Examining the utility of implementing stimulus-stimulus pairing as the first step to build and echoic repertoire

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EXAMINING THE UTILITY OF IMPLEMENTING STIMULUS-STIMULUS PAIRING AS THE FIRST STEP TO BUILD AN ECHOIC REPERTOIRE

by

Deva P. Carrion

A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Psychological and Quantitative Foundations in the Graduate College of The University of Iowa

August 2018

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CERTIFICATE OF APPROVAL

PH.D. THESIS

This is to certify that the Ph.D. thesis of

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has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Psychological and Quantitative Foundations at the August 2018 graduation.

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ABSTRACT

The present study investigated the use of stimulus-stimulus pairing (SSP) as the first step to build an echoic repertoire. We began with echoic probes to establish the child did not have the target sound in their echoic repertoire, then implemented SSP to increase the rate of the target vocalization, and systematically added direct reinforcement, and a delay, until the participant responded in 80% of trials; we then implemented echoic training. We conducted this procedure with 3 young children with autism. This procedure was effective for one of three participants, and her echoic learning history immediately generalized to other sounds. For the other two participants, SSP increased the rate of vocalizations; however, they did not respond in enough trials to move to echoic training before withdrawing from the study. This study provides preliminary evidence for the use of SSP as part of echoic training for children with limited functional communication.
PUBLIC ABSTRACT

The purpose of this study was to increase vocalizations in children with limited functional communication. To do this we paired specific vocalizations emitted by the experimenter with the participants highly preferred items or activities. In doing so, the sound itself becomes reinforcing, and in the absence of the experimenter emitting the sound the participant begins emitting the sound. Once the participant was emitting the sound more frequently, we directly reinforced this behavior. We then added a delay in the pairing procedure to allow the participant the opportunity to echo the sound, and we reinforced each time the participant did so.

We conducted this experiment with three participants, but only one completed all phases. For the one participant who completed the study, these procedures were effective in teaching her to echo sounds and words upon request. We did not obtain clinically significant levels of responding from the other two participants. One participant did not respond after two sounds were targeted, and the other withdrew before the first sound could be completely evaluated. Our results provide preliminary evidence in the effectiveness of this procedure to teach children the first step in building vocal language, echoing the sounds and words of others.
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CHAPTER ONE

INTRODUCTION

Autism Spectrum Disorder (ASD) is a pervasive developmental disorder characterized by social and communication impairments. Individuals with ASD often have restricted interests, and engage in repetitive patterns of behavior. Symptoms and behaviors associated with ASD are typically seen early in a child’s development, and a reliable diagnosis can be made as early as 2 years of age (National Research Council, 2001). According to the Center for Disease Control (CDC, 2018) the prevalence of ASD is increasing, indicating a need for more programs serving children with ASD. The most recent prevalence data from the CDC estimate that one in 59 children 8-years of age have an autism spectrum disorder. This number is steadily increasing from 1 in 150 in 2000, to the current prevalence of 1 in 59 in 2014 (Baio et al. 2018). ASD affects boys approximately 4 times more often than girls, a factor which has held relatively constant for several years now (Baio et al. 2018). In addition, most of the children with ASD had special education records (75-88%), and 31% are diagnosed with intellectual disability (Baio et al. 2018). This indicates that in addition to their social deficits, children with ASD often experience challenges that impact their learning and scores on cognitive assessments. Both learning and cognitive assessments require vocal or verbal responses, and when a child is unable to communicate this will greatly impact their abilities in these areas.

Part of the diagnostic criterion for ASD is “persistent deficits in social communication” (American Psychiatric Association, 2013, p. 50). These deficits can range from the inability to speak or communicate in any way, to difficulty in identifying and responding to social cues in a conversation. Woodka, Mathy, and Kalb (2013) evaluated the language development in children with ASD or severe language delay and found that 70% attained phrase speech, and only 47%
reached fluent speech at or after age 4. The children who did attain phrase or fluent speech were more likely to have higher nonverbal IQ and less social impairment (Woodka, Mathy, & Kalb, 2013). These data indicate that although many children with ASD demonstrate language delays, they do have the potential to make significant gains in language development. This is especially important as research indicates that children who acquire functional language by school age are more likely to have mild symptoms of ASD and better adaptive functioning as adults (Woodka, Mathy, & Kalb, 2013). Furthermore, language abilities in young children are correlated with social functioning, academic achievement, and psychiatric outcomes in adolescence and adulthood (Beitchman et al. 2001).

In another study, Anderson et al. (2007) evaluated the given diagnosis at age two and verbal ability by the age of nine. They found that for those diagnosed with an autism spectrum disorder (not including Pervasive Developmental Disorder-Not Otherwise Specified), nearly 29% of their sample did not develop vocal language by age nine, and another 24% used words but not sentences (Anderson et al., 2007). Although 29% of children did not acquire language by the age of 9, in another study Pickett, Pullara, O’Grady, and Gordon (2009) found that of 78 identified cases of late onset speech acquisition, nearly 21% of children acquired speech between the age of 9 and 13. Furthermore, they found that for children who did learn to speak, participation in behavior modification therapy was strongly correlated with verbal ability and “once they began speaking subsequent improvements were often quite rapid” (Pickett, Pullara, O’Grady, & Gordon, 2009, p. 19).

Interventions

Autism spectrum disorders affect how children interact with their family and community, how they learn, and their ability to care for themselves. Parents and service providers are
presented with an array of interventions without guidelines which are empirically supported and efficacious (Iovannone, Dunlap, Huber, & Kincaid, 2003). The National Research Council (NRC, 2001) created guidelines for evidence-based practice, which promote early identification and intervention, and family participation. Additionally, the NRC (2001) recommends educational services 25 hours a week, 12 months a year, where the child is engaged in developmentally appropriate educational activities that are systematically planned according to the goals set for that child. According to the NRC (2001), effective interventions focus on: spontaneous functional communication, social instruction in various settings, teaching play skills, and a proactive approach to problem behavior. Additionally, children with ASD should be integrated with typically developing peers when appropriate for that child’s educational goals (NRC, 2001).

The most well researched efficacious programs are based on the principles of applied behavioral analysis (Stahmer & Aarons, 2009). Applied behavioral analysis (ABA) primarily uses single subject design, but efficacy determinations made by clinicians outside of ABA and policy makers are largely based on randomized controlled trials. Furthermore, randomized control trials are seen as a late stage experimental design and should be used to compare the effects of interventions that have already been shown to be effective in single-subject studies (Smith, 2012).

Treatments in ABA can vary from highly structured, inclusive settings with a one-to-one student-to-teacher ratio to more naturalistic programs such as pivotal response training (PRT) and natural environment teaching (NET), which are more likely to be used in a typical school setting as they may be viewed as easier or more enjoyable to implement. Interventions may begin with the more rigid structure and progress to the natural environment once specific goals
have been reached. Students also display greater generalization of skills when taught using NET strategies (Stahmer & Aarons, 2009).

Rogers and Vismara (2008) refer to a “well-established” treatment as one that has manuals, has specific participant groups, and has either 2 independent group studies or at least nine single subject designs with a comparison to an alternative treatment or no treatment. Currently, the only intervention to meet the criteria for a “well-established” treatment is commonly referred to as the “Lovaas method” (Rogers & Vismara, 2008). The Lovaas method involves 20-40 hours per week of intensive behavioral intervention, typically of discrete trial teaching, beginning early in the child’s development. Early intensive behavioral intervention (EIBI) is synonymous with the “Lovass method” or the “Lovaas treatment approach.” Eldevik et al. (2009) defined EIBI as having the following elements: individualized comprehensive intervention, use ABA procedures to build skills, directed by at least one person with advanced training in ABA, goals and objectives are guided by typical developmental sequences, parents are trained to serve as co-therapists, intervention begins 1:1 with a gradual transition to working in groups, intervention begins in the home and is transitioned into the community and schools, and it is an intensive, year round intervention of 20-30 hours per week for a minimum of 2 years beginning at 3-4 years of age. Compared to a control group, students receiving EIBI are more likely to attain full-scale IQ (FSIQ) scores in the normal range and attend typical school (Rogers & Vismara, Lovaas, 1993). Lovaas (1993) reported that nearly 50% of children with ASD would reach this level of “recovery” after approximately 2 years of treatment.

One criticism of EIBI is that its effectiveness is determined due to the intensity of treatment. However, in a review of empirical studies of comprehensive treatments for children with ASD, Rogers and Vismara (2008) found that EIBI was more effective even when compared
to other treatments of similar intensity. One critical component is that intervention begins early, preferably as soon as a diagnosis of autism is suspected, because improvements of language, communication, FSIQ, and autism symptoms are most malleable in early childhood (Rogers & Vismara, 2008). Eldevik et al. (2009) conducted a meta-analysis of FSIQ scores and changes in adaptive behavior after EIBI and found large to moderate effect sizes for children receiving EIBI as compared to children receiving no intervention or eclectic provision.

**Early Identification**

Early identification of autism is imperative. The earlier a child is identified, the earlier they can start treatment, and research suggests that this will lead to greater improvements (e.g. MacDonald, et al. 2014). MacDonald et al. (2014) reported significant gains on the Early Skills Assessment toll after only one year of treatment, and children who started EIBI prior to 2-years of age had the greatest gains.

The majority of children diagnosed with ASD had documented developmental concerns in their health or education record by the age of three (CDC, 2018); this indicates that children with ASD are developmentally distinguishable from a very young age. In fact, Rowberry et al. (2015) conducted a longitudinal study on the development of 25 typically developing infants and 71 infants at high risk of developing autism based on having an older sibling with the diagnosis. The infants in the study were evaluated four times between the age of 12-months and 39-months. Results indicated that children who were later diagnosed with autism were rated more atypical in social and communication skills, but not in sensory and repetitive behaviors. Of all the factors evaluated in their study (e.g., social engagement, receptive communication, sensory processing, etc.) impaired vocal imitation was the one factor that correctly classified the majority of ASD cases with high specificity.
“Because language underlies most learning in the typical child, and is so conspicuously defective in children with autism, developing language skills is seen as a major goal of any training program” (Sundberg & Michael, 2001 p. 699).

**Language Development**

Mands, or requests for something, are the first verbal operant typically developing children acquire. A baby cries and a caregiver attends to their needs; even if they do not know exactly what the baby needs, a caregiver will run through potential reinforcers until the child stops crying. While a caregiver is attending to the infant’s needs, they are typically talking to the child. In doing so the caregiver’s voice is paired with conditioned or unconditioned reinforcers, such as food and warmth, and the caregiver’s voice becomes a conditioned reinforcer. Vocalizations from the child that are the most similar to their caregivers’ vocalizations then become automatically reinforcing, which leads to increased babbling. In other words, the sounds that are most similar to the caregiver’s sounds are reinforcing in and of themselves, and in the absence of social reinforcement these sounds increase in rate. Overtime the child’s vocalizations are reinforced in such a way that they are shaped into meaningful words, and eventually full sentences. Through natural contingencies of reinforcement, and sometimes punishment, a typically developing child develops an extensive verbal repertoire with skills in all verbal operants.

Additionally, typically developing individuals may learn one verbal operant for a stimulus and immediately generalize that learning to the other verbal operants. For example, a child may learn to echo the word “cookie” based on being fed their first cookie. Then be able to
immediately tact (or label) a picture of a cookie, mand (or ask) for cookie, and respond to the intraverbal question “what is your favorite food” with the response, “cookie.” Based on this observation in typical language development a traditional language perspective focuses on teaching tact and receptive language; however, children with limited language skills do not display this same generalization (Sundberg & Michael, 2001). This type of approach often leads to individuals who can receptively identify objects and label objects, but are still unable to emit requests for their basic needs and wants. Therefore, many teaching programs from a behavioral perspective initially focus on teaching mands (Sundberg & Michael, 2001).

In order to establish the speaker and listener roles that are essential for further development, training programs must first focus on teaching mands; this way a child learns that they can get what they want through specific verbal behavior (Sundberg & Michael, 2001). In other words, an individual learns the basic relationship of engaging in a specific response to obtain a specific reinforcer. By establishing these roles caregivers teach the child that he or she can obtain reinforcement for engaging in learned responses and they build a history of success, which can increase a child’s willingness to participate in learning sessions (Sundberg & Michael, 2001).

When first teaching mands, a program can focus on many different methods of communication: sign language, a picture exchange system, or an augmentative and alternative communication device. However, vocal speech should be pursued whenever possible. There are many advantages of vocal speech over other forms of communication: it is portable and always with the learner, adult speech sounds are paired with reinforcers and sounds themselves become reinforcers, and there is a “large speaking community that can easily model, prompt, and reinforce without special training” (Sundberg & Partington, 1998, p.51). However, vocal
communication does not come easily for all children, especially children with autism. Therefore, we must develop teaching programs to help these children learn to communicate in a way that will be the most beneficial for them, and the first choice should be vocal speech.

**The Importance of Echoics**

Skinner (1957) defines echoic behavior as “the simplest case in which verbal behavior is under the control of verbal stimuli, the response generates a sound-pattern similar to that of the stimulus” (p.55). Essentially, an echoic is when the listener echoes the verbal stimuli of the speaker, and does so without the response being under the control of other stimuli in the environment. In other words, the teacher tells the student, “Say ‘cat’” and the student says, “cat” in response.

The ability to echo verbal stimuli is an imperative skill for the teaching of other verbal operants. Throughout the literature on verbal behavior studies is the term echoic prompt (e.g., Vedora & Conant, 2015; Vedora, Meunier, & Mackay, 2009). An echoic prompt is when the teacher says the expected response and the learner’s echo of that response is reinforced. Over time the prompt is faded until the learner produces the learned response without the echoic prompt. For example, to teach a learner to tact a picture of a cat the teacher would hold up the picture and say, “What is it? Cat.” and the learner would be expected to echo the model, “Cat.” Over time the teacher may fade the prompt to a partial model, “What is it? Ca.” and eventually fade it out all together until the learner is responding correctly to just the prompt, “What is it?”

This is a traditional behavioral approach to teaching multiple verbal operants, but what if a child does not respond to these prompts?

Kodak and Clements (2009) evaluated the effects of concurrent echoic training to teach mands (i.e., requests) and tacts (i.e., labels). Their participant was a 4-year-old boy with autism.
who was not acquiring unprompted mands or tacts when they were taught in isolation. When these operants were taught in isolation the initial instruction was, “what is it?” with tacts and “what do you want?” for mands; and the boy only responded when presented with a model prompt. After showing that the child would only respond to a model prompt they then added echoic teaching trials before a mand or tact trial. This addition to his teaching protocol increased independent responding, whereas before his behavior was prompt dependent.

Ingersoll (2008) reviewed the importance of imitation training and its role in the development of social communication skills. In her review, Ingersoll sites many studies that indicate motor imitation training facilitates independent, spontaneous vocal imitation. This is an idea mentioned in many studies on vocal imitation, including stimulus-stimulus pairing, but very few studies directly looked at this relationship. Ross and Greer (2003) tested the effects of using generalized imitation training to teach vocal mands. They had five participants, young children without vocal speech for whom previous mand training was unsuccessful. The first step in their treatment was to teach ten large motor actions and small motor actions that involved the face (e.g. touch nose, purse lips). Once the participants mastered these motor imitation skills they added a vocal imitation that would serve as a mand as the last demand in a chain of imitation demands. Each chain started with two gross motor imitations, followed by two to three small motor imitations, and the final demand was the vocal imitation or mand. As the participants were successful they faded the motor imitations until the child was imitating vocalizations in isolation. This teaching method resulted in generalized vocal imitations for all participants.

**Practices for Teaching Vocal Imitation**

In applied behavior analysis there are three common procedures used when teaching children with speech delays new vocalizations: Standard Echoic Training (SET), mand training,
and Stimulus-Stimulus Pairing (SSP). SET involves presenting the antecedent stimulus and providing a reinforcer contingent on the child echoing the target vocalization. For example, the teacher would present the prompt, “Say, ‘bird’”, and give the learner a piece of his favorite snack contingent on the learner echoing the word, “bird.” Mand training is similar, except that the reinforcer matches the establishing operation and behavioral response. For example, a teacher might say, “If you want a chip then say, “chip.” Once the learner echoes, “chip” then he receives a chip. In contrast, SSP is a process by which stimulus A (vocalization) is paired with stimulus B (established/primary reinforcer) such that stimulus A becomes a conditioned reinforcer and production of the sound by the participant is said to be automatically reinforcing. With SSP the therapist emits the target sound and simultaneously or immediately delivers a reinforcer. For example, the therapist would simply say, “bird” and immediately deliver a preferred item. The delivery of the preferred item is not contingent on the listener’s behavior.

The biggest difference between these procedures is that in SSP the delivery of the reinforcer is not contingent on a response and there is no attempt to get the learner to respond immediately with the target sound. With SSP the goal is to increase the rate of the target sound after the learning trials, which should strengthen the vocal musculature and increase the future probability of vocalizations. In mand training and SET the vocal imitation is directly reinforced and reinforcement is contingent on the echoic response, while in the SSP procedure it is not. In fact, some studies control for adventitious reinforcement in order to isolate the vocalization under automatic reinforcement; in other words, if the participant echoes the target sound in the pairing trial reinforcement is withheld.

Previous studies have established the effectiveness of SSP in increasing subsequent unprompted emission of the target vocalization (e.g. Sundberg, Michael, Partington, & Sundberg
Still, other studies reported mixed results (e.g. Miguel, Carr, & Michael, 2002; Carroll & Klatt, 2008), and some showed no effect (Esch, Carr, & Michael, 2005; Normand & Knoll, 2006; Stock, Schulze, & Mirenda, 2008). Although several suggestions have been made, the literature is still unclear on what makes SSP effective for some, but not others. For example, Stock, Schulze, and Mirenda (2008) provide a list of procedural variables that warrant further investigation, and Shillingsburg et al. actually calculated effect sizes for a variety of variables using the research studies in the current literature. However, there is no research to date that clearly indicate procedural variables that would increase the likelihood of stimulus-stimulus pairing being effective.

**Establishing Stimulus-Stimulus Pairing as an Effective Procedure**

Sundberg, Michael, Partington, and Sundberg (1996) were the first to evaluate the effects of stimulus-stimulus pairing (SSP). Their study consisted of two experiments. The first experiment attempted to establish novel vocalizations (sounds, words, or phrases) with five children between 2- and 4-years-old; four participants had severe to moderate language delays, and one child was typically developing. Participants were individually exposed to three conditions within the session: pre-pairing, pairing, and post-pairing. Session length varied by participant, from 5-minutes to over 60-minutes. During the pre- and post-pairing conditions the participant had access to leisure items and there was no interaction with the therapist/experimenter, and data were collected on target and non-target vocalizations produced by the participants. During the pairing condition “a familiar adult approached the subject and emitted a specific vocal sound, word, or phrase (the targeted response) immediately followed by the delivery of an established form of reinforcement. The pairing procedure was repeated during a 1 to 2 minute period with approximately 15 pairings per minute” (Sundberg, Michael,
Partington, & Sundberg, 1996, p. 25). For all participants the stimulus-stimulus pairing procedure resulted in the unprompted emission of the target response in the post-pairing condition. Interestingly, for two of these participants, the vocalization emerged as a mand, and for one participant the vocalization was shaped into an echoic – an effect that generalized to new sounds.

The second experiment by Sundberg et al. (1996) was designed to investigate idiosyncratic variables observed in experiment one that may affect results – the participant’s emotional state, the duration of the pairing effect, and attempts to interrupt the paired response. The first procedure evaluated if the participants “current emotional state” affected the effectiveness of the pairing procedure. Sundberg et al. (1996) conducted the initial pairing session immediately after a period of time when the participant was silent. After the initial pairing session a post-pairing condition was conducted in which the participant did not emit the target sound. A second pairing condition was conducted with a new sound, which was again followed by a post-pairing condition. In the second post-pairing condition the second target vocalization was emitted, along with other vocalizations. A third and fourth pairing and post-pairing condition were conducted in a similar fashion. During the final three post-pairing conditions, the target sound from the previous pairing condition was observed, as well as other vocalizations. Additionally, in the second post-pairing condition the participant emitted the target sound in the first pairing condition. These data indicate the effectiveness of the pairing procedure, even when the emission of the sound is not immediately observed.

The second experiment by Sundberg et al. (1996) also examined the lasting effects of the pairing procedure by conducting extended pre- and post-pairing conditions. The procedures were similar to experiment one, “except the session was not terminated until the response ceased
to occur” (Sundberg et al., 1996, p. 32). Results indicated that the effects of the pairing procedure are temporary, with the unprompted vocalization of the target sound returning to the pre-pairing rate after 9 minutes.

The third procedure in experiment two attempted to disrupt the emission of a previously paired sound. To do this they paired a new phrase that was thought to be incompatible with an existing strong vocal-play response (i.e. new phrase “name that sound”, existing phrase “what sound is that”). However, the results indicated that disruption did not occur as the participant emitted both sounds independent of each other.

In a follow-up study Smith, Michael, and Sundberg (1996) evaluated the effect of the SSP procedure with two typically developing infants (age 11 and 14 months). The authors used similar procedures to Sundberg et al. (1996) regarding the pre- and post- conditions; however, the pairing conditions included a neutral, positive, and negative condition. In the neutral condition the experimenter emitted a target sound but there was no programmed consequence. In the negative condition the experimenter emitted a target sound and paired it with a verbal reprimand. Finally, in the positive condition the experimenter paired the target sound with tickles, or bubbles. Data indicated that no increase was observed in the neutral condition, immediate increases in the target sound and non-target sound were observed in the positive pairing condition, and an immediate decrease in all vocalizations was observed in the negative pairing condition. This study demonstrated that SSP procedures could increase vocalizations when paired with reinforcers, and could have the reverse effect if paired with punishers.

Yoon and Bennett (2000) replicated the Sundberg et al. (1996) study with three children between three- and four-years-old with severe developmental delays. None of the participants displayed speaker behavior or vocal imitation skills, and had limited listener skills. Yoon and
Bennett obtained results similar to Sundberg et al. (1996), with an observed increase in target sound production in the post-pairing condition, but again, these effects were temporary (between 3 and 11 minutes in the post-pairing condition). Additionally, two of their three participants emitted the target sound during the pairing procedure and may have experienced adventitious reinforcement for the emission of the target sound (i.e., delivery of the reinforcer coincided with the response, despite the reinforcer presentation not being contingent on the response). Therefore, a second experiment was conducted to compare SSP and standard echoic teaching (SET).

The second experiment retained two participants from experiment one and added one new participant with similar vocal behavior. The second experiment used a multiple baseline design across participants and evaluated the following conditions, listed in order: pre-echoic, echoic, post-echoic, pairing, and post-pairing. The pre- and post-echoic conditions were conducted similarly to the pre- and post-pairing conditions except that they were conducted before and after the echoic condition. In the echoic condition the experimenter emitted the vocal sound and access to the reinforcer was contingent on the participant echoing the target sound within 1-second of the experimenter. Approximately 36 trials were conducted in a 3-minute session. Of the three participants, only one emitted the target sound in the post-echoic condition. For all three participants, no target sound production was observed in the pre-echoic, echoic, or pairing conditions, and all three participants emitted the target sound in the post-pairing condition. Results of this study indicate that for children who are not yet able to engage in an echoic response, the SSP procedure is effective at increasing the rate of the target sound emission, even if the effect is only temporary.
Extending the Initial Research

Sundberg et al. (1996), Smith et al. (1996), and Yoon and Bennett (2000) produced studies that indicated that SSP was effective at increasing the spontaneous emission of the target sound immediately after pairing it with preferred items. Thus, the basis of the SSP procedure is to develop the increased emission of the target sound under automatic reinforcement. In other words, the child emits the sound in the absence of social reinforcers; therefore, we must assume that there is something about the sound itself that has taken on reinforcing properties. However, Yoon and Bennett (2000) reported that a participant emitted the sound during pairing trials, which may have resulted in adventitious reinforcement (i.e., inadvertently reinforcing the target sound emission when that was not the purpose of the procedures). Additionally, although the ratio of stimulus to reinforcement was one-to-one in all three studies, in the Smith et al. (1996) and Sundberg et al. (1996) studies the number of pairings was not constant across sessions or participants. Furthermore, all three studies only evaluated a single session for each participant, with the x-axis being minutes.

Miguel, Carr, and Michael (2002) sought to refine the methodology of the SSP procedure and evaluated the procedure with three boys with ASD. Miguel et al. (2002) increased the number of pairing sessions, had a constant number of pairing trials per session (20), presented the target sound five times per trial, and delivered the reinforcer between the third and fifth sound presentation. Results of the Miguel et al. (2002) study indicate that the SSP procedure immediately increased the spontaneous emission of the target sound for two of the participants, but, like previous studies, the results were temporary. Increases were not observed for the third participant, whose verbal repertoire was more extensive than the other two participants.
Rader et al. (2014) evaluated the effects of an “enhanced” SSP procedure on three children diagnosed with autism. Their methods during the SSP procedure were similar to the study conducted by Esch, Carr, and Grow (2009; described below under SSP to DR). Rader et al. (2014) compared the effects of a pairing condition and a control condition using multiple baseline across participants design. In the pairing condition they presented the sound three times, and then immediately delivered the preferred item. In the control condition they presented the target sound in a similar format, but did not deliver a preferred item. Additionally, they controlled for adventitious reinforcement in the SSP condition; if the participant emitted the target sound between the presentation of the sound and the delivery of the preferred item they implemented a 20-second correction delay. SSP resulted in the increased emission of the target sound for two of their three participants, and no increase was observed of the target sound in the control condition. The participant with null results engaged in tangibly maintained problem behavior during the treatment sessions, which the authors’ state may be the reason for null results. The results of this study further support the use of SSP to increase vocalizations for some children with limited functional vocal communication.

**SSP is Not Effective for All**

Of the fifteen studies currently published on SSP, three studies reported no observable increase in the target sound emission after conducting pairing trials. Esch, Carr, and Michael (2005) conducted a three-part study to evaluate the effect of SSP. In experiment 1 they evaluated the use of the SSP procedure immediately before SET trials. They began with echoic probe sessions, which were ten trials in duration. In each trial the experimenter presented the target vocal stimulus, and delivered a reinforcer contingent on the participant echoing the target sound. The next condition was similar, except that a pairing condition was conducted
immediately prior to the echoic trials. The pairing condition was also ten trials in duration; in each trial the experimenter presented the target sound three times and then delivered a preferred stimulus. Immediately after the pairing trials, ten echoic trials were conducted. For all three participants, “echoic responding did not increase following a stimulus-stimulus pairing procedure” (Esch, Carr, & Michael, 2005, p. 51).

In experiment 2 Esch, Carr, and Michael (2005) conducted a replication of Miguel, Carr, and Michael (2002) to evaluate if the “pairings did affect the frequency of post-pairing vocalizations.” Procedures were similar to the Miguel, Carr, and Michael (2002) study except that the target sound was presented at a sound to reinforcer ratio of 3:1 instead of 5:1. Two of the three participants from experiment one participated in experiment two, and no increase of the target vocalization was observed in the post-pairing observation. Finally, in experiment 3, Esch, Carr, and Michael (2005) directly reinforced spontaneous target sound production during 5-minute free play sessions. The direct reinforcement procedure resulted in increased target sound production for one participant as compared to baseline, but no effect was observed for the second participant. In summary, experiment one showed that conducting SSP trials immediately before echoic trials did not result in the acquisition of the target echoic, experiment two showed that SSP was not effective at increasing the target sound emission for 2 participants, and experiment three showed that direct reinforcement was effective at increasing the target sound emission for one of the two participants.

Normand and Knoll (2006) also attempted to replicate the Miguel, Carr, and Michael (2002) study. Procedures were similar except that the target sound was presented at a sound to reinforcer ratio of 7:1 instead of 5:1. Data indicate that SSP was ineffective at increasing the production of the target sound post-session. However, the authors did note that the target sounds
did appear to emerge as a mand for their participant. Additionally, it is important to note that this study used the highest sound to reinforcer ratio reported in the literature. During the pairing procedure they delivered the preferred item after the fourth presentation of the target sound; therefore, four presentations were paired with the restriction of the preferred item, and three presentations were actually paired with the item. Furthermore, their participant had already acquired several vocal mands and tacts, but had poor articulation. Results from other studies indicate that the SSP procedure is most effective with individuals with little to no functional vocal communication (e.g. Yoon & Feliciano, 2007).

The third study to report null results was conducted by Stock, Schulze, and Mirenda (2008). They compared the effect of SSP, SET, and a control condition on the emission of target sounds. Three children diagnosed with Autism Spectrum Disorder participated in their study; two were 4-years-old, and one was a 2-year-old. In all sessions the target sound was presented five times per trial. In the control condition the preferred item was delivered 10 seconds after the presentations of the target sound. In the SET condition the preferred item was delivered contingent on the participant emitting the target sound within 5-seconds of the experimenter. And in the SSP condition the experimenter delivered the preferred item between the second and fifth presentation of the target sound. The three conditions were evaluated in a multi-element design, with each condition including only one target sound. For two of the three participants the SET condition was more effective at evoking the emission of the target sound, however, the authors’ note that the sound was still not under echoic control. For one participant, SSP was the most effective, but like previous studies, this effect was brief.
**Procedural Variables**

SSP is sometimes effective at increasing the post-session emission of the target sound, but there are no clear predictive variables to indicate with whom, when, or how it is most likely to be effective. Stock, Schulze, and Mirenda (2008) provide a list of procedural variables that warrant further investigation: reinforcer type (i.e. edibles, tangibles, and social interaction), experimenter familiarity, manner of target sound presentation (e.g. vocal inflexion, facial expressions), latency from sound presentation to reinforcer, and the rate and density of pairings.

Miliotis et al. (2012) compared the ratio of sound presentations to reinforcer delivery. Four conditions were evaluated, two with a ratio of 1:1, and two with a ratio of 3:1, and each ratio had a pairing condition in which the preferred stimulus was presented immediately after the presentation of the target sound, and a control condition in which no preferred stimulus was delivered. Two participants were included in this study and both participants’ data indicated that the 1:1 pairing condition was the most effective at increasing target sound production.

Additionally, of the studies previously conducted that demonstrated an increase in target vocalizations, four used a 1:1 ratio (Smith et al., 1996; Sundberg et al., 1996; Yoon & Bennett, 2000; Yoon & Feliciano, 2007), and one used a 3:1 ratio (Esch, Carr, & Grow, 2009). Two studies reported mixed results and both employed a 5:1 ratio (Carroll & Klatt, 2008; Miguel et al. 2002). Furthermore, the studies that reported no observed increases of the target vocalization employed a ratio of 3:1 (Esch et al. 2005), 5:1 (Stock et al., 2008), or 7:1 (Normand & Knoll, 2006). Stock et al. (2008) suggest that higher ratios result in the target sound being more frequently paired with withholding of, rather than the delivery of, reinforcement. Miliotis et al. (2012) provide evidence of this suggestion.
Shillingsburg, Hollander, Yosick, Bowen, and Muskat (2015) conducted a review of the SSP studies published prior to 2015. Their review included 13 studies of SSP that were conducted with children with autism or developmental delays; one study was excluded because the participants were typically developing (i.e., Smith, Michael, & Sundberg, 1996). They calculated effect sizes based on the participant characteristics and procedural variations, when the information was available. They looked at the following participant characteristics: age, gender, diagnosis, and language skills. They evaluated the following procedural variations: whether the target sound was novel or current, the number of sounds per pairing, the number of pairing per minute, the type of pairing (simultaneous, after the sound, during the sound, or discrimination training), whether the experimenters controlled for adventitious reinforcement, and the type of preferred items used as reinforcers (i.e., edibles, toys, social/physical interaction). While some differences were observed in the effect sizes for these variables, the authors noted that “numerous procedural and participant variables overlapped, making it difficult to discern which variable(s) produced the results” (p. 229). There is not yet enough research to inform clinicians on the specific procedures that would be most effective or the learner characteristics that would predict positive results with SSP.

**SSP to Direct Reinforcement**

Overall, SSP has been shown to be an effective procedure for increasing the production of the target sound under certain conditions (e.g., 1:1 stimulus: reinforcer ratio, early learners; e.g., Sundberg, Michael, Partington, & Sundberg, 1996, Miliotis et al., 2012). However, this increase is only temporary; lasting only a few minutes after the SSP session is ended. Some studies have attempted to take advantage of this temporary increase by implementing a direct
The goal of SSP is to increase vocalizations, but the clinical utility is to move towards establishing stimulus control over the vocalization. Simply put, it is not enough to get a child saying a word, but we eventually need to teach that child to use his or her words functionally. Some studies on SSP note that they observed their participants use the target vocalization as a mand, even when SSP was not effective overall. For example, Normand, and Knoll (2006) reported that SSP was ineffective overall; however, during two sessions the participant reached for the preferred items used in the pairing sessions and repeated the target sound as if manding for the item.

Yoon and Feliciano (2007) specifically evaluated the utility of SSP and the subsequent acquisition of mands with six children between 2- and 5-years-old. The participants varied in their verbal repertoires and data indicated that of these participants, verbal forms (i.e., echoic, tacts, mands, and intraverbals) had an inverse relationship with vocal play (all other vocalizations). Two target sounds were selected for each participant and each sound was assigned to one of two condition sequences. In one condition sequence, post-pairing, the session began with a pre-pairing, followed by pairing, and post-pairing. In the second condition sequence, the mand sequence, the session began with pre-pairing, then pairing, and ended with direct reinforcement. The pre- and post-pairing condition procedures were identical to those described in Sundberg et al. (1996). The pre-pairing condition was 5 minutes in duration, followed by the pairing condition. The pairing condition was similar to the procedures in Sundberg et al. (1996) except that the condition was 3-minutes in duration for each participant, with approximately 12 pairings per minute. In the direct reinforcement condition the reinforcer
was present to indicate availability to the participant. The reinforcer was delivered contingent on the participant emitting the target sound, however, no prompts were provided.

Results of Yoon and Feliciano’s (2007) study were mixed. Two of the six participants displayed an increase in the target vocalization in both the post-pairing and direct reinforcement condition. Three participants emitted the target sound during the pairing condition, of whom two did not emit the target sound during post-pairing or direct reinforcement, and one only emitted the target sound in the post-pairing condition. The final participant did not emit the target sounds during any condition. Interestingly, the two participants with the most effective results displayed the highest rate of vocal play and lowest frequency of verbal forms. In contrast, the three participants who displayed the most verbal forms in baseline did not emit the target sounds in either the post-pairing or direct reinforcement condition. This indicates that SSP may be most effective with children who have not yet developed any vocal forms and have high rates of vocal play.

Ward, Osnes, and Partington (2007) also evaluated the effect of implementing direct reinforcement in conjunction with SSP. They evaluated the utility of differential reinforcement and implementing a delay in the SSP procedure to obtain stimulus control of the target vocalization. They conducted their study with two participants, both of whom did not have an echoic repertoire. SSP sessions were approximately ten minutes in duration, and the sound to reinforcer ratio was 1:1. They began with pairing sessions in which there was no delay between the experimenters/teachers emission of the target sound and the delivery of the reinforcer. During this time they also directly reinforced all emissions of the target sound. They then systematically introduced a delay between the presentation of the sound and the delivery of the reinforcer to give the participant the opportunity to engage in an echoic response, and reinforced
the participants’ emission of the target sound as an overgeneralized mand. In the final step in their study they differentially reinforced echoic responses over spontaneous mands or vocal play. Although this study did not isolate the automatic reinforcement component of SSP, they effectively made subtle changes over time to shape sound into mand, and finally shaped the sound into an echoic response. This study effectively displayed the clinical utility of SSP along with direct reinforcement procedures to develop an echoic repertoire.

In a similar study, Carroll and Klatt (2008) evaluated the effect of the SSP with two young children (age 22- and 23-months) diagnosed with autism, then implemented multiple transfer procedures to obtain echoic control of the sound. Two sounds were evaluated for each participant, a novel sound that the experimenters had not previously heard the participant emit, and a known sound which was the “lowest frequency on-syllable vocalization produced by participants throughout observations” (Carroll, & Klatt, 2008, p. 137). During the SSP condition the target sound was presented five times, with the preferred item delivered between the second and fifth presentation. For one participant increases were not observed for known target sound, and the novel sound remained in baseline. However, after ten SSP sessions a direct reinforcement condition was introduced. The participant immediately responded to the direct reinforcement contingencies, accurately echoing the target sound in 75-100% of trials. However, no increases of the target sounds were observed in the post-session condition.

For the second participant, SSP was effective for the known target, but not the novel target. Carroll and Klatt (2008) then evaluated several variations of direct reinforcement procedures to obtain echoic control of the known target sound. Five direct reinforcement procedures were evaluated. The first consisted of five SSP trials immediately followed by twenty direct reinforcement trials where the participant had 5-seconds to respond in order to
access her preferred item. The second procedure included only the twenty direct reinforcement trials. Neither the first nor the second procedure was effective at increasing target sound production. The third procedure consisted of providing reinforcement contingent on the participant emitting the target sound at any time during the session. If the participant emitted the sound the therapist immediately delivered the reinforcer while presenting the target sound. Mild increases were observed in the third condition. In the fourth procedure the participant was exposed to fifteen direct reinforcement trials and delivery of the preferred stimulus was contingent on the production of any vocalization within 15-seconds of the antecedent stimuli. After four sessions a 5-second delay to reinforcement was implemented for non-target vocalizations. Moderate increases were observed in this phase. Finally, the greatest increases were observed in the fifth condition, which was similar to the second condition except that the reinforcer was delivered if the participant emitted the target sound within 15-seconds of the experimenter.

However, this process was displayed with only one participant for one sound and five different procedures were used before echoic control was achieved. Therefore, we cannot be certain if it was the last procedure that was responsible for the behavior change, or if it is the progression from the first procedure to the fifth that is necessary for the behavior change.

Data from Carroll and Klatt’s study (2008) provide evidence for the effectiveness of SSP and the subsequent acquisition of echoics. However, they did not evaluate additional sounds once the desired effects were observed for one sound. At the end of the study, each participant learned to emit one sound under echoic control. Future studies should evaluate if this effect is generalized in that new echoics can immediately be taught or if SSP still needs to occur prior to SET. Furthermore, for the first participant who did not display increases in the production of the
target sound in post-pairing sessions the SET procedure was immediately effective. Therefore, in the Carroll and Klatt study it is unknown whether SSP had any effect on the subsequent echoic condition, but Esch, Carr, and Grow (2009) evaluated just that.

Esch, Carr, and Grow (2009) evaluated the effects of SSP and “the subsequent effects of programmed reinforcement of pairing-induced speech responses” (p. 236). In their SSP condition the target sound was presented three times and the participants preferred stimulus was immediately presented. For all participants SSP resulted in increases of the target vocalization. Following the observed increases in the SSP condition a programmed reinforcement (i.e., direct reinforcement) condition was introduced. The purpose of this condition was to strengthen the target response. Prior to each echoic session, SSP trials were conducted until the participant emitted the target response. Following the initial response, the echoic session began and the participant was presented with his/her preferred item contingent on emitting the target sound. For all participants, the direct reinforcement procedure resulted in the maintained or increased rate of target sound production as compared to the SSP condition.

A Comparison of SSP and SET

While the research indicates that using SSP followed by direct reinforcement procedures to obtain echoics and mands can be effective, it can also be a long and arduous process. In comparison, echoic or vocal imitation training, when successful, is very clear and direct. It is also a much more common procedure. Therefore, a comparison of the two procedures is warranted. Two studies have compared the effects of echoic teaching and SSP, and a third study compared SSP to operant discrimination training.

Yoon and Bennett (2000) were the first to publish a study comparing the effects of SSP and SET (described previously in “Establishing SSP as an Effective Procedure”). Their study
included two experiments; in the first they displayed SSP as an effective procedure in increasing the emission of the target sound, and in the second they evaluated the effects of SET and SSP both within sessions and post-sessions. The results of their study indicated that SET did not increase the emission of the target sound either within session or post-session; however, SSP did result in an increase of the independent emission of the target sound in the post-session interval. However, this study only evaluated the immediate effects, with the x-axis in minutes. They did not investigate the cumulative effects of multiple sessions.

Lepper, Petursdottir, Esch (2013) compared operant discrimination training (ODT), SSP, and a control condition. Their dependent variable was the emission of the target sound during the inter-trial interval; a 10-15-second interval that began 5-seconds after the presentation of the sound and the initiation of the next trial. They compared the effects of these conditions on their dependent variable in an alternating treatments design, and each session included 20 trials. In the operant discrimination training (ODT) sessions the experimenter taught the participant to engage in an arbitrary response (i.e. arm raise) upon the presentation of a target sound. This was essentially taught as a receptive command; the experimenter presented a target sound, the participant was expected to engage in the response, and reinforcement was contingent on the motor response. In the SSP condition the experimenter presented the sound three times, and delivered a reinforcer simultaneously with the third sound presentation. Finally, in the control condition the experimenter presented the sound, waited 20-seconds, and then delivered a preferred item. Each condition had a target sound and a non-target sound. In the sessions with the non-target sound the experimenter presented the target sound and then the ITI interval followed. There were no programmed consequences for the emission of the non-target vocalization.
Results of this study indicated that ODT and SSP were equally effective at increasing the emission of the target sound during the ITI. No increase was observed in the target or non-target sounds in the control condition, or in the non-target sounds in the ODT or SSP conditions. These data indicate that ODT and SSP may both be effective at increasing target sound emissions when paired with reinforcers.

The most recent study to evaluate SSP was conducted by Cividini-Motta, Scharrer, and Ahern (2016). Their study compared the teaching effects of vocal imitation training (VIT), a mand model procedure (MM), and SSP on echoic responding. The goal of their study was to assess these procedures to determine the most effective procedure for teaching echoics/vocal imitation for each participant. Cividini-Motta, Scharrer, and Ahern (2016) used an alternating treatments design and conducted functional analysis probes to determine if the target vocalization was under echoic control. Their study included 6 participants, between 7- and 17-years-old, with developmental delays. The results of their study indicated that VIT or MM was most effective for half of their participants, one participant acquired the echoic response in all three conditions equally, SSP was most effective for one participant, and the final participant did not obtain any echoic response. Interestingly, the one participant with SSP as the most effective procedure was also the only participant without any echoic skills at the onset of the study. It is also important to note that the SSP procedure was the only condition in which the emission of the target response was not reinforced as the experimenters opted to control for adventitious reinforcement. Additionally, the model frequency to reinforcer ratio in the SSP condition was 5:1, while the ratio in both the MM and VIT procedure was 1:1. This study evaluated the effects of these conditions on echoic responding, while placing any echoic responding in the SSP condition on extinction and reinforcing echoic responding in the VIT and MM conditions.
Therefore, it is not surprising that participants were more likely to learn the echoic response in the MM and VIT conditions as compared to the SSP condition.

**Automatic to Social Reinforcement**

The procedures for SSP are focused on pairing the sound with highly preferred items such that the sound itself becomes under the control of automatic reinforcement. In other words, there is something about the sound itself that is reinforcing, and in the absences of others saying it, the child emits the sound himself. If this is true, then each emission of the target sound should increase the future probability of emission of that sound; in other words, the rate of target sound emission should continually increase.

However, it is not enough to just increase the rate of target sound production. The end goal for any clinician should be to teach the child to use these vocalizations with purpose. To do this a clinician should provide social reinforcement for target sounds and obtain functional control over the sound, whether as a mand or as an echoic. The child should learn that the emission of specific sounds under certain conditions lead to specific reinforcement. To do this, a clinician might increase vocalizations using SSP (i.e., automatic reinforcement), and then differentially reinforce the vocalization as a mand or echoic (i.e., provide social reinforcement) until the vocalization comes under the control of the social contingencies (i.e., the child emits the sound when prompted [echoic] or when their motivation is for the specific item [mand]).

**Present Study**

There are currently only 15 research studies and one review article published on SSP. Most studies directly evaluate if SSP is effective at increasing the spontaneous emission of the target sound immediately after the pairing trials, and for the most part, the answer is yes. Twelve of the fourteen studies indicated increased rates in target sound emission for at least some of their
participants. However, not all studies reported positive results. One stated possibility for these different findings is the child’s existing repertoire. Yoon and Feliciano (2007) evaluated the effect of SSP and found that the largest effect of the SSP procedure was seen with the participants who had the least functional communication skills (e.g., mand, tact, intraverbal) and highest vocal play or babbling. It was suggested that learners with fewer verbal skills would experience the most effective results (e.g., Stock, et al. 2008, Yoon & Feliciano, 2007). If this is true, the increase in vocalizations under echoic control should decrease the subsequent effectiveness of the SSP procedure. Future studies should include more participants, with varying levels of verbal skills to determine the accuracy of such suggestions.

Even when SSP is effective at increasing the target sound, the clinical utility of this procedure should ultimately lead to an echoic response. Skinner (1957) describes an echoic response as the most basic verbal response. Echoic skills are imperative in teaching additional vocal forms, because once a child is able to echo then other types of language can then be prompted. Seven studies compared the effects of SSP to other procedures used to increase vocalization. Four of these studies implemented SSP first, followed by a direct reinforcement procedure to eventually obtain stimulus control over the target vocalization. All four of these studies reported success in obtaining the target sound either as a mand or as an echoic. However, these four studies differed in the procedures used, the order of conditions, and the experimental design; this leaves the clinician unclear as to the exact methods to use.

The current study is designed to evaluate the utility of implementing SSP, along with a transfer protocol, to build an echoic repertoire. Specifically, this study should answer the following research questions:
1. Will stimulus-stimulus pairing increase the rate per minute of the target sound? And if so, to what level?

2. Will adding direct reinforcement change the level, stability, or trend of the post-pairing interval?

3. Does adding a delay to the pairing session result in increased advantageous reinforcement?

4. Once we observe adventitious reinforcement in at least 50% of trials, for 3 consecutive sessions, can we then transfer this sound to echoic control?

5. ULTIMATE QUESTION: Can we use this protocol as a way to transfer a sound from automatic reinforcement to social reinforcement?
CHAPTER THREE

METHODS

Participants and Setting

Three participants were recruited from clinics located at the Center for Disabilities and Development (CDD). All three participants have a diagnosis of autism and have less than ten vocalizations under instructional control (i.e. will repeat a sound or word when prompted).

Suzie was a 4-year, 5-month old female with a history of challenging behavior (socially maintained self-injury), and was able to echo some sounds or words at the start of the study (i.e. her name, eww, and cookie); however, she responded inconsistently. Suzie also attended a skill acquisition clinic for 12 hours per week, and preschool for approximately 6 hours per week. She also had a history of speech therapy with limited speech acquisition. Suzie was also able to imitate basic motor actions such as clapping hands and knocking on the table.

Bruce was a 2-year, 5-month old male. At the start of the study Bruce was reported to use the vocalization, “yeah” functionally, however he did not echo the word when prompted. He did not display the ability to imitate motor actions. Bruce attended a daycare and was on a waitlist for a local early intervention clinic. He did not receive any additional therapeutic services prior to or during his enrollment in the study.

Joey was a 3-year, 5-month old male who obtained his autism diagnosis one week prior to enrolling in the study. Joey was reported to say mom, and dada. However, these vocalizations were not observed during his participation. Joey did not display the ability to imitate motor actions. Joey did not attend any day care or preschool, he stayed home under the care of his mother. Joey was on a waitlist for a local early intervention clinic. Additionally,
Joey received speech services for one hour per week during his participation in this study. The onset of these services coincided with the onset of his participation.

Sessions were conducted twice per week for approximately 60 minutes each visit. A table of the number of sessions per visit can be found in Table 2. All of Joey’s, and Suzie’s sessions were conducted in a standard therapy room at the Center for Disabilities and Development (CDD). Bruce’s sessions were conducted once a week in a treatment room at the CDD, and once per week via Skype. During the Skype sessions Bruce’s father conducted all procedures with coaching from the experimenter. The therapy room contained a table and chairs, a video recording device, and the participants’ preferred toys. Additionally, the examiner kept edibles, which served as reinforcers.

**Response Definitions**

Responses of interest across all phases were *target sounds* emitted by the participant. Target sounds were defined as any vocalization that is acoustically or phonologically similar to the target sound, and matched the sample sound in number of phonemes. For example, if the target sound was “buh”, then “bah” or “beh” was also accepted as a target vocalization, but “bat” or “bin” was not counted as a target sound. Giggles, squeals, cough, or sneezes were not counted towards sound production.

**Data Collection and Interobserver Agreement**

A trained observer collected data on target sounds using pencil-paper data collection. Each occurrence of target sound production was recorded within each trial and during the post-trials interval. Frequency data on target sounds in the post-trials intervals were converted to rate per minute for analysis. Within trials, data were collected on target responses for each trial conducted. These data were converted into “percent of trials” for analysis.
Two independent, trained observers recorded session data for 30% of Suzie’s sessions, 32% of Bruce’s sessions, and 0% of Joey’s sessions due to early termination of participation. Interobserver agreement was calculated using the number of agreements divided by the number of agreements plus disagreements and converted to a percentage. For the post-trials data, agreements were calculated as total agreement for each minute for the frequency of both target sounds. For example, if one observer recorded eight target sounds in a one-minute interval and the second observer recorded 10 target sounds for that same interval, then 80% agreement was achieved for that minute. The minute-by-minute agreement for the three-minute recording period was averaged to obtain the average agreement for that session. For the trial-by-trial data, both observers were required to agree on the occurrence of a response and whether the response was the target response for agreement to occur. Interobserver agreement was then calculated by dividing the number of agreements by the number of agreements plus disagreements, resulting in a ratio and converted into a percentage. Interobserver agreement was 100% for Suzie for both within trials and post-trials. Interobserver agreement for Bruce’s targets “yeah” and “di” was 100% and 92% for the post-trials data, and 97% and 100% for the within trials data, respectively.

Procedures

General Procedures. Prior to implementing the experimental treatment procedures, a paired-choice preference assessment and a free play observation were conducted to determine the potential reinforcers and target vocalizations to be used during treatment. We then conducted echoic probes on at least four target sounds to determine if the participant would echo the sounds when prompted. These data informed which target sound we would implement treatment with first; the sound with the greatest percent of trials with correct responding would be introduced into treatment first. We then implemented treatment with one target sound. Treatment included
five phases: baseline, stimulus-stimulus pairing (SSP), stimulus-stimulus pairing with direct reinforcement (SSP+DR), and stimulus-stimulus pairing delay with direct reinforcement (SSP Delay +DR), and standard echoic teaching (SET). After we completed the five treatment phases we repeated the echoic probes to determine if learning occurred.

Additionally, if we completed the four treatment phases with two target sounds and the participant did not meet criteria for conducting echoic probes after ten SSP delay +DR sessions then we implemented motor imitation training. This was completed with only one participant, as he was the only participant to meet this criteria.

**Pre-experimental Assessments.** Prior to the onset of the study caregivers were asked to provide a list of the child’s most preferred edible items. These items were then evaluated for preference using a paired-choice preference assessment (Fisher et al., 1992). Eight to ten items were included in the preference assessment for each child. Each item was paired once with every other item until all possible pairs were assessed. Each pair was presented to the participant and he or she was asked to choose one. The four to five items selected most were considered higher preferred and served as potential reinforcers throughout the assessment. These items were alternated within sessions based on the participants indicating response (e.g., reaching for an item, pointing to it, etc.).

Following preference assessments, a twenty to thirty minute free play observation was conducted. During this free play observation the participant had free access to toys and attention from the experimenter and his or her caregivers. The purpose of the free play session was to observe the participant’s frequency and range of sounds in vocal play. The sounds with the highest frequency were selected for treatment.
**Echoic Probes.** After the preference assessment and free play observation were conducted we then conducted echoic probes for a minimum of four target sounds. The purpose of these probes was to establish if the participant had the target vocalization in their echoic repertoire. To do this, one probe session was conducted for each target sound.

Each session consisted of 10 trials, and trial-by-trial data were collected on the participant’s vocal productions. Each trial began with the experimenter approaching the participant, with a preferred item in view of the participant, and delivering the prompt, “say,” followed by the target sound. If the participant echoed the target sound within 5 seconds of the prompt then it was considered a correct response and the experimenter immediately delivered the reinforcer and brief praise. The next trial was initiated after the participant consumed the reinforcer. If the participant did not echo the target sound within 5 seconds of the prompt then the next trial was initiated. To prevent frustration in the case that the participant was not able to echo after two to four trials, an easy demand that was in the participant’s repertoire (e.g. high five, motor imitation) was delivered so that the participant could engage in a response that we could reinforce.

If the participant echoed the target sound for 50% of trials or more then another probe session would be conducted. This would be continued until the data stabilized, indicating a need for treatment, or the participant met mastery criteria. However, this did not occur with our current participants. Mastery criteria are defined as three consecutive sessions with correct responding in 80% of trials or greater. We then initiated treatment with the target sound with the highest percent of trials with correct responding that did not meet mastery criteria.

**Baseline.** The purpose of this condition was to provide the participant with the same exposure to a target sound and the same access to preferred items as in the treatment conditions
(below), without pairing the sound with the presentation or removal of a preferred item, or directly reinforcing production of the target sound. Each baseline session was approximately seven minutes in total duration and consisted of 10 trials each (each trial lasted approximately 45-seconds). At the beginning of each trial the experimenter approached the participant and presented the target sound. After 15 seconds a preferred item was delivered independent of the participant’s vocal behavior. The participant was permitted access to the item for another 15 seconds, or in the case of an edible, until the item was fully consumed. Fifteen seconds after the item was removed or consumed a new trial was initiated; this continued until 10 trials were completed. Immediately after the 10 trials a 3-minute free play observation was conducted. During this time the participant had free access to attention from the experimenter and his or her caregiver, and moderately preferred toys.

Here is an example description of a baseline session, for the target sound, “up,” using an M&M as the preferred item. The experimenter approached the participant, if not already engaged in play with him or her, and said, “up.” The experimenter then continued to engage in child directed play. Once 15-seconds passed the experimenter then gave the child an M&M. Once the M&M was consumed the experimenter waited another 15-seconds, thus concluding that trial, and initiated the next trial. This was repeated until 10 trials were complete. A timer was then set for 3-minutes. During this time the experimenter engaged in child led play with the participant.

Baseline sessions were conducted until we observed stability in the data for a minimum of three sessions, until the data indicated a decreasing trend, or until a maximum of 6 sessions were conducted.
Stimulus-stimulus pairing (SSP). The purpose of this condition was to evaluate if pairing reinforcers with a target sound would affect the rate of target sound production in the three-minute post-trial observation. Access to the reinforcer was not contingent on the participant’s vocal behavior and was delivered simultaneously with the emission of target sound by the experimenter. Each session consisted of 10 trials followed by a 3-minute free play interval, and ranged in total duration from approximately 5-minutes to 10-minutes.

At the beginning of each trial the experimenter approached the participant, presented the target sound once while simultaneously delivering the preferred item or activity. If the preferred item for a specific trial was an activity then the participant accessed the activity for approximately 10-seconds, the experimenter then paused, waited for an indicating response from the participant (e.g., reaching, initiating eye contact, pointing), then initiated the next trial (i.e., repeating this sequence). If the preferred item was an edible then the participant was delivered a small piece of the edible and permitted to consume it. The experimenter then waited for an indicating response and initiated the next trial. If the participant did not emit an indicating response within 30-seconds the experimenter presented other potential reinforcers and waited for the participant to indicate he/she wanted an item. This procedure was repeated until 10 trials were complete. A timer was then set for 3-minutes. During this time the experimenter engaged in child led play with the participant and there were no programmed consequences for emission of the target sound.

Here is an example description of a baseline session, for the target sound, “wee,” using an M&M as the initial reinforcer. Trial 1: The experimenter approached the participant, if not already engaged in play with him or her, said, “wee” while simultaneously placing an M&M in the participant’s mouth or hand. Trial 2: The experimenter then held the M&Ms out, in view of
the participant. The participant immediately reached for the M&Ms. The experimenter took one out of the bag, and said “wee” while simultaneously placing the M&M in the participant’s mouth or hand. Trial 3: The experimenter again held the M&Ms out, in view of the participant. However, after 30-seconds the participant showed no interest in the M&Ms; therefore, the experimenter held out chips and marshmallows. The participant smiled when he saw the marshmallows and looked at the experimenter. The experimenter then pulled out a mini marshmallow and said, “wee” while simultaneously placing the marshmallow in the participant’s mouth or hand. This was repeated until ten trials were completed. A timer was then set for 3-minutes. During this 3-minute interval the experimenter engaged in child led play with the participant and did not provide a consequence if the participant emitted the target sound.

SSP sessions were conducted until one of three things was observed: 1) we observed stability in the data for a minimum of three sessions, 2) we observed a decreasing trend, or 3) until a maximum of 5 sessions were conducted with variable rates in the post-trials interval.

**Stimulus-stimulus pairing with direct reinforcement (SSP+DR).** The purpose of the SSP+DR condition was to evaluate the effect of direct reinforcement on the 3-minute post-trials observation; this condition is the first step to transitioning the vocalization from automatic reinforcement to social reinforcement. We hypothesized it would be necessary to obtain high and stable rates of the target sound in the post-trials interval. Each session consisted of 10 trials followed by a 3-minute free play interval with direct reinforcement and ranged in total duration from approximately 5-minutes to 10-minutes.

In the SSP+DR condition the trial-by-trial procedures were identical to the SSP condition. However, in the 3-minute post-trials observation we reinforced each emission of the target sound by the participant with access to a preferred item or activity and praise. In other
words, if the participant emitted the target sound at any time during this 3-minute interval the experimenter immediately delivered praise and the participant’s high-preferred item or activity.

For example, for the target sound, “wee.” The experimenter conducted the trials as described above for the SSP condition. A timer was then set for 3-minutes. During this 3-minute interval the experimenter engaged in child led play with the participant. When the participant emitted the target sound, “wee,” the experimenter immediately and enthusiastically said, “Great job saying ‘wee!’” and gave the participant an M&M. If the participant said, “wee” again the experimenter responded in the same manner.

SSP+DR sessions were conducted until one of three things was observed: 1) stability in the data for a minimum of three sessions, 2) until the participant echoed the target sound in 30% of trials for 2 sessions, or 3) until a maximum of 10 sessions were conducted with no effect on the participant’s emission of the target sound.

**Stimulus-stimulus pairing with delay + direct reinforcement (SSP Delay +DR).** The purpose of this condition was to provide the participant with the opportunity to echo the target vocalization within session to increase the probability of advantageous reinforcement. These session trials were similar to the SSP trials except the reinforcer delivery was delayed instead of simultaneous, which gave the participant the opportunity to echo the target sound. Additionally, each target sound emission was also reinforced during the 3-minute post-trials interval. This is the second step to transitioning the vocalization from automatic reinforcement to social reinforcement. Each session consisted of 10 trials followed by a 3-minute post-trials interval, and ranged in total duration from approximately 5-minutes to 10-minutes.

At the beginning of each trial the experimenter approached the participant, presented the target sound, and waited 5-seconds before delivering the reinforcer. If the participant echoed the
target sound at any time within the delay the reinforcer was immediately delivered. However, access to the reinforcer was not yet contingent; therefore, the participant would still receive the preferred item even if he or she did not echo the target sound. All other procedures were identical to the SSP+DR condition.

Here is an example using the target sound, “buh”, and fries as the reinforcer. Trial 1: The experimenter approached the participant, if not already engaged in play with him or her, said, “buh” with the French fry in the participants view, but just out of reach. The experimenter then silently counted to five, and then gave the participant the fry. Trial 2: After the participant indicated she wanted another French fry, the experimenter took one out and said, “buh” with the fry in the participants view but out of reach. This time the participant echoed “buh” within a few seconds and the experimenter immediately gave the participant the fry and said, “Great job saying ‘buh’!” This was repeated until 10 trials were complete. A timer was then set for 3-minutes; during this time the experimenter engaged in child directed play with the participant and reinforced each emission of the target sound as described in SSP+DR.

SSP Delay+DR sessions were conducted until one of two things occurred: 1) we observed 3 consecutive sessions with correct responding in at least 50% of trials, in which case we then implemented echoic sessions, or 2) a minimum of 5 sessions were conducted and no change was observed or a decreasing trend was observed, in which case we then reversed to the last condition with the highest post-trial rates or attempted the treatment procedures with a new sound.

**Standard echoic teaching (SET).** The purpose of the SET sessions was to gain stimulus control of the target sound by directly reinforcing the production of the target sound when prompted and only when prompted. Each session was 10-trials in length, and ranged from 2-
minutes to 5-minutes in duration. The trial-by-trial procedures for this condition are identical to the echoic probes; however, we only conducted these sessions with one target sound for multiple sessions, whereas the echoic probe sessions alternated sounds across sessions. Additionally, these sessions were conducted until the participant met mastery criteria. Then, once a target vocalization was mastered we repeated the treatment process, beginning with echoic probes for the remaining target sounds.

**Experimental Design**

The effects of SSP, SSP+DR, SSP Delay+DR, and SET on target sounds were assessed using a non-concurrent multiple probe design across sounds and within participants. Stimulus-stimulus pairing has been shown, with mixed results, to briefly increase the emission of a target sound. This brief increase is thought to occur due to automatic reinforcement. However, this effect is not sustained over time. In this study, we implemented stimulus-stimulus pairing, then used specific procedures designed to transfer the sound from automatic reinforcement to social reinforcement.

Target sounds were sounds in the participants’ vocal repertoire, as established by the initial free play observation, but not yet in the participant’s echoic repertoire. Echoic probes were first implemented to establish that the participant was not able to repeat the target sound when asked. Data from the echoic probes determined the order in which the sounds were introduced into treatment, and we implemented treatment with one sound at a time. We then implemented the treatment sequence to increase the rate of the target sound emitted by the participant, and then systematically shape the response into an echoic. The sound was first shaped up as an overgeneralized mand in the SSP+DR and SSP delay+DR conditions. Then we obtained stimulus control and shaped the sound up as an echoic in the SET condition. Once the
participant mastered one sound as an echoic we conducted echoic probes with the remaining
target sounds to determine if this skill generalized or if treatment procedures needed to be
repeated with another target sound.

This study examined this specific sequence as a means to build an echoic repertoire, and
whether learning history would generalize to other sounds as an echoic or if the sequence needed
to be repeated. Additionally, if the sequence did need to be repeated, we wanted to know how
many echoics needed to be in the participant’s repertoire before the effects did generalize.
CHAPTER FOUR

RESULTS

Pre-Experimental Assessments

The Behavioral Language Assessment Form (BLAF). We used The Behavioral Language Assessment Form (BLAF) to assess the participants’ verbal repertoires at intake. The BLAF is an informant assessment typically completed by primary caregivers. Informants were asked to rate their child’s skills in 12 areas: cooperation, requesting, motor imitation, vocal play, vocal imitation, match to sample, receptive, labeling, receptive by function, feature, and class, conversation skills, letters and numbers, and social interaction. Caregivers are asked to select a category in which their child falls; generally, 1 indicates the child does not yet have the skill, a 2 through 4 indicate increasing levels of the skill, and a 5 indicates the child has multiple responses in the area. The BLAF is designed to identify the initial areas for a language intervention program to target teaching. See Appendix I for a full review of the BLAF.

Notably, all participants were given a score of 3 in the area of vocal play, which indicated that they “vocalized many speech sounds with varied intonations” (BLAF, pg. 2). A score of 4 or 5 would indicate that they used words in their vocal play. Bruce and Joey were both given a score of 1 in the area of vocal imitation, which indicates that they were not able to repeat any sounds or words when asked. Suzie, however, was given a score of 2 in the area of vocal imitation, indicating that she would repeat a few specific sounds or words (BLAF pg. 2).

Furthermore, all participants were also scored at a level 2 in the area of motor imitation, indicating that they could imitate a few motor actions. However, Suzie was the only participant who displayed this skill during her participation in the study.
Suzie was rated as a level 2 or level 3 learner overall. Her mother rated her as a level 4 learner in the areas of cooperation with adults and matching to sample. She rated her has having relative strengths, as indicated by a score of 3, in the following areas: vocal play, receptive, and social interaction. Her greatest weaknesses, as indicated by a score of 1, were in the areas of labeling and receptive by function, feature, and class. She was given a score of 2 in all other areas.

Bruce was rated as a level 1 or level 2 learner overall. However, there was variability across scores. He was rated has having relative weaknesses (with a score of 1) in the following areas: requesting, vocal imitation, matching to sample, labeling, receptive by function, feature, and class, conversation skills, and letters and numbers. Bruce was rated as a level 3 for vocal play only. He was rated at a level 2 in all other areas.

Joey was rated as a level 1 learner overall. However, his mother did rate him as a level 3 for vocal play, and a level 2 for cooperation, requesting, motor imitation, and receptive skills. This indicates that Joey was a very early learner, with a strengths in these areas.

Preference assessment. Prior to the initiation of experimental procedures we conducted a paired choice preference assessment (Fisher et al., 1992). We first asked caregivers to report eight to ten preferred edible items and eight to ten preferred leisure items/toys. We then assessed these items to determine which the child was most likely to choose. The items selected most often are presumed to be the most preferred and therefore the most likely to function as reinforceers.

Suzie’s mother identified ten edible items and ten leisure items for the preference assessment. The highest preferred edible items were M&Ms, peanut butter M&Ms, Kit Kats, chocolate chip cookies, and pretzels (see Figure 1 for Suzie’s graphed preference assessment.
results). Additionally, during the experimental procedures Suzie’s mother indicated that Suzie also liked McDonald’s French fries. Therefore, French fries were later introduced into the array of preferred edibles that she could indicate that she wanted. Anecdotally, Suzie displayed strong motivation for the fries; reaching for them with eye contact as soon as they were in view. Additionally, leisure items were available in the session room throughout the intervention.

Bruce’s caregivers reported ten edible and ten leisure items for the preference assessment. However, the leisure items were their personal items from home which could not be assessed. Any leisure items that were comparable that we had in clinic were placed in the session room and Bruce had free access to these items throughout the sessions (i.e., blocks, toys with music and lights, bubbles). Results of the edible paired choice preference assessment indicated that grapes, Doritos, M&Ms, yogurt melts, and cheese puffs were his highest preferred items (see Figure 2 for Bruce’s graphed preference assessment results). These items were present throughout sessions and delivered according to the condition’s contingency.

Joey’s caregivers reported 8 edible items for assessment. They reported that he had very little interest in leisure items at the time. The only item he would engage with was the iPad. However, we opted not to use it in the preference assessment because interaction with the iPad limits social interaction and Bruce displayed problem behavior when the iPad was removed. We included various toys in the session room that Joey was able to engage with at his leisure. His highest preferred items were Oreos, Reece’s Puffs cereal, Crunch Berries cereal, and Reece’s Pieces (see Figure 3 for Joey’s graphed preference assessment results). These items were present throughout sessions and delivered according to the condition’s contingency.
Experimental Procedures

Participant 1 – Suzie. Suzie’s graph can be viewed in Figure 4. The sounds emitted most frequently in the free play observation were: “ahh” (0.55rpm), “we” (0.33rpm), “zuu” (0.22rpm), “buh” (0.17rpm), and “guh” (0.17rpm). The first sound we introduced into treatment was the target sound “ahh,” which is not depicted in the graph. We immediately observed Suzie engage in high rates of problem behavior and negative vocalizations with the introduction of this sound; therefore, we ended treatment with this sound and introduced treatment with a second sound, “we.”

In the echoic probe condition Suzie responded correctly in one out of the 10 trials, indicating the greatest likelihood that this sound was in her repertoire and could be shaped in to an echoic. In baseline Suzie did not respond to the presentation of the sound in the first two sessions, but by the third baseline session she emitted the target sound in two out of the ten trials. However, we did not observe an increase in the spontaneous emission of the target sound in the post-session interval. We then implemented stimulus-stimulus pairing, and observed a steep increase in the rate of the target sound emission in the post-session interval, while responding within session never increased beyond baseline levels. We then implemented the third condition, stimulus-stimulus pairing followed by direct reinforcement. By the third session of this condition we observed the emission of the target sound increase to a rate per minute of 12 in the post-session interval and she echoed the target sound in 40% of trials. Therefore, we moved to the fourth treatment phase, stimulus-stimulus pairing with a delay, followed by direct reinforcement. This condition allows for the greatest opportunity for the participant to engage in echoic responding, and reinforcement for echoic responding, without access to preferred items.
being contingent yet. By the third session Suzie was engaging in an echoic response in 90% of the trials.

We then moved to the standard echoic teaching condition, in which access to preferred items was contingent on Suzie echoing the target sound. Suzie immediately responded correctly in 100% of trials across four sessions. We then conducted echoic probes on the three remaining target sounds and Suzie’s responding generalized to the new target sounds. Suzie met mastery criteria for the three additional targets within three sessions, which were conducted across two visits. We then coached Suzie’s mother and primary caregiver to conduct echoic sessions to determine if the skill would generalize to other therapists. Suzie again met mastery criteria within four sessions with her mother acting as therapist.

**Participant 2 – Bruce.** Bruce’s graph can be viewed in Figure 5. The sounds emitted most frequently during the free play observation were “yeah” (0.7rpm), “di” (2.26rpm), and “bah” (0.56rpm). During the echoic probes the target sound “yeah” was the only sound he responded to, and only in one of 10 trials. Therefore, we initiated treatment with this sound first. During baseline sessions Bruce’s post-session emission of the target sound decreased from an initial rate per minute of 1.5 to zero across three sessions. We then implemented stimulus-stimulus pairing with the target sound. Once SSP was implemented we observed the target sound increase, but not much beyond the highest rate observed in baseline before returning to zero. We then implemented stimulus-stimulus pairing followed by direct reinforcement. Bruce’s responding in the post-session interval remained low and variable, while the within session responding remained at zero. We then implemented stimulus-stimulus pairing with a delay to the preferred item, followed by a direct reinforcement interval. The post-session
emission of the target sound decreased in this condition, while the within session responding increased – but not to socially significant levels. In this phase we also switched therapists, from the experimenter to the caregiver. When the experimenter was conducting session the participant was attending to the father consistently, while his attending to the experimenter was fleeting. We hypothesized that the increased attending might assist in the acquisition of the echoic. While modest increases were observed, in both the within session responding and the post-session rate of spontaneous emission, the responding remained low and did not reach socially significant levels.

We then implemented the treatment sequence with a second sound, with the father conducting all sessions with coaching from the experimenter. We began with echoic probes to establish that the target sound was not in Bruce’s repertoire. Bruce did not respond to any of the echoic probes across two sessions. We then implemented the baseline condition, in which the sound was emitted by the therapist at the same rate as in the SSP condition, but it was neither paired with preferred items nor was access to preferred items contingent on the participant emitting the target sound. Bruce did not emit the target sound during the baseline condition. We then implemented SSP condition. In this condition we observed an immediate increase in the post session condition, but only for one session before the post session rate returned to zero. Additionally, no increase was observed in the within session trials.

Once we established that SSP alone would not result in a sustained increase in the target sound we moved to SSP+DR. We immediately observed an increase from a rate per minute (rpm) of zero in baseline to .33rpm in SSP+DR. By the sixth session of SSP+DR we observed the greatest rpm in the post-session condition at 3.33. This rate was high, but variable, and we observed an overall decreasing trend. Additionally, throughout all sessions we did not observe
Bruce emit the target sound within session. Therefore, we then implemented SSP Delay + DR. The aim in this condition was to create the greatest opportunity to reinforce the emission of the target sound. In the first session Bruce emitted the target sound in one of the ten trials; this was the only occurrence of within session emission that was observed for this target sound. Additionally, post-session emission remained low.

We then attempted to teach Bruce motor imitation skills under the hypothesis that motor imitation skills may be a prerequisite skill for vocal imitation skills. We implemented errorless teaching procedures in a mass trial format, focusing solely on motor imitation. After several weeks, and multiple visits, Bruce was not able to master motor imitation skills and his caregivers opted to withdraw from the study.

Participant 3 – Joey. Joey’s results can be viewed in Figure 6. During the free play observation the highest emitted phonemes were “mmm” (1.23rpm), “eee” (0.43rpm), “eye” (0.2rpm), and “guh” (0.1rpm). During echoic probes Joey responded to the echoic “mmm” in three of ten trials. We then implemented baseline sessions and Joey’s responding decreased. No emission of the target sound was observed post-session and responded within session only once. We then implemented SSP and observed a slight increase in the post-session emission of the target sound. We then implemented SSP+DR, which is where we observed the greatest increase in the emission of the target sound, but much like with Bruce, this increase was short-lived and after the fourth session of this condition we observed an overall decreasing trend in the rest of this phase. However, we also observed an increase in the within session emission of the target sound from zero in baseline and SSP to a high of 30% of trials in SSP+DR. However, responding was variable, and returned to zero in the final two SSP+DR sessions. We then
implemented SSP Delay + DR where we continued to observe variable responding. Joey’s caregiver then decided to withdraw from the study.
CHAPTER FIVE

DISCUSSION

Our first research question was, “will stimulus-stimulus pairing increase the rate per minute of the target sound? And if so, to what level?” All participants displayed an increase in the target sound following stimulus-stimulus pairing procedures as compared to baseline. However, the level change was variable across participants. For Bruce and Joey the level change was small and did not sustain across sessions. Additionally, the participant with the greatest observed level increase was also the participant for whom the transfer procedures were effective.

Our second research question was, “will adding direct reinforcement change the level, stability, or trend of the post-pairing interval?” Results indicate that this was the condition in which the greatest increases were observed for all participants, and again, the greatest increase was observed with the only participant for whom the transfer procedures were effective.

Our third research question was, “does adding a delay to the pairing session result in increased advantageous reinforcement?” This is where the deviation across participants is strongest. With Joey and Bruce, no change was observed within trials or in the post-pairing condition from the SSP+DR condition to the SSP Delay + DR condition. However, with Suzie we immediately observed a decrease in the post-trials condition while maintaining her within trials response rate. Furthermore, by the third session she echoed the target response in 100% of the trials. Suzie was also the only participant with whom we conducted SET sessions with, as she was the only participant who met criteria to conduct these sessions. For Suzie, this transfer procedure was effective and she immediately echoed the target response in 100% of the trials and this effect generalized to her caregiver.
The ultimate question of this study was, “Can we use this protocol as a way to transfer a sound from automatic reinforcement to social reinforcement?” For one of our three participants the answer was yes, but it was not effective for the other two. However, that does not mean that stimulus-stimulus pairing was ineffective. We observed increases in the spontaneous emission of target sounds for all participants in our test conditions as compared to baseline. However, these increases were variable and did not increase to clinically significant levels for Joey or Bruce (i.e., a level high enough to provide sufficient opportunities for adventitious reinforcement). Also, for the one participant for whom it was effective, this effect quickly generalized to all other sounds and to other teachers. This indicates that once the connection is made that she can echo vocal stimuli to obtain reinforcement she was able to echo various vocal stimuli. In other words, once Suzie learned the contingencies for access to social reinforcers she readily emitted the target response.

Based on these results our biggest remaining question is, why this procedure was for Suzie but not Bruce or Joey. There are several possible reasons (discussed further in limitations). First, Suzie was attending an early intensive behavioral clinic for 12.5 hours per week, pre-school that used the STAR curriculum (a curriculum based on the principles of ABA) for 6 hours a week, and she had a history of services from a Speech-language pathologist (SLP). These services taught her the foundational skills of how to learn, including joint attention, cooperation with adults, and working for a period of time for a reinforcer. These services had also attempted to teach Suzie echoics and vocal mands without success. In comparison, Bruce and Joey had not yet received any such services and had not yet been exposed to any formal teaching. Their attention to the experimenter was qualitatively different than Suzie’s. Suzie looked at the experimenter during these procedures and she was also socially engaged. She
enjoyed playing with the experimenter, and her most powerful reinforcers revealed to be social interactions such as tickles, being chased, and being picked up. Another possible reinforcer, as noted by Suzie’s mother, was the facial animation exhibited by the experimenter.

Although the results of this study indicate that this procedure was only effective for one of three participants, it was still effective for one participant, and for her these results are huge. As part of this study we showed that we were able to use stimulus-stimulus pairing as the first step to building an echoic repertoire and her learning very quickly generalized to other sounds. After the completion of this study the experimenter continued to work with her to teach mands and other echoics, which she quickly acquired (i.e., emitted spontaneous mands within 10 trials) and displayed discrimination. Her mother now reports that she is “echoing everything” and she now emits spontaneous speech including “I love you” to her mother. Clinicians at her EI clinic also report significant reductions in self-injurious behavior, which used to occur several times per appointment and within one month of completion of this study rates reduced to at or near zero.

**Connecting to Previous Research**

Currently, there are relatively few studies published on stimulus-stimulus pairing for increasing vocalizations. There is only one other study that evaluated cumulative effects of stimulus-stimulus pairing as the first step to teaching an echoic or mand (Ward, Osnes, Partington, 2007). This study is one of the few in the literature to examine the effects of stimulus-stimulus pairing across multiple sessions within participants. The initial studies on stimulus-stimulus pairing evaluated the effects across one session, with the x-axis being minutes (i.e., Sundberg, Michael, Partington, & Sundberg, 1996; Smith, Michael, & Sundberg, 1996; Yoon & Bennett 2000). However, this quickly shifted to evaluating the cumulative effects of
multiple sessions (e.g., Miguel, Carr, & Michael, 2002; Esch, Carr, & Michael, 2005; Normand & Knoll, 2006). This study adds to the literature in examining the cumulative effects of stimulus-stimulus pairing, and the possibility of shaping vocalizations into echoic responses for some participants based upon Suzie’s results.

Like previous studies, this study yielded mixed results (e.g., Miguel, Carr, & Michael, 2002; Carroll & Klatt, 2008). However, unlike previous studies, we evaluated multiple procedures to determine which might be the most promising in establishing a vocal repertoire. The only other study that attempted this was by Ward, Osnes, and Partington (2007). They conducted a clinical study in which they used stimulus-stimulus pairing to increase vocalizations. They then reinforced the target vocalization as a generalized mand, and then shaped it into an echoic. However, they did not systematically evaluate their procedures in specific stages, and therefore could not identify which procedure resulted in the greatest increase. In fact, their graph only contained phase labels to indicate baseline and pairing. This made it difficult to interpret at what point the reinforcement shifted to social contingencies versus automatic reinforcement. However, their reported results were clinically promising, as they were the first to shape a vocalization into a mand or echoic response.

In contrast, this study systematically evaluated the effects of stimulus-stimulus pairing under three separate conditions: 1) stimulus-stimulus pairing with immediate access to reinforcers followed by a brief interval in which no programmed consequences were in place, 2) stimulus-stimulus pairing with immediate access to reinforcers followed by a brief interval in which emission of the target sounds was socially reinforced, and 3) stimulus-stimulus pairing with delayed access to reinforcers followed by a brief interval in which emission of the target sounds was socially reinforced. The evaluation of these three separate conditions informs
clinical practice, in that we learned that the condition in which access to reinforcers is immediate and then emission of the target sound is directly reinforced results in the greatest increase in the spontaneous emission of the target sound for all participants. However, this effect was not observed for all sounds. For example, Bruce’s data indicate no difference between SSP and SSP+DR for one target sound, and for the second target sound we observed higher rates of responding in the SSP+DR condition as compared to the SSP condition (and all other conditions).

Previous studies attempted to isolate the automatic reinforcement properties of the pairing procedure, and many implemented a changeover delay to avoid advantageous reinforcement. The logic behind this procedure is that if the emission of the target sound was automatically reinforcing, then we may not need as much social intervention to increase vocalizations. In other words, if emitting vocalizations was reinforcing in and of itself, then the child would independently and spontaneously emit ever increasing rates of vocalizations. However, the literature suggests otherwise as several studies have suggested that the increased emission of target sounds following stimulus-stimulus pairing is brief, lasting only a few minutes. The results of this study indicated that the greatest increase in the spontaneous emission of the target sound was observed in the SSP+DR condition. This tells clinicians that it is likely to be more beneficial to combine stimulus-stimulus pairing with direct reinforcement procedures to achieve the highest possible rates of vocalizations.

The most promising result of this study is that for the participant with whom the transfer procedures were effective, she immediately generalized this learning to other sounds and other teachers (i.e., her mother). Furthermore, after the study concluded, she rapidly learned new words as mands (i.e., “fry” for French fry, “push” to be pushed while on a swing, “up” to be
picked up, and “spin” to be spun around whether in someone’s arms or in a spin chair). These words were acquired using mand training. We first paired the word with the item, and then added a delay once she began to echo the target response. Suzie displayed discrimination with these mands as well, she did not mand for items that were not present, and consumed the reinforcer when presented with two choices followed by a mand. Furthermore, her mother has reported since that Suzie is “echoing everything now.” This sets the stage for Suzie to learn other verbal operants through her pre-school and intensive ABA services.

Limitations

This study has several limitations. First, the study was only conducted with 3 participants and two of the participants withdrew before all study procedures could be evaluated. One of the participants withdrew before we could attempt the procedures with a second target sound or evaluate the impact of teaching motor imitation on subsequent vocal imitation. Therefore, we do not know if the procedure could be effective for him.

Additionally, the participants varied in terms of their current verbal repertoire and social engagement. Suzie, the participant for whom the procedures were most effective, had a history of learning in an intensive ABA clinic, experienced speech therapy, and attended a preschool with a curriculum based on the principles of ABA. Therefore, she learned how to learn. She displayed joint attention skills, had a motor imitation repertoire, and had a history of inconsistently responding to echoics. In contrast, the other two participants were notably younger, more recently diagnosed, did not have a history of attending preschool, or receiving speech or intensive ABA services. Furthermore, Suzie’s most potent reinforcers revealed to be social engagement in the form of being picked up and spun around or other motions, or being tickled or chased. In contrast, the other two participants did not appear to enjoy social games
with the experimenter and actively avoided eye contact. These are all extraneous variables that were not controlled for, which may have impacted the results of this study.

A third limitation is that the procedures were implemented in the same order for each participant. Therefore, we cannot determine if the results would be different had we implemented a different sequence, or possibly eliminated certain conditions all together. For example, if we implemented SSP+DR prior to SSP would we have observed similar increases in the post-trials interval? Future studies should investigate such possibilities.

Another limitation is that we did not establish the preferred items as reinforcers. In fact, due to the fact that the procedure was ineffective for Bruce and Joey, we have to wonder if the edibles served as reinforcers. Furthermore, Suzie’s reinforcers that actually lead to positive results were social interactions and McDonald’s French fries that her mother brought to the appointment. These two things were not included in the initial preference assessment and we moved towards these items when Suzie began refusing the highly preferred items identified in the preference assessment. Given this, it is possible that the preferred items we used with Joey and Bruce were not reinforcing and we may have achieved different results had we explored different items with Bruce and Joey. Future studies should consider completing a reinforcer assessment in addition to the preference assessment to ensure that the item(s) used actually serve as reinforcers.

**Future Studies**

Future studies should include more participants, and control for these extraneous variables to evaluate which may impact the effectiveness of stimulus-stimulus pairing as a first step to building an echoic repertoire. Perhaps the first step in doing so would be to conduct stimulus-stimulus pairing procedures with a large number of participants, with various
repertoires and levels of social engagement. Then one could evaluate if there are any prerequisite skills that increased the likelihood of the procedures being effective at increasing vocalizations.

Additionally, the results of this study indicate that the greatest increase for all participants was observed in the SSP+DR condition. This result might suggest that clinicians should implement SSP+DR if they wish to achieve the greatest gains; however, we do not know if there is a sequence effect or if SSP+DR would be the most effective in a clinical setting. This condition was conducted after multiple baseline sessions and SSP sessions. Future studies and clinicians may wish to evaluate this procedure in isolation so that the target sound does not contact extinction. By starting with direct reinforcement procedures clinicians and researchers may observe greater increases, which may then lead to greater probability of the target coming under echoic control. Future studies should evaluate this possibility and determine the most efficient methods for obtaining echoics and vocal mands.

Furthermore, future studies should evaluate the differences between SSP and mand training. In clinical settings mand training is thought to be the best method for obtaining stimulus control of vocal behavior. This often involves the teacher vocally labeling the item and withholding access until the learner emits a vocal response. In some cases this can be any vocal response, and then shaping procedures are used to obtain closer and closer approximations of the target label. For example, when attempting to teach a child to request their bottle a caregiver may first label the bottle multiple times. Then a caregiver may withhold access and wait for the child to emit some vocal response, then they child may be required to say “buh”, and so on until the child is emitting a recognizable vocal response or request. This is often effective for many children. Future studies should evaluate such a sequence, which is paired with a specific
reinforcer, with a sequence that includes a generalized mand (i.e., a vocal response that is reinforced by access to various preferred items), and/or to stimulus-stimulus pairing. Such a study could greatly inform clinical practices.

The participants in this study varied in their verbal repertoires at the initiation of the study, as assessed by the BLAF. These differences became more apparent through interaction with this study. For example, Suzie was cooperative with adults and the experimenter was able to build rapport with her. In contrast, Bruce and Joey were relatively uncooperative and Joey especially avoided the experimenter when social interactions were attempted. Suzie also displayed motor imitation skills during the study procedures. She was able to imitate gross motor actions spontaneously and during the echoic probes. In contrast, neither Joey nor Bruce displayed motor imitation skills during their participation. These were the two most apparent differences between the participants; therefore, we hypothesize that these skills are likely to impact the participant’s ability to respond to the SSP procedures. Future studies should control for these variables, or consider teaching these skills when possible to evaluate their impact on the effectiveness of these procedures.
References


Table 1. Behavioral Language Assessment Form results by participant

<table>
<thead>
<tr>
<th>Participant</th>
<th>Cooperation</th>
<th>Request</th>
<th>Motor Imitation</th>
<th>Vocal Play</th>
<th>Vocal Imitation</th>
<th>Match to Sample</th>
<th>Receptive</th>
<th>Labeling</th>
<th>RFFC</th>
<th>Conversation</th>
<th>Letters and Numbers</th>
<th>Interaction</th>
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Table 2. Number of sessions by visit per participant.

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Figure 1. Results of Suzie’s paired choice preference assessment.
Figure 2. Results of Bruce’s paired choice preference assessment.
Figure 3. Results of Joey’s paired choice preference assessment.
Figure 4. Results of Suzie’s vocalization study sessions.
Figure 5. Results of Bruce’s vocalization study sessions.
Figure 6. Results of Joey’s vocalization study sessions.
Appendix

The Behavioural Language Assessment Form

The BLAF
By Sundberg & Partington (1998)

Name: _______________  Age: _______  Date: __________

<table>
<thead>
<tr>
<th>Cooperation</th>
<th>Request</th>
<th>Motor Imitation</th>
<th>Vocal Play</th>
<th>Vocal Imitation</th>
<th>Match to Sample</th>
<th>Receptive</th>
<th>Labelling</th>
<th>RFFC</th>
<th>Conversation</th>
<th>Letters and Numbers</th>
<th>Interaction</th>
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</table>

For the following question, indicate the level of performance that best describes the learner’s typical level of performance.

I. COOPERATIONS WITH ADULTS _________ (enter score).
   How easy is it to work with the child?

   1. Always uncooperative, avoids work, engages in negative behaviour.
   2. Will do only one brief and easy response for a powerful reinforcer.
   3. Will give 5 responses without disruptive behaviour.
   4. Will work for 5 minutes without disruptive behaviour.
   5. Works well for 10 minutes at a table without disruptive behaviour.

II. REQUEST (MANDS) _________
   How does the learner let his needs and wants be known?
1. cannot ask for reinforcers; or engages in negative behaviour
2. pulls people, points, or stands by reinforcing items
3. uses 1-5 words, signs or pictures to ask for reinforcers
4. uses 5-10 words, signs or pictures to ask for reinforcers
5. Frequently requests using 10 or more words, signs, or pictures.

III. MOTOR IMITATION

Does the learner copy actions?

1. cannot imitate anybody’s motor movements
2. imitates a few gross motor movements modelled by others
3. imitates several gross motor movements on request
4. imitates several fine and gross motor movements on request
5. easily imitates any fine or gross movements, often spontaneously

IV. VOCAL PLAY

Does the learner spontaneously say sounds and words?

1. does not make any sounds (mute)
2. makes a few speech sounds at a low rate
3. vocalizes many speech sounds with varied intonations
4. vocalizes frequently with varied intonation and says a few words
5. vocalizes frequently and says many clearly understandable words

V. VOCAL IMITATION

Will the learner repeat sounds or words?

1. cannot repeat any sounds or words
2. will repeat a few specific sounds or words
3. will repeat or closely approximate several sounds or words
4. will repeat or closely approximate many different words
5. will clearly repeat any word, or even simple phrases

VI. MATCHING TO SAMPLE

Will the learner match objects, pictures and designs to presented samples?

1. cannot match any objects or pictures to a sample
2. can match 1 or 2 objects or pictures to a sample
3. can match 5 to 10 objects or pictures to a sample
4. can match 5 to 10 colours, shapes, or designs to a sample
5. can match most items and match 2 to 4 block designs

VII. RECEPTIVE _________
Does the learner understand any words or follows directions?

1. cannot understand any words
2. will follow a few instructions related to daily routines
3. will follow a few instructions to do actions or touch items
4. can follow many instructions and point to at least 25 items
5. can point to at least 100 items, actions, persons or adjectives

VIII. LABELLING (TACTS) _________
Does the learner label or verbally identify any items or actions?

1. cannot identify any items or actions
2. identifies only 1 to 5 items or actions
3. identifies 6 to 15 items or actions
4. identifies 16 to 50 items or actions
5. identifies over 100 items or actions and emits short sentences

IX. RECEPTIVE BY FUNCTION, FEATURE, AND CLASS _________
Does the learner identify items when given information about those items?

1. cannot identify items based on information about them
2. will identify a few items given synonyms or common functions
3. will identify 10 items given 1 of 3 functions or features
4. will identify 25 items given 4 functions, features, or classes
5. will identify 100 items given 5 functions, features or classes

X. CONVERSATION SKILLS (INTRAVERBALS) _________
Can the learner fill-in missing words or answer questions?

1. cannot fill-in missing words or parts of songs
2. can fill-in a few missing words or provide animal sounds
3. can fill-in 10 non-reinforcing phrases or answer at least 10 simple questions
4. can fill-in 20 phrases or can answer 20 questions with variation
5. can answer at least 30 questions with variation

XI. LETTERS AND NUMBERS _______
Does the learner know any letters, numbers, or written word?

1. cannot identify any letters, numbers, or written words
2. can identify at least 3 letters or numbers
3. can identify at least 15 letters or numbers
4. can read at least 5 words and identify 5 numbers
5. can read at least 25 words and identify 10 numbers

XII. SOCIAL INTERACTION _______
Does the learner initiate and sustain interactions with others?

1. does not initiate interactions with others
2. physically approaches others to initiate an interaction
3. readily asks adults for reinforcers
4. verbally interacts with peers with prompts
5. regularly initiates and sustains verbal interactions with peers