Conde (2013) evaluated the effects of DOR on the acquisition of intraverbal responding in typically developing preschool children. This study also represents the only published use of a DOR in the direct instruction of a vocal verbal operant. Six participants were recruited due to delayed acquisition of intraverbal responses when taught using differential reinforcement and error correction procedures. During baseline, the experimenters delivered 10 trials (5 antonyms and 5 synonyms) in which correct responses were rewarded and incorrect responses were followed by a model of the correct answer and then praise for an echoic response of the model. For example, the experimenter might say "Name the same as tall" and a correct answer might be "Giant". The intervention was identical to baseline except that participants were prompted to repeat the instruction before answering it ("Name the same as tall. You say it.") Findings indicated that accuracy increased to mastery when the participants engaged in the DOR of repeating the question prior to responding to it. This finding is unique in that it suggests that inclusion of a DOR requirement could be beneficial when trying to establish stimulus control over vocal responses.

An unpublished study from our lab (Devine & Petursdottir, 2014) evaluated whether a similar effect might be observed on the acquisition of tacts by typically developing children, using a nonverbal DOR. In this study, participants were taught to tact novel stimuli including pictures of foreign flags, outlines of countries, and Chinese characters in both a pointing condition (OR) and an IMTS condition (DOR). For each participant, an adapted alternating-treatments design (Sindelar, Rosenberg, & Wilson, 1985) embedded into a multiple baseline design across stimulus sets was used to compare responding across conditions. During the OR condition, participants were expected to point to the target stimulus out of an array of four stimuli, and then to provide the correct tact when asked "What is it?" Conversely in the DOR condition, the experimenter handed the participant a card with the sample stimulus printed on it and instructed him to "Put this with the one it matches" before prompting a tact by asking "What is it?" Acquisition rates were roughly equal across conditions for all three participants. Although participants sometimes showed faster acquisition in one condition, these differences were not consistent within participants. It is possible that in this study and that of Reed et al. (2012), the DOR did not produce an effect because the participants already attended sufficiently to the distinguishing features of the stimuli. Participants may have been able to learn about the the relevant stimulus without attending to multiple features of each. For example, discriminations between Chinese characters may have been based on a single distinguishing feature of each stimulus. Conversely, participants in Kisamore et al. (2013) were required to attend to multiple features of each verbal stimulus because the task was to correctly answer prompts such as "Name the opposite of tall" and "Name the same as tall". In this situation, not only must the participant attend to the word "tall", but also what precedes it in order to then produce a synonym or antonym accordingly. This may be akin to many instructional situations that involve learning to

label stimuli; for example, learning to label letters of the alphabet requires distinguishing line orientations, curves, and spatial relations among these features (e.g., E vs. F, O vs. Q, b vs. d). Furthermore, participants in the Kisamore et al., (2013) study were selected for participation specifically because they had a history of difficultly acquiring the target discriminations under typical instructional conditions. As a result, the purpose of the present study was to investigate the effects of a DOR as an intervention when children failed to acquire tacts of compound stimuli with overlapping features that which required attention to multiple stimulus elements.

Present Research

The present work was designed to further test the efficacy of using a DOR as a treatment for slow or failed compound stimulus control over vocal tacts. Specifically this study examined if a DOR requirement would produce acquisition of tacts to compound stimuli when DOR absent instruction had not. Unpublished data from our lab suggest that four- and five-year-old typically developing children may fail to acquire, or show slow acquisition, of tacts involving compound stimuli. Specifically, participants were taught to tact images of four stick figures that represented four unique color-shape combinations. Correct responses required attending both to the color of the stick figure (red or blue), and to a shape displayed within the torso of the figure (heart or plus sign). Figures 1 and 2 show acquisition data from two representative participants, one who eventually mastered the task and one who did not. A summary of results for four participants who received training with these stimuli can be found in Table 1 below.

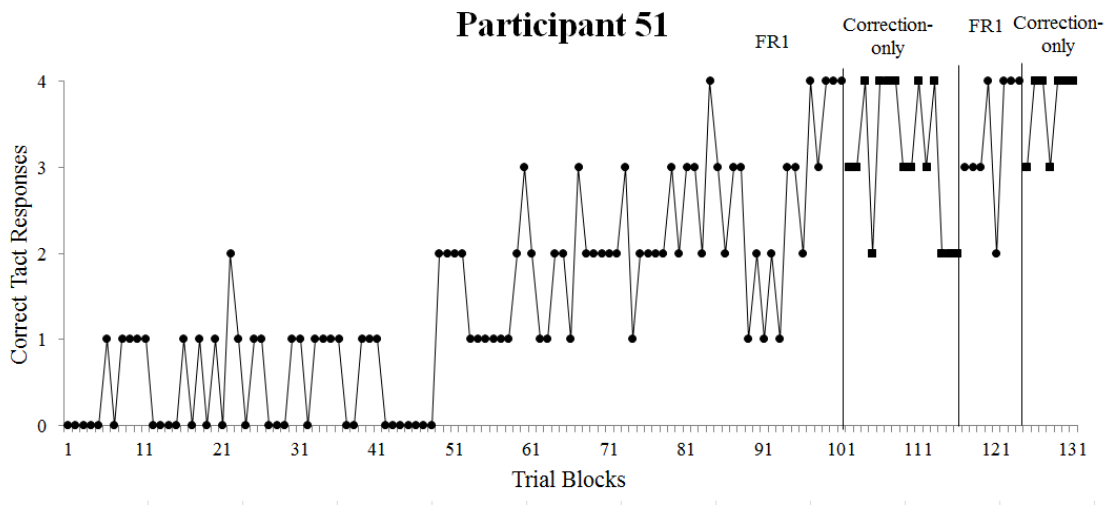

Figure 1. Graph depicting performance of participant 51 in unpublished study.

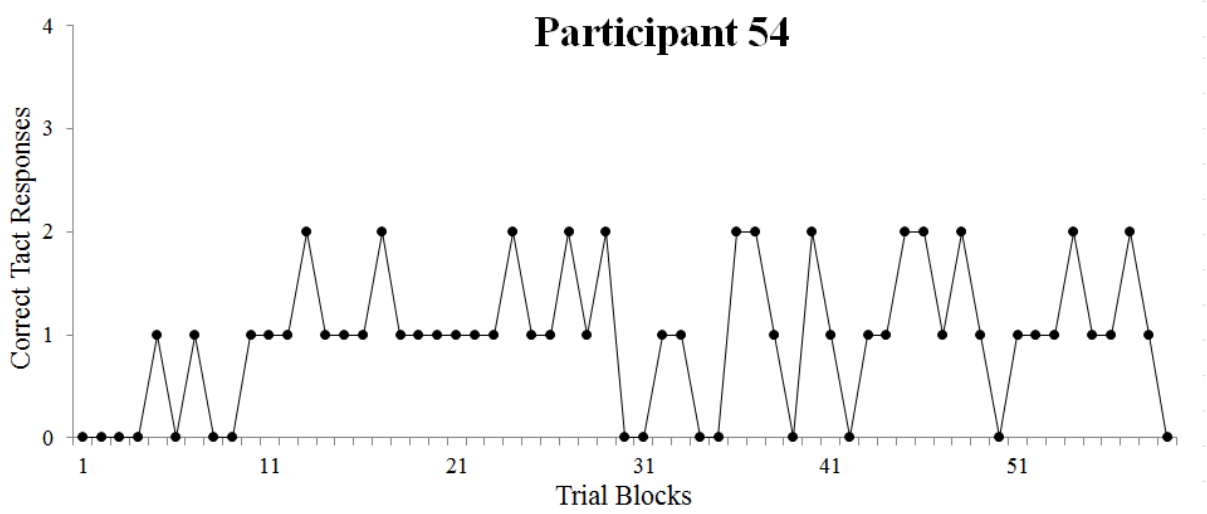

Figure 2. Graph depicting performance of participant 54 who never reached mastery criteria (due to dropping out of the study).

Table 1

Trials to Criterion for Unpublished Study

Participants	Mastered?	Number of Trials
Participant 50	yes	188
Participant 51	yes	404
Participant 52	No	228
Participant 54	No	236

These data demonstrate that even typically developing children may struggle to acquire tacts of stimuli which are composed of two or more features under typical instructional conditions. Therefore, the present study made use of the same type of stimuli and the same general instruction procedure for the pre-intervention condition.

In the present study, the first instructional condition was DOR absent. One stimulus was presented in each trial and the participant was asked to name it. This procedure is representative of those typically recommended for teaching tacts in early intervention programs (Leaf & McEachin, 1999; Lovaas, 2003; Maurice, Green, & Luce, 2003) and identical to the procedure we have previously found to result in acquisition failures with these stimuli. When acquisition was not observed, an identity-matching DOR requirement was implemented. If the identity-matching DOR did not produce an effect in Phase 1 of the study, additional interventions were implemented in Phase 2 that included a verbal DOR and precurrent-response training.

Phase 1

Method

Participants. The participants included five children who attended a local day care center or pre-school. Brent, Gary, and Anna all attended a local Montessori school, whereas Kenneth and Maria both attended a church day care center. Table 2 shows each participant's age

at the beginning of the study and *Peabody Picture Vocabulary Test IV* (PPVT 4; Dunn & Dunn, 2007) score. All sessions took place at the participants' school or day care center in a separate room. Session length was approximately 15-20 min. One to two sessions were conducted per day, up to five days per week. The participant and the experimenter sat adjacent to one another at a small table with all of the testing materials, and a second observer was present when available. All sessions were videotaped.

Table 2

Chronological Ages and PPVT Score for each Participant

Participants	Age	PPVT Age Equivalent Score
Brent	4 yrs, 2 mo	5 yrs, 0 mo
Gary	4 yrs, 11 mo	2 yrs, 2 mo
Kenneth	5 yrs, 1 mo	5 yrs, 1 mo
Anna	3 yrs, 5 mo	3 yrs, 10 mo
Maria	3 yrs, 8 mo	5 yrs, 4 mo

Materials. Visual stimuli for all participants were presented in MS PowerPoint and displayed on an *hp* EliteBook 840 laptop with a 30.48 cm screen. Materials for Kenneth and Maria also included laminated cards that each contained one of the stimuli. The visual stimuli consisted of four stick figures with red or blue outlines and filled-in shapes (hearts and plus signs for Kenneth and Maria; suns and stars for Brent, Gary, and Anna) inside their torsos (see *Figures 6-8*). Each stick figure stimulus was 9.45 cm tall and 5.08 cm wide and contained a smiley face in the head. Each stimulus represented a unique color-shape compound, and was given a one-syllable name (see Table 3) that was not an English word and consisted of sound combinations that do not occur in the ten most popular American names for children born between 2009-2013 (Social Security Administration, 2013), for example, "Zut" and "Unk".

Table 3

Descriptions of Stimuli

Participants	Name	Color	Shape
Kenneth, Maria	Ohmp	Red	Plus
	Jid	Red	Heart
	Prat	Blue	Plus
	Dek	Blue	Heart
Anna, Brent, Gary	Rom	Red	Star
	Qui	Red	Sun
	Zut	Blue	Star
	Unk	Blue	Sun

Response measurement and interobserver reliability. During all sessions, correct and incorrect responses were recorded on data sheets. A correct tact was scored if the participant accurately labeled the target visual stimulus within 5 s of the experimenter's question ("Who is this?"), whereas an incorrect tact was scored if the participant failed to label the stimulus correctly within 5 s. If the participant vocalized two or more names within 5 s of the delivery of the instruction, only the first response was scored as correct or incorrect (i.e., no self-corrections were accepted). The content of all incorrect responses was recorded. During the intervention phase, data were also collected on the accuracy of the identity matching DOR. A correct DOR was scored if the participant pointed to the target stimulus on the screen within 5 s of the presentation of the sample stimulus. An incorrect response was scored if the participant pointed to an incorrect stick figure or failed to respond within 5 s.

A second independent observer collected data during at least 30% (range, 30-100%) of all sessions in each condition for each participant to assess interobserver reliability. The secondary data were recorded either live during the sessions, or subsequently from video. For each trial, an

agreement was scored if both observers scored the participant's responses identically as correct or incorrect. Interobserver agreement (IOA) was calculated by dividing the number of agreements by the sum of agreements and disagreements, and converting the product to a percentage. These data were collected for the IV (IMTS responses) and DV (tact responses). For Brent, Gary, Kenneth, Anna, and Maria, mean agreement was 100% across all measures and all conditions in Phase 1.

Pre-experimental assessments.

An echoic assessment was conducted, in which participants were asked to echo each of the names used in the study to ensure that they could correctly vocalize them. For example, the experimenter delivered the instruction "Say *Unk*" and a correct response was scored if the participant said "*Unk*" or a close acceptable approximation. An approximation was considered acceptable if both the experimenter and a second observer agreed on the name that the participant attempted to say.

A brief discrimination assessment was performed to ensure that each participant could discriminate the differences between the compound stimuli. Participants were shown a card with of one of the stick figure stimuli printed on it, and directed to "point to the one this matches". Each of the four comparison stimuli cards (one was identical to the sample stimulus) were presented on the table in a horizontal line directly in front of the participant. A point to the comparison stimulus that matched the sample was considered a correct response. Incorrect responses included a point to any of the other stimuli, multiple stimuli, or no response within 10 s. Mastery criterion required that participants correctly match each stimulus during the first exposure to it or, the next three consecutive exposures if any errors occurred during the first. Table 4 shows the number of trials each participant required to reach this criterion. Participants

who did not meet this criterion were not included in the experiment. One female participant aged 3 years, 8 months did not participate in the study because she could not accurately match the stimuli. During all pre-tests, participants received tokens for cooperation, following instructions and answering distractor tasks correctly (questions unrelated to the experiment, such as "How old are you?").

Table 4

Trials to Criterion for Discrimination Assessment

Participants	Number of Trials
Brent	16
Gary	4
Kenneth	4
Anna	4
Maria	4

Procedure.

Experimental design. A nonconcurrent multiple-baseline design across participants (Watson & Workman, 1981) was used to evaluate the effects of a DOR on the acquisition of tacts if response accuracy stabilized below mastery level in the DOR absent condition. Instruction for all participants began with the DOR absent condition (which served as the baseline), and transitioned into the DOR present instruction if mastery criterion was not met in the DOR absent condition. The DOR present condition was implemented in a stair step fashion across participants such that the number of sessions in the DOR absent condition differed across participants. If the introduction of the DOR produced mastery, the DOR absent condition was re-introduced to examine whether accuracy would maintain in the absence of the DOR.

Pre-Instruction Probes. Each participant was exposed to two trial blocks of pre-instruction probes, one with and one without a DOR component. Trials were presented in the same manner as in the DOR absent and DOR present instructional conditions (see sections that follow) except that no feedback was provided on the accuracy of the response. Instead, the experimenter waited 5 s for a response and then moved to the next trial. Tokens were delivered periodically throughout for compliance.

DOR absent instruction. The slides in the DOR absent condition each contained one stick figure in the horizontal and vertical center of the slide. The center of the symbol within the torso was 8.89 cm from the top of the slide and 11.43 cm from the left or right edge of the slide (see Figure 3).

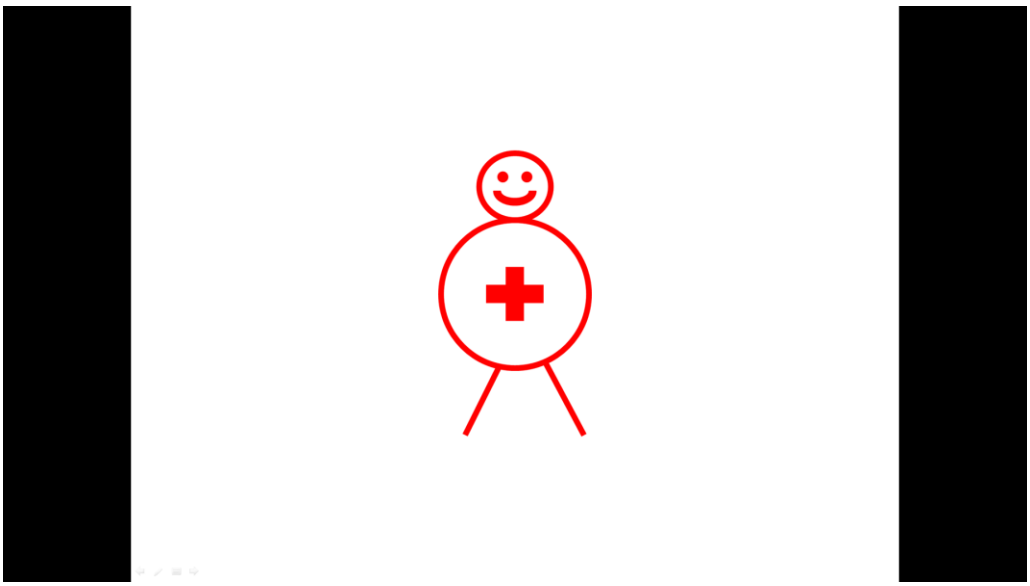

Figure 3. Screenshot of a DOR absent slide.

Each session consisted of 2-6 trial blocks that contained four trials each (one for each stimulus). Presentation of the trials within each block was semi-randomized. Participants earned three tokens for each unprompted correct response and one token for each prompted correct response. A session ended when the participant had accumulated 24 tokens. Thus, session length

varied based on performance during instruction, in which a greater magnitude of reward was contingent on correct responses than prompted responses. Each trial began with the presentation of one DOR absent slide and an instruction to look at the screen. The experimenter then pointed to the stimulus on the slide and asked the participant "Who is this?" During the first two trial blocks of the first session, the experimenter provided a 0 s prompt delay by immediately pointing to the target stimulus and labeling it (e.g., "This is *Unk.* Who is this?"). A prompt delay was introduced in the third trial block. A trial began in the same manner as before, but the experimenter waited up to 5 s for an independent response after asking "Who is this?" An incorrect response or no response within 5 s was followed by the experimenter providing the correct response and repeating the question as before (e.g., "This is *Unk.* Who is this?"). The experimenter also provided occasional reminders that the participants could answer by saying "I don't know" rather than guessing (Remember, if you do not know who this is, you can say "I don't know"). DOR absent instruction was terminated when performance reached 100% correct across three consecutive trial blocks or performance was stable with no upward trend for at least 25 trial blocks.

DOR present instruction (intervention). The slides used in the DOR present condition each contained all four stimuli aligned across the slide. The placement of the visual stimuli on these slides was rotated such that each stimulus was presented in each position at least once during each block of four trials, and each stimulus was presented equally often in all positions as the target stimulus, resulting in a balanced design. On the slides used for Kenneth and Maria, the center of the shapes within each torso was also 8.89 cm from the top and bottom of the slide (as in the DOR absent slides) and the furthest left and right stick figures are 3.18 cm from left and right edge of the slide respectively (see Figure 4). On the slides used for Anna, the stimuli were

presented at the bottom of the screen with the center of the shapes 14.28 cm from the top and 4.78 cm from the bottom of the slide; each slide additionally contained the target stimulus for that trial at the top of the screen.

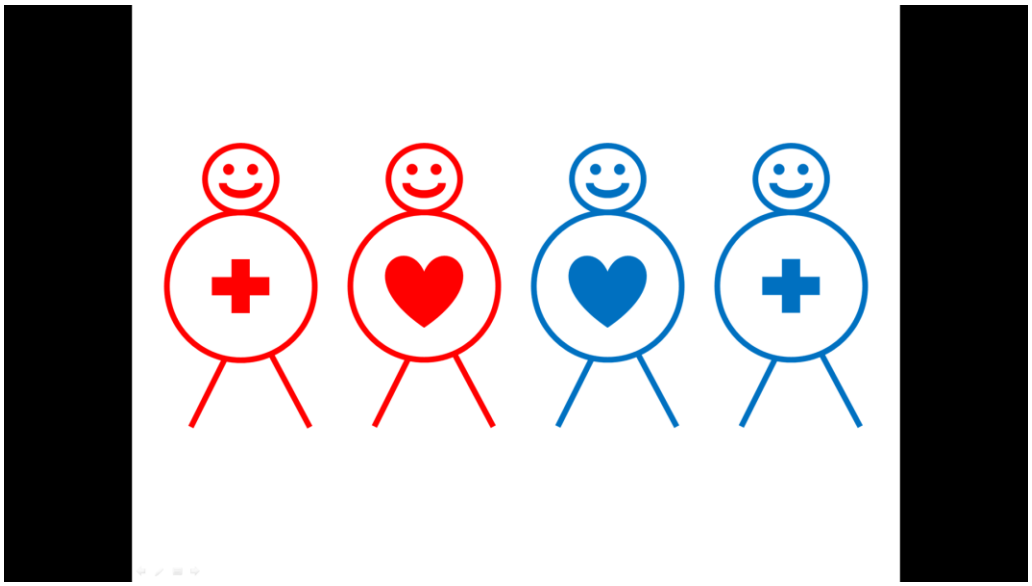

Figure 4. Screenshot of a DOR present (intervention) slide for Kenneth and Maria.

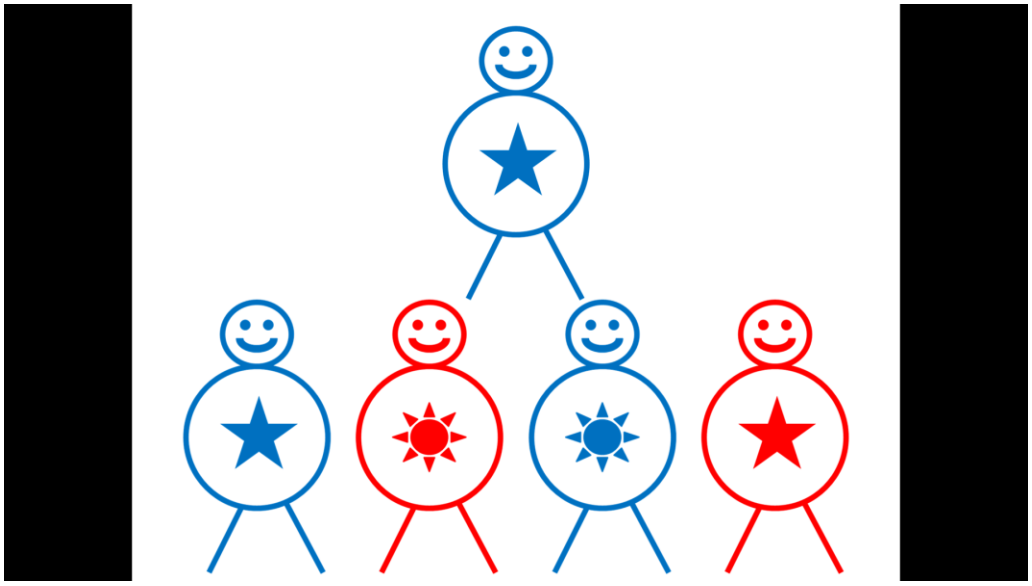

Figure 5. Screenshot of a DOR present (intervention) slide for Anna.

At the beginning of each trial for Kenneth and Maria, the experimenter presented a card with a printed stick figure that was identical to the target stimulus (as in the discrimination

assessment pre-test) and said “point to the one this matches”. For Anna, the experimenter pointed to the sample stimulus at the top of the screen and said “point to the one this matches.” If a participant did not match correctly, the experimenter prompted the correct answer by using a model and instructing the participant to point to the correct stimulus. Once the participant successfully matched, the experimenter asked “Who is this?” and waited up to 5 s for a response. The remainder of the trial proceeded in the same manner as trials in the DOR absent condition.

Results and Discussion

The intervention (DOR present instruction) was predicted to result in acquisition of the target tacts. Prior unpublished research from our lab suggested that three-to five-year-old participants were unlikely to master these discriminations under standard tact instruction procedures similar to the DOR absent condition. However, two of five participants in this study (Brent and Gary) mastered the discrimination in the DOR absent condition (both in 172 trials; see Figure 6), and for the remaining participants, the introduction of the identity-matching DOR did not produce a reliable effect.

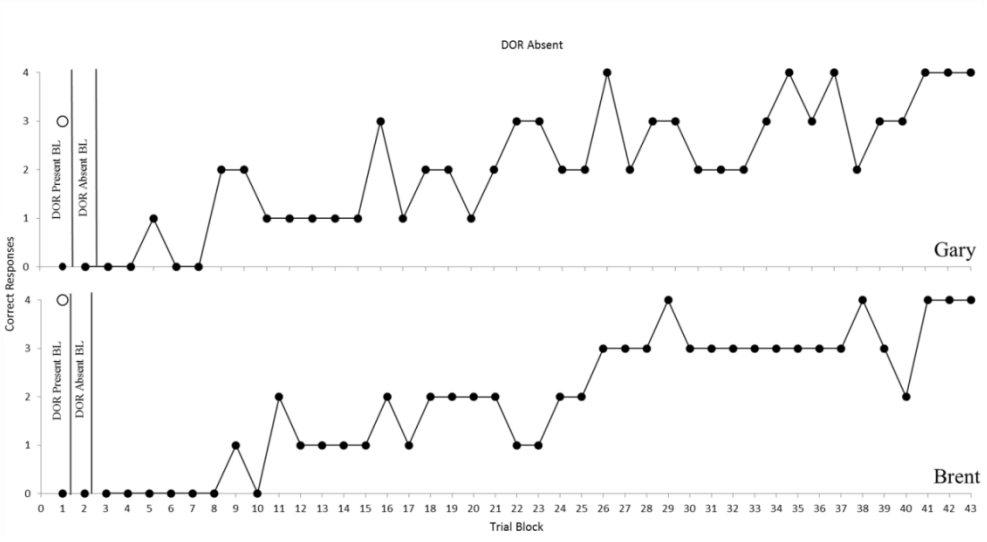

Figure 6. Phase 1 Results for Gary and Brent. The open circles represent correct DORs and the filled circles represent correct tacts.

Results for Kenneth, Anna and Maria are displayed in Figure 7. As is shown in the top panel of the graph, Kenneth's performance accuracy soon rose above chance levels in the DOR Absent condition as indicated by the filled circles (see top panel of Figure 7). An error analysis (see Figure 8) indicated that Kenneth had difficulty discriminating between Dek and Prat who shared their blue color. Specifically, on 50% of trials in which the correct answer was "Dek", Kenneth said "Prat". Once the DOR present instruction was implemented (indicated by the solid black phase change line), Kenneth's accuracy increased immediately to 100% and he reached mastery criterion as quickly as was possible. His matching responses were also 100% accurate as indicated by the open circles. The final DOR absent phase was omitted initially due to an experimenter error. Therefore, a few weeks later, maintenance was tested under the DOR present condition. Because accuracy had declined, tacts were re-trained to mastery in the DOR present condition and then evaluated under DOR absent conditions. Kenneth's performance remained accurate, suggesting that the DOR was no longer necessary for him.

The middle panel shows Anna's performance. Anna performed slightly above chance level in the DOR absent condition. An analysis of her errors indicates that she was labeling Unk fairly reliably, but she said "Qui" in the majority of all other trials and still offered an "Unk" response occasionally when Zut or Rom were shown. Although Rom and Qui are both red (see Table 3 for description of stimulus features), Zut and Qui do not share any features in common, so the response did not appear to be under the control of either color or shape. It is possible that this error persisted because it was reinforced intermittently in trials in which "Qui" was a correct response. This intermittent reinforcement may have sufficed to maintain control over the response by all stimuli other than Unk without promoting further discrimination. The "I don't know" reminders (experimenter instruction that it was okay to say "I don't know" rather than

guessing one of the other names) that were intended to prevent reinforcement of such errors, appeared ineffective at suppressing guessing responses for Anna. During the DOR present instruction, "Qui" became less predominant; and Anna began alternating it with "Rom", but it still appears that no stimulus control over these responses (including "Zut") developed. Ultimately, the DOR present instruction was not sufficient to produce mastery of this discrimination task for Anna.

The bottom panel shows Maria's performance. Maria performed at or slightly above chance levels for most of the DOR absent instruction. An analysis of her errors suggests that Maria frequently said "Jid", no matter which stimulus was presented. She also emitted many responses that fell into the category of "Other" (mostly "I don't know"). In general, there was a considerable amount of variability in the errors she made. During the DOR present condition, Maria's performance remained at or slightly above chance levels. In this condition, Maria rarely provided "I don't know" responses and she stated "Jid" to almost all of the trials presented. A fine-grained analysis of each trial block suggests that this change began to occur prior to the DOR present intervention. Just as with Anna, the DOR present instruction was not effective at producing acquisition for Maria.

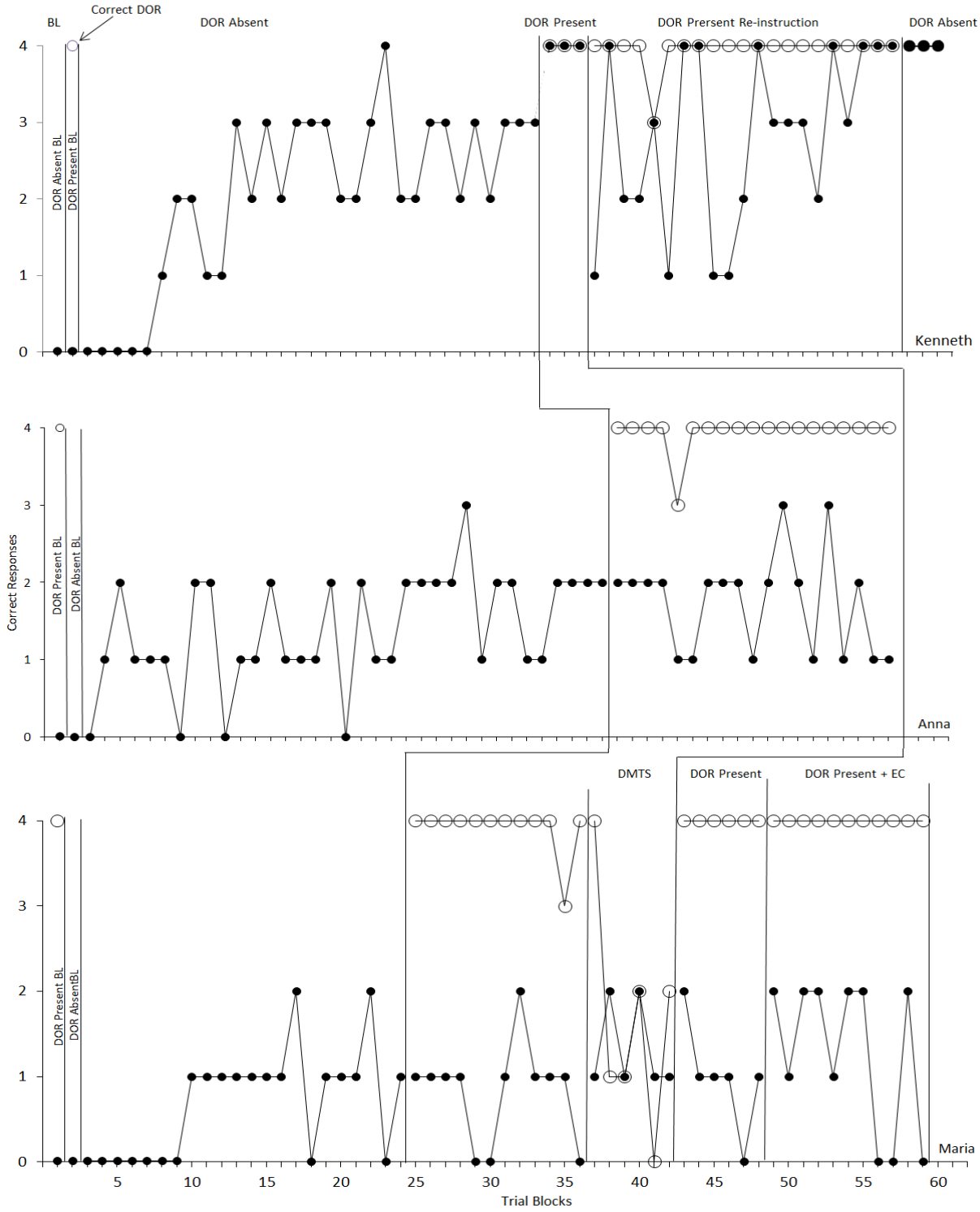

Figure 7. Phase 1 Results of the DOR intervention for Kenneth, Anna and Maria. The open circles represent correct DORs and the filled circles represent correct tacts.

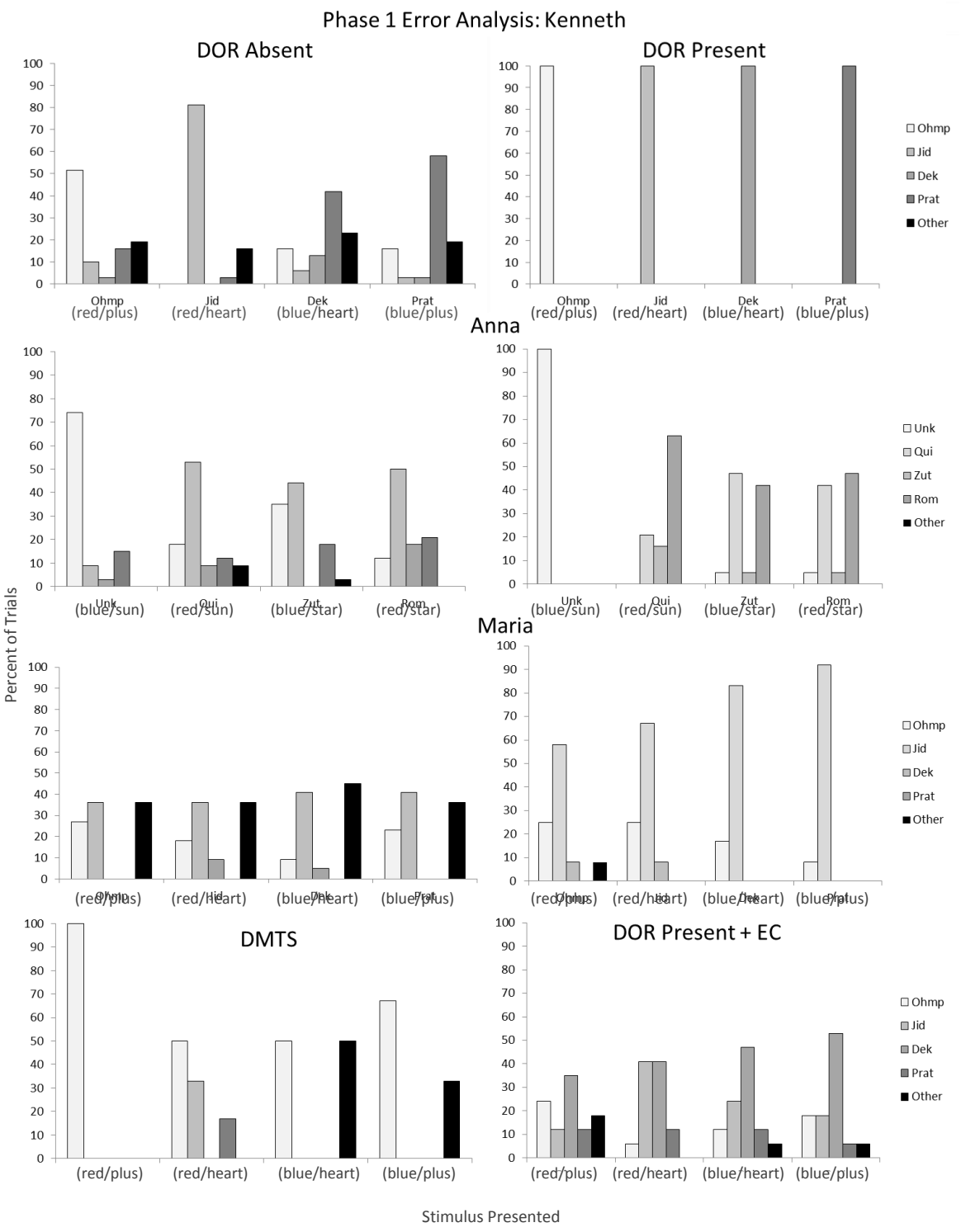

Figure 8. Error analysis for Kenneth, Anna and Maria. The x-axis represents the stimulus presented and the y-axis represents the percentage of trials in which each possible response was provided, for all graphs.

For Maria, two procedural modifications to DOR present instruction were implemented when it became evident that there was no increase in accurate labeling. First, after 24 trial blocks of DOR present instruction, a delayed match-to-sample (DMTS) procedure was introduced in which the sample stimulus was presented and removed roughly about 1 s before the comparison array was presented. The intention was that inserting a small delay would require Maria to focus and perhaps retain information about the relevant features of the compound stimulus for at least 1 s in order to correctly match it to the comparison stimulus. Not only did this intervention fail to provide any benefit to Maria's labeling performance, it also led to deterioration in matching performance. A return to DOR present instruction resulted in recovery of accurate matching performance. However, Maria was still labeling the stimuli correctly in only about 25% of trials. The error analysis indicates that Maria labeled Ohmp correctly each time it was presented, but that she also said "Ohmp" frequently when she saw the other three stimuli. Her most common error was saying "Ohmp" when she was shown Prat; these two stimuli shared the plus sign in common.

A particular pattern of responding that Maria showed next led to a unique error correction (EC) protocol for her. During every trial, Maria would say the name of a stimulus (usually not the correct name) and then look directly at the experimenter for feedback. This meant that when the experimenter provided the correct answer, Maria was looking at the experimenter's face rather than the stimulus. As it was discovered that Maria had a difficult time responding accurately when delays were built in to the matching task, it was hypothesized that anything but simultaneous pairing of the auditory name and sight of the visual stimulus might produce too long of a delay for her to retain the information. Therefore, whenever Maria responded incorrectly, the experimenter removed the sample stimulus and said "Let's try again". She then

re-presented the sample stimulus and instructed Maria to match it to the comparison stimulus ("Point to the one it matches"). As Maria was moving her finger toward the correct comparison stimulus, the experimenter stated the auditory name of the stimulus. In this way, the sight of the visual stimulus was simultaneously paired with its auditory name as presented vocally by the experimenter, effectively removing any delay from the feedback process. Minimal gains in labeling performance were noted during the first few trial blocks in this condition, followed by a decrease in performance (see trial blocks 48-59 of bottom panel of Figure 7). Maria generally tended to alternate between saying "Jid" and "Dek" as shown in Figure 8.

Overall, only Kenneth showed the predicted increase in accuracy to mastery level with the introduction of the DOR requirement. No improvements in acquisition were shown by Anna or Maria in the intervention phase. Taken together, these results do not suggest that an identity-matching DOR reliably remediates failures to acquire tacts of compound stimuli. Given this, the experimenter went on to test further interventions in Phase 2, in an attempt to improve the labeling performance of Anna and Maria as well as to learn about other possible interventions to inform future research on establishing complex discriminations involving vocal responses.

Phase 2

The first intervention tested in Phase 2 was an alternative DOR procedure (verbal DOR) that consisted of having the participant label the features (color and shape) of the stimulus prior to naming the entire compound stimulus. These response requirements may also be considered a DOR in that participants emitted a different combination of verbal responses to each stimulus. This intervention was implemented because it seemed possible that such a DOR requirement might better promote discrimination of the individual features of each stimulus than did the identity matching DOR.

The purpose of the second intervention was to teach the participants chains of responses that verbally related the color and shape of each stimulus to its name. If the participants mastered these chains, they would be able to use them to guide correct responding in tact trials. Thus, they might function as precurrent behavior, or those behaviors which make subsequent responses more effective at gaining access to reinforcement (Skinner, 1968). Once established, precurrent behaviors may be maintained by the correct performance on the behavior which follows them. For example, the precurrent behavior of consulting a map may be maintained by reaching a preferred destination. A potential concern, however, was that learning the verbal chains might be just as difficult as learning to label the stimuli, due to requiring similarly complex discriminations between overlapping stimulus components (i.e., color names and shape names). In order to make the task more interesting and potentially easier to learn, therefore, the chains were taught in the form of songs with accompanying hand gestures. In other words, the singing plus the gestural movements could provide extra-stimulus prompts that might help the participants learn the response chain.

The first step of training consisted of simply teaching the participants to echo the songs without a requirement to produce them independently. Following this song practice, DOR absent instruction was introduced to assess whether song practice alone would affect performance. If it did not, the next programmed step was additional instruction to ensure that the participants could sing the songs independently. It was hypothesized that if participants could sing the songs independently, they should be able to respond correctly in tact trials under the DOR absent condition.

Method

Participants and Materials. Anna and Maria served as participants for this study and the experimental task and materials remained the same as in Phase 1.

Response measurement and interobserver reliability. Data were collected in the same manner as in Phase 1 and additional measures were added (delayed matching response, color/shape labeling, verbal DOR, song responses). For both Anna and Maria, mean agreement was 100% across all measures and all conditions in Phase 2.

Color/shape tact instruction (Maria only). Before the verbal DOR intervention was implemented, it was necessary to ensure that the participants could label the color and shape components of the stimuli. Anna was able to label both the colors and the shapes, but Maria was unable to label one of the shapes (the plus sign). As a result, Maria received training to label the colors and the shapes before Phase 2 began. During these trials, the stimuli were separated into their component parts (see Figures 9-12). Maria was presented with either a red or blue stick figure stimulus that did not contain a shape in the torso (for color trials) or a black outlined heart or plus sign (for shape trials). She was asked to label the color and shape respectively. Each trial block contained one trial of each stimulus. Correct responses were rewarded with a token, and incorrect responses were followed by feedback ("This is a plus") and a repeat trial to allow for an independent correct response. Mastery criterion was set at four consecutive trial blocks at 100% correct, and Maria reached the criterion in 15 trial blocks (60 trials). After Maria completed this phase, the experimenter returned to the DOR present + EC instruction to determine if her ability to label all of the relevant features of the stimuli had produced any collateral benefits in tacting. Again, no meaningful increases in performance were noted.

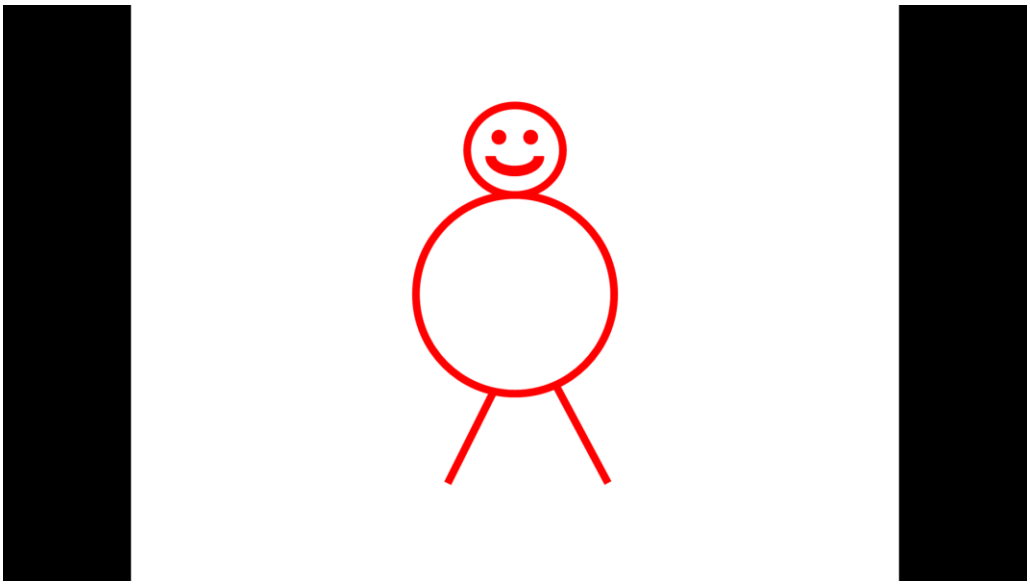

Figure 9. Screenshot of a slide used for color instruction of red for Maria.

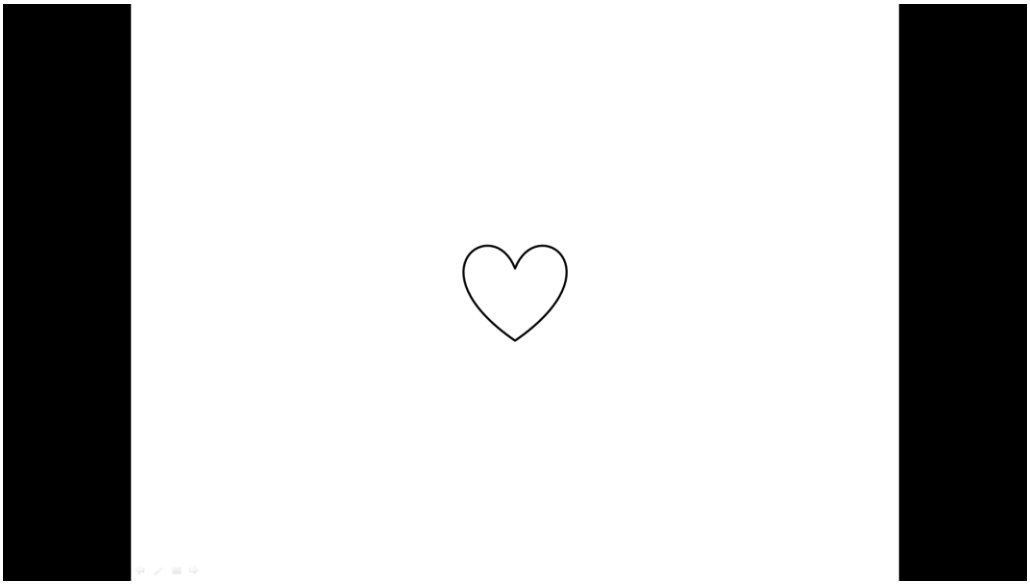

Figure 10. Screenshot of a slide used for shape instruction of heart for Maria.

Figure 11. Screenshot of a slide used for color instruction of blue for Maria.

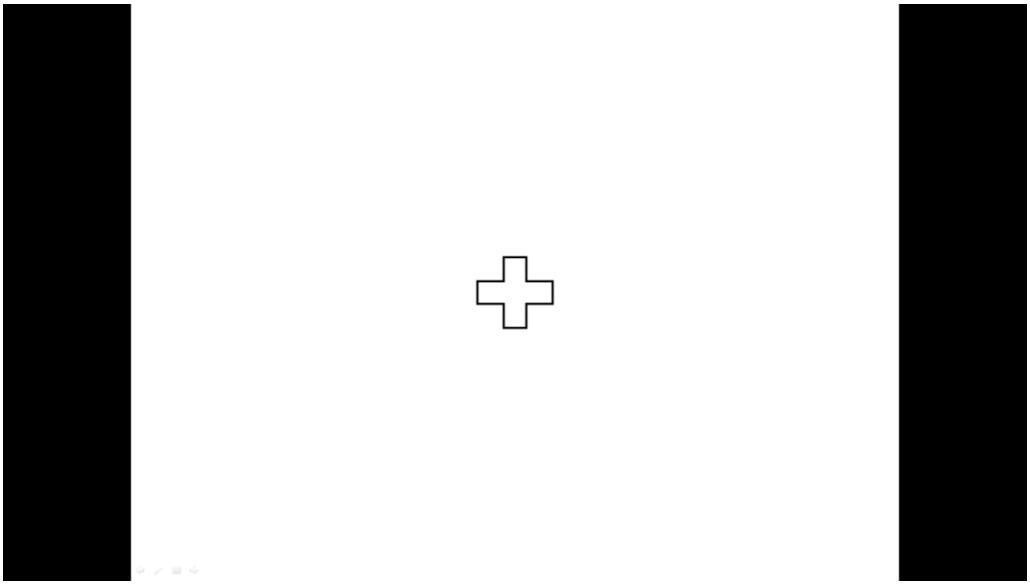

Figure 12. Screenshot of a slide used for shape instruction of plus for Maria.

Verbal DOR instruction. During the verbal DOR condition, participants were presented with the DOR absent slides because a matching response was no longer necessary. Participants were prompted to vocally state the relevant features of the stimuli. The experimenter asked "What shape is it?" and "What color is it?" in a semi-random order prior to each tact trial. Thus, on every single trial, participants were asked to state the color, shape, and then name of each

stimulus. The order of the questions varied across trials. When errors occurred, the experimenter said "Let's try again" and repeated the question. Therefore, participants had to respond correctly to both of the questions about the stimulus before they were asked to label it.

Song practice. Following the verbal DOR instruction, participants were taught to imitate a short song about each stimulus. During this condition, no experimental stimuli were presented. Participants were asked to listen to the experimenter sing a three word song and then to repeat it back to her. The four songs were basic descriptions of each stimulus; the color, the shape, and the name. For example, the experimenter sang "Blue, plus, prat!" while clapping her hands (once for each word) and then asked participants to repeat the song with the hand gestures. Each song was performed with a physically different hand gesture and a slightly different melody in order to enhance discernibility. Responses were scored as correct when participants produced the correct words of the song, in the correct order. Incorrect responses were followed by an additional trial to allow for a correct response to occur. Feedback was also provided on hand gestures ("try again, clap like this" while experimenter provided model); however, the accuracy of hand gestures was not considered toward a correct or incorrect song. Sessions consisted of randomly ordered trial blocks (four trials of the same song) and the mastery criterion required correct responding for ten trial blocks in a row for each of the four songs. One token was delivered for correct responses, and no tokens were delivered for incorrect responses.

DOR absent instruction. Once participants mastered the ability to reliably echo all of the songs without any stimuli present, the experimenter introduced the DOR absent condition again to assess if learning the songs had an effect on tact trial performance. Procedures in this condition were identical to the original DOR absent instruction in Phase 1.

Results and Discussion

Results of Phase 2 are shown in Figure 13. After implementation of the verbal DOR, Anna demonstrated small gains in acquisition (top panel of Figure 13). She responded around 50% correctly during the DOR present instruction, but her performance jumped to roughly 75% correct during the verbal DOR condition. An error analysis (Figure 14) indicates that during the verbal DOR condition, she mastered labeling Unk, and responded correctly to Zut fairly reliably (>70%) but still offered "Zut" responses inappropriately to the other stimuli (Qui and Rom) and she continued to have difficulty discriminating between Qui and Rom who share their red color in common. It is unknown whether continuing in this condition would have ultimately produced complete mastery. However, a similar number of trials were devoted to this procedure as to the two prior conditions. Maria (bottom panel of Figure 13) responded at 75% correct on two separate trial blocks (she had never responded above 50% per trial block prior to this condition) under the verbal DOR instruction. However, her overall performance in this condition was highly variable and even after 26 trial blocks, no reliable gains were apparent.

As indicated in the fourth phase of the top panel, song practice alone resulted in immediate acquisition for Anna, who reached the mastery criterion in eight trial blocks (340 trials over the entire study) during the final DOR absent condition. A brief probe was conducted following mastery in which the experimenter instructed Anna to finish the songs that the experimenter started (with no stimuli present). The experimenter sang the first two words of the song (the color and shape) and then paused. Anna's task was to complete the song by filling in the name of the stimulus. Anna performed 100% correctly across all songs over three trial blocks. These results suggest that the echoic instruction from the song practice intervention was sufficient to teach Anna the correct labels of the stimulus when given information about the

relevant stimulus features. That is, Anna had successfully learned the chain of verbal responses that related stimulus features to their names.

For Maria, no increases in acquisition were observed after song practice alone. The experimenter then embedded an additional prompt into the DOR absent instruction to encourage Maria to use her newly learned song skills to help her label the stimuli correctly. As each DOR absent slide was presented, Maria was instructed to "Sing your song". If Maria completed the song, the experimenter then asked her to label the stimulus. However, Maria was not successful at singing the song for the majority of trials (as indicated by the open circles on trial blocks 100-103 of the bottom panel). It appears that despite her previous mastery of labeling the shapes and color of the stimuli, as well as imitating the songs, Maria still could not produce the word "plus" and thus was unable to sing the song about "Prat" or "Ohmp". She struggled to sing the other two songs fluently as well. That is, unlike Anna, song practice had not resulted in Maria learning to sing the songs independently.

It is possible that both of the interventions in Phase 2 were ineffective for Maria because of the difficulty she had with labeling a plus sign (it appears to have been a completely novel stimulus to her at the time of the study whereas red, blue and heart were not). Although she received training with this task, she required over 15 trial blocks (60 trials) just to master labeling a plus sign and she continued to struggle with this task for the duration of Phase 2. Another possible explanation for Maria's poor performance during this phase is that her long history of practicing errors and of receiving reinforcement for a predominant response (which seems to have been under the control of presentation of any of the stimuli), interfered with any possible new learning about the stimuli. She never learned to sing the songs independently and it is unknown whether her continued participation in the steps to follow the song practice

intervention could have resulted in acquisition of the songs and subsequently increased performance on tact trials. An extra step was planned to teach Maria to sing the songs without an echoic prompt first (as Anna was able to do without any additional instruction), however she was withdrawn from the day care center she attended and no further sessions occurred.

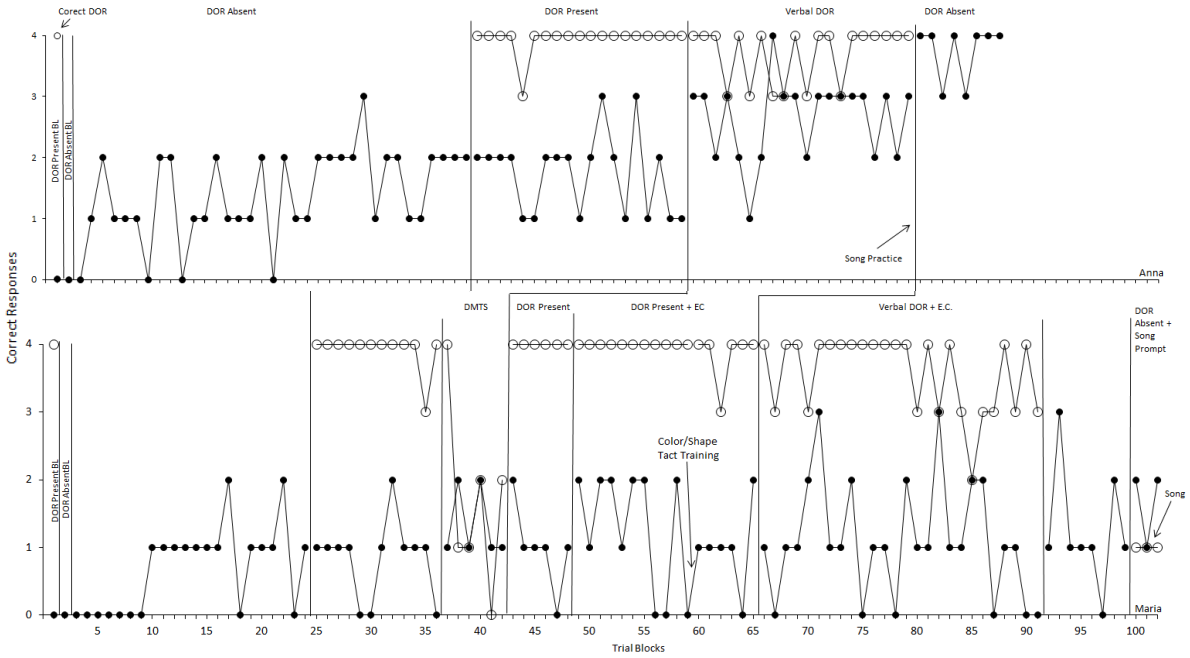

Figure 13. Phase 2 Results for Anna (beginning with the Verbal DOR condition) and Maria (beginning with the Color/shape tact training embedded in the DOR present + EC condition). The open circles represent correct DORs and the filled circles represent correct tacts.

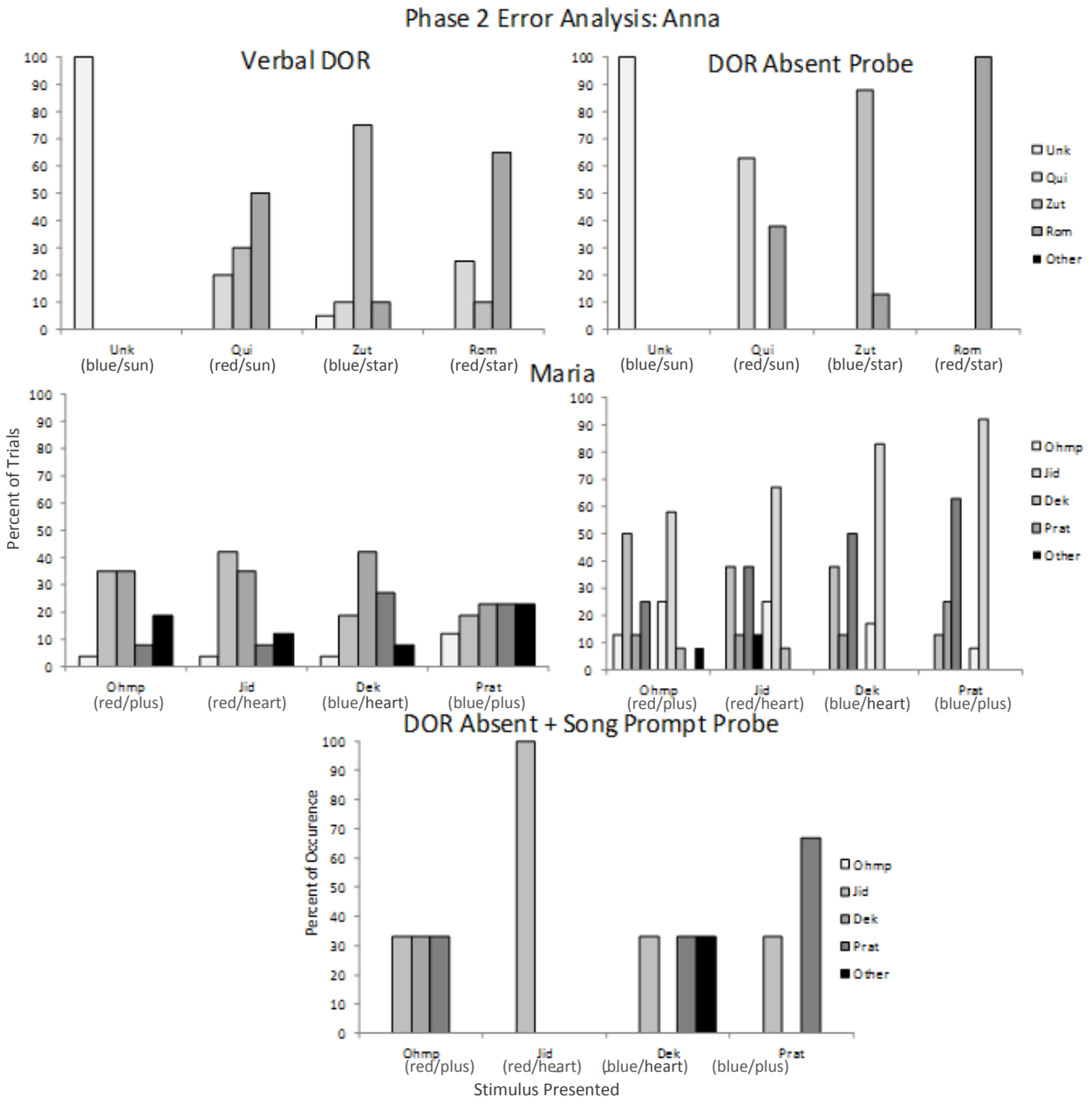

Figure 14. Phase 2 Error Analysis.

General Discussion

Overall, the initially proposed intervention which included a DOR component in the form of an IMTS requirement did not reliably enhance acquisition in Phase 1. Although it appears that the matching requirement put the participants into contact with the relevant features of the

stimuli (based on their mostly correct matching performance), it is evident that this alone did not ensure that all participants would be able to label the stimuli independently. Out of three participants, only Kenneth demonstrated immediate acquisition when the IMTS DOR was introduced. Although the increase in accuracy was abrupt and coincided completely with the implementation of the DOR, the possibility that it would have occurred without the intervention cannot be ruled out due to failure to replicate the effect with the other two participants. However, it is possible that the DOR was, in fact, an effective intervention for Kenneth but not for the other participants. Unlike Anna and Maria, Kenneth's baseline performance by the end of the DOR absent condition was of intermediate accuracy. He showed reliable discrimination of two of the compound stimuli and the color blue appeared to exert stimulus control over the response "Prat", but he did not correctly discriminate between the blue/heart (Dek) and the blue/plus (Prat) compounds. It is possible that a DOR component is most likely to increase response accuracy when stimulus control has already been established to some degree. In other words, perhaps the identity matching DOR enhances performance more so than it enhances acquisition, as has been demonstrated in most previous studies on the effects of a DOR on various MTS tasks (Constantine & Sidman, 1975; Gutowski, Geren, Stromer & Mackay, 1995; and Dube & McIllvane, 1999).

By contrast, Anna and Maria both demonstrated almost a complete lack of compound stimulus control over tacts at the time that the IMTS DOR intervention was introduced. Anna responded correctly to one stimulus compound, but indiscriminately to the other three, whereas Maria responded indiscriminately to all four stimuli. Taken together, these results could suggest that an identity-matching DOR enhances acquisition only in its final stages when compound stimulus control is partially developed but some discriminations between elements remain to be

established (e.g., Kenneth showed discriminated responding to red heart vs. red plus, and to the color red vs. the color blue, but did not yet discriminate blue heart vs. blue plus). Again, however, it is important to keep in mind that no experimental control could be demonstrated over the effect observed with Kenneth because the other participants did not respond to the DOR intervention in Phase 1.

In Phase 2, additional interventions were tested for Anna and Maria. The first intervention was a verbal DOR that required participants to say out loud the color and shape of the stimuli before labeling it. The verbal DOR intervention did not produce mastery for Anna or Maria; nonetheless, slight gains in acquisition were demonstrated for Anna during this condition. As Anna showed a similar pattern of responding to Kenneth's during the DOR absent condition in Phase 1; perhaps re-introducing the identity-matching DOR on top of the verbal DOR might have produced mastery, but this possibility was not tested.

Following the verbal DOR, precurrent instruction in the form of song practice was introduced. During this intervention, participants were taught to echo songs about the stimuli. The songs consisted of three-word melodies that described the physical attributes of each stimulus ("Blue, plus, Prat!") and each had a unique cadence and hand gesture that accompanied it. The goal of this intervention was to teach participants to emit a verbal chain independently that could function as precurrent behavior. In other words, if the participants could learn to sing the songs about the stimuli, these could function as a rule that would govern correct responses on tact trials. This intervention ultimately produced mastery for Anna but did not improve Maria's performance. This intervention was likely effective for Anna and not for Maria because only Anna learned to sing all four of the songs independently without explicit instruction. Although the experimenter did not note any overt applications of the rule/songs to the tact trials, it is

possible that Anna was covertly engaging in this response during the DOR absent condition in which she mastered the tacting task.

Anna's ability to easily acquire these intraverbals through a limited amount of echoic training alone warrants discussion. As mentioned above, the ability to emit the correct label after hearing the shape and color of the stimulus seems to require discriminations of compound verbal stimuli that are of similar complexity as the discriminations of the visual stimuli themselves. One possible explanation for this difference is that singing and the use of hand gestures provided extra-stimulus prompts which made it easier to respond correctly. In other words, saying "Prat" did not need to be tightly controlled by the blue/plus compound as it could be under the control of the melody and associated movements. One possible direction for research might include an investigation of acquisition under typical teaching methods to a condition similar to the song practice instruction.

Another possible explanation for Anna's ability to learn the songs is that this intervention could have been the beginning of an errorless teaching procedure because during the song practice, each response was prompted echoically. Perhaps preventing errors in this way made a difference for the establishment of appropriate stimulus control. Despite Anna's eventual mastery of the task, it is important to note that just as with Kenneth, increases in correct responding could have just coincided with the introduction of the verbal DOR and song practice and may not represent the potency of any particular intervention. Another recommendation for future research that arises from Anna's data would be to compare an errorless teaching procedure to instruction similar to that in the DOR absent condition to parse out the errorless teaching component from the song practice intervention.

Finally, Maria's failure to acquire the tacts despite numerous interventions deserves elaboration. It is unknown which intervention, if any, would have resulted in acquisition of this tact repertoire for Maria. However, a few aspects of the instructional procedures may have prevented her being successful. Firstly, during Phase 1 Maria picked up reinforcement for a predominant response ("Jid") whenever it happened to be the correct response (approximately every third time she said it), which may have interfered with learning the other names of the stimuli. Also, although the programmed consequences were supposed to provide differential reinforcement in the form of a higher magnitude reward for independent correct responses relative to prompted responses, it is possible that Maria did not discriminate the differential magnitude, and thus, there was no real incentive for her to respond correctly prior to the prompt in each trial . By the time Phase 2 was introduced, Maria had a lengthy history of making errors and this may have contributed to stagnation of tacting performance. Perhaps if the verbal DOR or the song practice were implemented sooner, Maria might have been more successful. Lastly, Maria was also one of a pair of twins and was born prematurely; both of these circumstances are known to lead to possible delays in development and could help explain why none of the interventions produced changes in acquisition.

It is possible that Maria would have acquired the target tacts if more effective instructional procedures had been used from the beginning, such as most-to-least prompting or blocked-trials procedures (e.g., Slocum, Miller, & Tiger, 2012) that may be appropriate for beginning learners. These procedures were not used in the present study, as its initial purpose was to examine a relatively simple way to remediate acquisition failures under instructional conditions that are more similar to those typically used for learners who have moved beyond the initial stages of an early intervention program (e.g., Leaf & McEachin, 1999) If Maria had been

available for continued participation in the study, additional interventions would have been implemented. The next planned intervention included teaching her to engage in the precurrent behavior (i.e., the song chains) correctly and without a prompt. If she had been unable to acquire the song chains, a blocked-trials procedure would have been implemented. This intervention would have scaled back the expectations of Maria by requiring her to learn to tact only one stimulus at a time. In a blocked-trials procedure a learner is given numerous trials of the same task over and over until some mastery criterion is met (Slocum, Miller & Tiger, 2012). Typically this method begins with massed trials of one instructional target to a criterion, followed by massed trials of a second target to the same criterion. Then, trial blocks for the first target are alternated with trial blocks for the second target. As long as accuracy is maintained, the number of consecutive trials for the same target is gradually reduced until accuracy is maintained when both targets are presented in a random sequence. Additional targets may then be added. Similar procedures have been found to be effective across a variety of skills and populations (Williams, Perez-Gonzalez & Quieriroz, 2005; Perez-Gonzalez & Williams, 2002; Saunders & Spradlin, 1989, 1990 & 1993).

Little research has focused on the arrangement of instructional trials to teach vocal labeling, or tacts, of novel stimuli. Despite the inconclusive results, this study suggests some avenues for future research. First, taken together, this study and the previous, unpublished study (Devine & Petursdottir, 2014) provide no evidence that procedures intended to enhance observation of the visual stimuli affect acquisition of vocal labels, at least for typically developing children. In the present study, acquisition clearly required attention to multiple features of each stimulus, and participants either acquired the labels fairly slowly (Brent and Gary) or did not acquire them under typical instructional conditions (Kenneth, Anna, and Maria).

However, DORs did not reliably bring about acquisition, perhaps suggesting that failures to observe the visual stimuli do not play a large role in failures to acquire their spoken labels. Kenneth's data, however, suggest the possibility that observation failures may play a role when performance stabilizes at intermediate accuracy. Stabilization at intermediate accuracy levels is a well-known phenomenon in the literature on discrimination learning for individuals with developmental delays (e.g., McIlvane, Kledaras, Stoddard, & Dube, 1990). Future research might examine whether adding a DOR requirement once accuracy reaches 50-75% will reliably produce a jump to 100% accuracy as it did for Kenneth. If so, it may suggest that a DOR requirement can be implemented as a "quick fix" when initial progress in an acquisition program is followed by failures to reach high accuracy levels.

Second, future research might examine the role that verbal processes play in children's acquisition of complex discriminations. In the present study, Anna mastered the target tacts only after being taught verbal response chains that potentially mediated her labeling responses, and Maria, who never mastered the tacts, had difficulty labeling one of the stimulus features (the plus sign). Future research might examine extent to which children who acquire labels of similar stimuli without intervention do so because they are labeling their features (e.g., by asking follow-up questions) and examine whether it is more efficient to teach discriminations of complex visual stimuli via verbal rules than through traditional discrimination training procedures.

Answers to these questions might help inform instructional strategies used in early intervention programs for children with autism or other developmental delays, and also have other potential applications, for example, in the development of educational software for children.

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ABSTRACT

DEVELOPING COMPOUND STIMULUS CONTROL OVER VOCAL TACTS

by Bailey Devine, M.S., 2012
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The present research examined whether an intervention with a DOR component could enhance acquisition of tacts following poor to intermediate performance under typical teaching procedures. Participants included five reportedly typically developing children between the ages of three and five years who attended local daycares. In Phase 1, the experimenter attempted to teach participants to label compound stimuli first using a DOR absent condition (designed to mimic standard tact instruction methods), and then using a DOR present condition which required participants to engage in an identity match to sample (IMTS) response. The results revealed that two participants mastered the task during the DOR absent phase and did not require the intervention, and that the DOR component did not enhance acquisition for 2/3 remaining participants. Phase 2 was conducted to bolster acquisition for the two participants who were unsuccessful in Phase 1. Interventions in Phase 2 included a verbal DOR as well as precurrent behavioral training. Results revealed that the precurrent response training enhanced acquisition for one participant and not the other. These findings suggest that DOR manipulations may not be an effective intervention to produce the necessary discrimination skills to master tacts of compound stimuli that share features in common.