This work is dedicated to Christopher Rubow.
ACKNOWLEDGMENTS

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EVALUATIONS OF IMITATION TRAINING WITH CHILDREN WITH AUTISM

By

Meghan A. Deshais

August 2018

Chair: Timothy Vollmer
Major: Psychology

There is a large body of research that suggests that discrete trial teaching is effective for teaching imitation to children with autism spectrum disorder (ASD). However, there are few empirically based guidelines about how to optimize child learning in a discrete trial training arrangement. In Experiment 1, we compared the effects of two types of S^D presentation on rates of acquisition of gross motor imitative responses. We found that an ongoing-model S^D presentation may produce faster acquisition than a delayed-model S^D presentation for some children with ASD. In Experiments 2 and 3, we investigated the types of imitative responses that are most readily acquired by children with autism spectrum disorder. The results of Experiment 2 suggest that object imitation responses that do not leave products may be acquired more quickly than responses that do leave a product by some children with ASD. We also found that repetition and auditory feedback may be the variables responsible for the differential rates of acquisition we observed. The outcomes from Experiment 3 were mixed but suggest that for some children, dynamic responses may be more readily acquired than static responses during gross motor imitation training.
CHAPTER 1
INTRODUCTION

Imitation in Autism

Broadly speaking, imitation can be defined as instances in which an individual exhibits a response that was previously modeled (demonstrated) by another person. According to the American Academy of Pediatrics, typically developing children begin imitating gestures between 8-12 mos of age. Although imitation deficits are not included in the DSM-V (American Psychiatric Association, 2013) diagnostic criteria for autism spectrum disorders (ASD), many researchers suggest that imitation can be considered a core deficit of ASD (Rogers & Williams, 2006; Williams, Whiten, & Singh, 2004). There is a large body of evidence that children with ASD do not imitate the behavior of others as frequently or accurately as typically developing children or children with other disabilities (DeMyer et al., 1972; Gonsiorowski, Williamson, & Robins, 2016; Ingersoll, 2008; Rogers, Hepburn, Stackhouse, & Wehner, 2003). Imitation skills have been shown to be positively correlated with the development of important skills such as communication (Gregory, DeLeon, & Richman, 2009; Stone & Yoder, 2001; Toth, Munson, Meltzoff, & Dawson, 2006), cognition (Strid, Tjus, Smith, Meltzoff, & Heimann, 2006), and social behavior (Ingersoll & Meyer, 2011; Stone, Ousley, & Littleford, 1997). At this point it remains unclear if the imitation deficits exhibited by children with ASD are unique to the disorder or if they can be accounted for by overall developmental level (Rogers et al. 2003). Research has indicated that pre-treatment imitation skills are predictive of treatment outcomes for children with ASD (Sallows & Graupner, 2005). Additionally, the effectiveness of a number of instructional strategies (model prompts, video modeling) used with children with ASD are dependent on imitation. Given the importance of imitation skills, most early intensive behavioral intervention (EIBI) curriculums (Lovaas, 1981; Maurice, Green, & Luce, 1996; Partington, 2008;
Sundberg, 2008) recommend that imitation should be taught early on in the course of intervention.

**Teaching Imitation Skills to Children with Autism**

There is large body of research that suggests that discrete trial teaching (DTT) is effective for teaching imitation to children with ASD (Baer, Peterson, & Sherman, 1967; Garcia, Bear, & Firestone, 1971; Lovaas, Berberich, Perloff, & Schaeffer, 1966; Lovaas, Freitas, Nelson, & Whalen, 1967; Metz, 1965; Young, Krantz, McClannahan, & Poulson, 1994). However, methodologically rigorous studies about how to optimize child learning in a DTT arrangement are lacking. Ledford and Wolery (2011) conducted a review of research on imitation training for children with disabilities. Their analysis indicated that: (a) there are few evidence-based recommendations about instructional procedures (e.g., variations in discriminative stimulus \[S^D\] presentation, types of prompts, prompt fading, etc.) for imitation training, (b) there are no evidence-based recommendations about how to best sequence instruction during imitation training, and (c) more research is needed in these areas so that evidence-based guidelines for imitation training can be established.

Since the publication of Ledford and Wolery, a handful of studies aimed at evaluating instructional procedures have been published. Video modeling has been demonstrated to be an effective strategy for teaching imitation to some children with ASD (Cardon, 2012; McDowell, Gutierrez, & Bennett, 2015). These outcomes are interesting given that imitative skills are thought to be a necessary pre-requisite for the acquisition of new behavior through video modeling. Miller, Rodriguez and Rourke (2015) demonstrated that the use of a mirror may facilitate acquisition of imitative responses. Most recently, Valentino, LeBlanc, and Conde (2017) used a pre-assessment to inform the development of individualized instructional strategies for children struggling to acquire imitative responses.
Development of a Generalized Imitative Repertoire

The ultimate goal of imitation training programs for children with ASD is for them to develop a generalized imitative repertoire. An individual is said to possess a generalized imitative repertoire when they are able to reproduce novel actions without prior exposure to those models and without explicit reinforcement following each response. Studies have shown that generalized imitation can be established by reinforcing a sufficient number of imitative responses (Garcia et al., 1971). Research has also shown that as long as some imitative responses are reinforced, individuals will continue to imitate nonreinforced responses (e.g., Brigham & Sherman, 1968). Conversely, if reinforcement is discontinued, all imitative responding will decrease. These findings suggest that imitative behavior may constitute a functional response class (Catania, 2007; Peterson, 1968).

Several theories have been proposed to explain generalized imitation. The conditioned reinforcement theory suggests that the topographical similarity between the child’s response and the adult model acquires conditioned reinforcing properties and becomes discriminative for reinforcement (Baer & Sherman, 1964; Gladstone & Cooley, 1975; Greenburg, 1979). The discrimination failure hypothesis proposes that the persistence of nonreinforced imitative responses is due to the child failing to discriminate between responses that will and will not be reinforced (Bandura & Barab, 1971). Thus, nonreinforced responses persist despite the complete absence of reinforcement for those responses. The social demands theory posits that imitation is a member of a larger class of generalized instruction following behavior and that the training procedures used in many imitation training studies are responsible for the persistence of imitative responses that are not reinforced (Martin, 1971; Steinman, 1970, Steinman & Boyce, 1971). In other words, children continue to imitate nonreinforced responses because of the child’s learning history with respect to complying or failing to comply with an adult-issued instruction. Although
a consensus has not been reached regarding the mechanism responsible for the emergence of generalized imitation, it is widely acknowledged that imitation is a critical skill in the course of child development because it allows children to learn skills via modeling (Bandura, 1971).

**Aspects of Imitation Training**

Given the importance of this skill and the lack of evidence-based guidelines for imitation training for children on the autism spectrum, the goal of the current research is to aid in the establishment of empirically based guidelines for teaching imitation to children with ASD. To begin, we are interested in two specific aspects of imitation training: the mode of \( S^D \) presentation and the form of the imitative responses themselves. To date, there is only one published study on \( S^D \) presentation during imitation training with children on the spectrum (Valentino et al., 2017; discussed below). The discrete trial arrangement commonly used in clinical practice utilizes a single therapist presenting learning trials to a child. At the beginning of each learning trial, the therapist delivers an \( S^D \) to the child (vocal instruction to “do this” + model) and waits for the child to respond or prompts the child to perform the target action. Early on in the course of imitation training with children with ASD, physical prompts are almost always necessary to evoke target responses from the child (McDowell et al., 2015). In the standard arrangement, the therapist’s model is usually discontinued prior to the delivery of a physical prompt. In fact, when the target response involves both arms (e.g., clapping), the model has to be discontinued because it is impossible for the therapist to simultaneously model the target response and prompt the child. In other words, the model is no longer present during the response interval. This is loosely analogous to a delayed match-to-sample arrangement in which the sample stimulus is no longer present when the organism selects from comparison stimuli. Basic research has demonstrated that delayed match-to-sample arrangements are more difficult than standard match-to-sample arrangements in which the sample stimulus is still present when
the organism selects from comparison stimuli (Davidson & Osborne, 1974). Furthermore, correct matching has been shown to decrease as a function of delay (Blough, 1959; Grant, 2011). Given these findings, it is possible that a delayed model might not be optimal in the context of imitation training with children on the spectrum.

Recently, Valentino et al. (2017) explored the possibility of adverse effects of delayed imitation following $S^D$ presentation. They conducted a pre-assessment with two children with ASD who were struggling to learn imitation. The results of the pre-assessment indicated that one subject, George, displayed specific deficits in delayed imitation. To address this deficit, the authors designed an intervention that eliminated the delay between the therapist’s model and physical prompts. A second therapist was used to prompt the child, allowing the primary therapist to present the model continuously throughout the response interval. For George, the “second prompter” condition produced faster acquisition of imitative responses than other conditions. However, in their evaluation of the second prompter intervention, Valentino et al. (2017) did not separate the effects of an ongoing model $S^D$ presentation from the effects of using a second therapist during training. Therefore, the isolated effects of an ongoing model $S^D$ presentation on acquisition of imitative responses by children with ASD remains unknown. In Experiment 1, we extended Valentino et al. by comparing the effects of these two types of $S^D$ presentation on rates of acquisition of gross motor imitative responses while controlling for the effects of a second therapist.

Currently, there are no published studies investigating the types of imitative responses that are most readily acquired by children with autism. More than 40 years ago, Piaget (1963) and Bandura (1977) suggested that response features such as simplicity, visibility, familiarity, and salience might influence the development of imitation. However, none of the aforementioned
recommendations are based on empirical evidence. This gap in knowledge presents a problem when designing imitation training programs. Without information about what types of target responses are easy to learn and what types of target responses are more challenging to learn, it is difficult to establish appropriate instructional sequences. A number of curriculum guides used by practitioners to develop skill acquisition programs for children with ASD provide suggestions for target selection or outline instructional sequences for imitation training (Maurice, Green, & Luce, 1996; Partington, 2008; Sundberg, 2008); however, none of these guidelines are directly evidence-based.

When practitioners teach object imitation to children with ASD, the target responses involve the use of one or more objects, usually toys. A review of the aforementioned curriculum guides indicates that commonly taught object imitative responses can be broken down into two categories: responses that leave a permanent product and responses that do not. This distinction has not been examined in any published research, nor is it addressed in skill acquisition curriculum guides. Prior to the current research, we hypothesized that children would learn object imitation responses that leave a product (i.e., dropping a block into a cup) faster than responses that do not (i.e., sliding a block back and forth). The product left behind is the outcome of the target response. A block sitting at the bottom of a cup is the outcome produced by the target response (the child picks up the block and drops it in the cup). Although this does not necessarily map on to a standard match-to-sample arrangement because the sample stimulus (target response) is not present during the response interval, rather the outcome is present, it is possible that the outcome could serve as a prompt to the child. Object imitative responses that do not leave a product, offer no such possibility. In Experiment 2, we compared rates of acquisition for imitative responses that did or did not produce permanent products. We also conducted an
investigation of the stimulus features of object imitative responses that might influence acquisition.

The outcomes from Experiment 2 led us to wonder if there are features of gross motor responses that might similarly influence acquisition. Gross motor imitative responses that are commonly taught by practitioners can also be broken down into two categories: static and dynamic responses. Static imitative responses are movements that are not repetitive in nature (i.e., touching head). Dynamic imitative responses are movements that involve rapid, repetitive movement (i.e., rubbing tummy). The distinction between these two types of gross motor imitative responses has not been explored in research and there is no mention of this distinction in skill acquisition curriculum guides. To develop empirically based instructional sequence guidelines for imitation training, more information is needed about the difficulty of target responses. Thus, in Experiment 3, we compared rates of acquisition of static imitative responses to dynamic imitative responses during gross motor imitation training.
CHAPTER 2
GENERAL METHODS

Subjects and Setting

Subjects were children diagnosed with ASD, who, according to their teachers or clinicians, exhibited a clinically significant deficit in imitation skills. To be eligible, subjects must have scored below a 5 on the motor imitation section of the VB-MAPP Milestones Assessment: Level 1 (Sundberg, 2008) or below a 21 on the Motor Imitation Scale (MIS; Stone et al., 1997). Table 1 summarizes subject characteristics (age, sex, placement, verbal behavior skills, and problem behavior) of the subjects (N=9) who participated in this series of studies.

Sessions were conducted in classrooms or therapy rooms at a local autism clinic, public school or university-based clinic. All rooms contained a small table, chairs, and relevant work materials.

Dependent Variables and Definitions

All experiments included two types of trials, independent trials and prompted trials. Independent trials were trials in which a therapist did not deliver prompts. Prompted trials were trials in which a therapist delivered a physical prompt at a 0-sec time delay (immediately following the SD). Across all experiments, the dependent variable was the percentage of correct imitative responding on independent trials. We calculated the percentage of correct responses on independent trials for each session by dividing the number of independent trials with correct responses by the total number of independent trials and multiplying the result by 100.

At the beginning of all trials, the therapist established eye contact with the subject and presented the SD (“Do this” + model). Then, the therapist gave the child 5 s to respond (with or without a prompt, depending on the type of trial). If the trial involved the use of an object, the therapist and child used identical objects. To prevent the subject from responding prior to the completion of the SD, the therapist kept the child’s object out of reach until it was the child’s
opportunity to respond. Finally, the therapist delivered the relevant consequence to the subject depending on the trial type or training phase.

Data were collected using paper and pencil. Observers recorded correct responses when the subject exhibited a response with point-to-point correspondence (to the model), at least one time, within 3-s (Experiment 3) or 5-s (Experiments 1 and 2) of the $S^D$. During independent trials, observers scored correct responses when the subject exhibited a response with point-to-point correspondence without any assistance. Operational definitions were created for all target responses. Approximations to target responses were not scored as correct with two exceptions. First, for target responses that were modeled in a repetitive fashion, subjects were not required to emit the same number of repetitions as the model. If, during the $S^D$ presentation for the target response “clap,” the therapist clapped their hands 4 times, the child need only clap once for their response to be scored as correct. Second, the child was not required to exhibit target responses on the same side of their body as the model. If the therapist modeled the target response “wave” using her left hand, the child was not required to use a specific hand for their response to be scored as correct. During independent trials, observers recorded incorrect responses when the subject failed to emit a response with point-to-point correspondence or exhibited an error. Across all experiments, we used a most-to-least, within and across-session prompting sequence (explained in more detail below).

Procedures

Independent Trials

The therapist never delivered prompts during independent trials. If the subject responded correctly (without assistance), the therapist provided a reinforcer. If the subject responded incorrectly, the therapist implemented error correction. For the sake of brevity, the term
reinforcer will be used to refer to the simultaneous presentation of social praise and brief access to a highly preferred item (edible or toy).

**Prompted Trials**

During prompted trials, the therapist instituted the programmed prompt for the duration of the response interval or until the subject responded correctly or exhibited an error. If the subject responded correctly, the therapist provided the reinforcer. If the subject responded incorrectly, the therapist implemented error correction. In Experiment 1, reinforcers were always delivered following error corrections during prompted trials. Our rationale for delivering reinforcement following prompted trials regardless of the participant’s response was that we wanted to deliver reinforcement following any emission of a correct response (prompted or otherwise). In Experiments 2 and 3, reinforcers were delivered following error corrections during prompted trials only during the initial stages of training. After a subject correctly imitated a target response during at least one independent trial across two sessions, the therapist no longer delivered reinforcers following error corrections on prompted trials. That is, after two instances of correct responding with no assistance, we discontinued reinforcement following incorrect responses on prompted trials in an attempt to thwart the development of prompt dependence. We made this change because during Experiment 1 we observed a few instances of a participant appearing to “wait” for a therapist prompt.

**Independent Phase**

During the Independent phase, sessions consisted of 10 independent trials. An initial probe trial was not conducted because sessions in the Independent phase did not contain any programmed prompts, therefore we did not need to determine whether the prompts were needed.
Prompt Phases

During the 6:4 prompt phase, sessions consisted of two full-physical prompted trials, two moderate-physical prompted trials, two light-physical prompted trials, and four independent trials. For example, if the target response was clap hands, the full-physical prompt consisted of hand-over-hand assistance, the moderate physical prompt consisted of assistance from the subjects’ elbows, and the light physical prompt consisted of assistance from the subjects’ shoulders. During the 3:7 prompt phase, sessions consisted of one full-physical prompted trial, one moderate physical prompted trial, one light physical prompted trial, and seven independent trials.

Initial Probes

All prompt phase sessions were preceded by an initial probe trial. The purpose of the initial probe trial was to determine whether the subject needed the prompts that were programmed for that session. Initial probe trials were identical to independent trials except that the therapist did not implement error correction following an incorrect response. If the subject responded incorrectly on the initial probe trial, the session was conducted as outlined by the prompt phase. If the subject responded correctly on the initial probe trial, the therapist delivered the reinforcer and started the session with independent trials instead of the prompted trials outlined by the prompt phase. Independent trials continued until the end of the session or until the subject responded incorrectly on two consecutive trials at which point the therapist reintroduced the programmed prompts for that session beginning with the most intrusive prompt. The programmed prompt sequence continued until 10 trials were completed.
Error Correction

Error correction consisted of full-physical (hand-over-hand) assistance. The therapist implemented error correction when the subject failed to respond by the end of the response interval or when the subject exhibited an error.

Interobserver Agreement and Procedural Fidelity

A second, trained observer collected data independently during a portion of sessions across all subjects and phases of each experiment. Interobserver agreement was calculated for each session using the exact trial agreement method by dividing the number of independent trials with agreements by the total number of independent trials and multiplying by 100. An agreement was defined as both observers scoring a “correct” or both observers scoring an “incorrect” for a given trial.

For Experiment 1, a second observer collected data independently during at least 40% of sessions for each subject across all phases. Mean agreement for Joey was 100% for baseline sessions, 99% (range, 82% to 100%) for training sessions, 100% for maintenance sessions, and 98% (range, 92% to 100%) for interspersed trials sessions. Mean agreement for Pacey was 99% (range, 90% to 100%) for baseline sessions, 99% (range, 91% to 100%) for training sessions, 100% for maintenance sessions, and 100% for interspersed trials sessions. Mean agreement for Dawson was 97% (range, 80% to 100%) for baseline sessions, 97% (range, 80% to 100%) for training sessions, 99% (range, 75% to 100%) for maintenance sessions and 100% for interspersed trials sessions.

For Experiment 2a, a second observer collected data independently during at least 44% of sessions for each subject across all phases. Mean agreement for Avi was 100% across all phases. Mean agreement for Felicity was 100% across all phases. For Experiment 2b, a second observer collected data independently during at least 24% of sessions for each subject across all phases.
Mean agreement for Beckham was 100% for baseline sessions and 99% (range, 40% to 100%) for training and maintenance sessions. Mean agreement for Felicity was 100% for baseline sessions and 99% (range, 80% to 100%) for training and maintenance sessions.

For Experiment 2c, a second observer collected data independently during at least 20% of sessions for each subject across all phases. Mean agreement for Avi was 96% (range, 80-100%) for baseline sessions and 100% for training and maintenance sessions. Mean agreement for Charlie was 99% (range, 80-100%) for baseline sessions and 100% for training and maintenance sessions. Mean agreement for Lewis was 95% (range, 80-100%) for baseline sessions and 99% (range, 90%-100%) for training and maintenance sessions.

For Experiment 3, a second observer collected data independently during at least 21% of sessions for each subject across all phases. Mean agreement for Ace was 94% (range, 90% to 100%) for baseline sessions and 100% for training and maintenance sessions. Mean agreement for Beckham was 100% for baseline sessions and 96% (range, 80% to 100%) for training and maintenance sessions.

Observers collected data on therapist behavior during baseline, training, and maintenance sessions for a subset of our subjects (25%). For each trial, observers scored if the therapist established eye contact with the subject prior to the $S^D$, presented the correct prompt (if programmed), and delivered the correct consequence. Procedural fidelity was calculated by dividing the number of correct responses by the sum of correct and incorrect responses and multiplying the result by 100 to yield a percentage. Percentage correct scores were averaged across sessions for each participant. Procedural fidelity averaged 99.31 (range, 77-100%).
Pre-Experimental Procedures

Imitation Assessment

Prior to each experiment, we conducted brief assessments of subjects’ imitation skills using either the VB-MAPP Milestones Assessment: Level 1 motor imitation section (Experiment 1; Sundberg, 2008) or the MIS (Experiments 2 and 3; Stone et al., 1997). The therapist did not deliver any programmed consequences for correct or incorrect responses during the VB-MAPP or MIS. The MIS is a 16-item assessment that consists of specific imitation responses that are directly tested with each child (i.e., clapping); the VB-MAPP does not outline specific responses to be tested and requires a lengthy observation. Given these advantages, we switched to the MIS following the completion of Experiment 1.

Preference Assessment

A 5-10 item multiple stimuli without replacement preference assessment (MSWO; DeLeon & Iwata, 1996) was conducted with each subject to identify preferred edibles or toys for use as reinforcers during sessions.

Target Assessment

Prior to baseline, a brief target assessment was conducted with each subject to identify target responses. The target assessment was conducted using the same procedures as the MIS (Stone et al., 1997). The experimenter presented three trials of each potential target response and recorded subject responses. Responses to which the subject never responded correctly were selected as target responses. To equate instructional histories for the targets assigned to different experimental conditions, we consulted each subject’s clinical team to ensure that target responses did not involve skill elements being taught in clinical programming. Recent research has suggested that naming interventions (tact and listener responding) and familiarity with target responses may affect imitative behavior (Camões-Costa, Erjavec & Horne, 2011; Erjavec &
Horne, 2008). If the subject had a listener responding program for body parts, actions, or nursery rhymes (i.e., “head, shoulders, knees, and toes”) or a tacting program for body parts or actions, we excluded target responses with any common elements. In addition, we did not use any musical instruments or light-up toys during Experiments 2a, 2b, or 2c because of the difficulty equating the stimulation (potential extraneous reinforcement) provided by those objects across experimental conditions.

**Post-Experimental Procedures**

Following Experiments 2 and 3, we conducted a post-experiment MIS (Stone et al., 1997) with each subject using procedures identical to the pre-experimental MIS.
Table 2-1. Subject characteristics.

<table>
<thead>
<tr>
<th>Name</th>
<th>Sex</th>
<th>Age*</th>
<th>Placement</th>
<th>Verbal behavior skills</th>
<th>Problem behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ace</td>
<td>M</td>
<td>7</td>
<td>Private therapy clinic for children with ASD</td>
<td>No vocal speech, used Proloquo2Go application on iPad to mand</td>
<td>Aggression, skin picking, spit play, and elopement</td>
</tr>
<tr>
<td>Avi</td>
<td>M</td>
<td>4</td>
<td>Private therapy clinic for children with ASD</td>
<td>No vocal speech, used combination of sign language and picture cards</td>
<td>Disruptive behavior, noncompliance, flopping, and tantrums</td>
</tr>
<tr>
<td>Beckham</td>
<td>M</td>
<td>4</td>
<td>Private therapy clinic for children with ASD</td>
<td>Strong echoic repertoire, used one and two-word utterances that consisted of single words</td>
<td>Aggression</td>
</tr>
<tr>
<td>Charlie</td>
<td>M</td>
<td>3</td>
<td>Private therapy clinic for children with ASD</td>
<td>No vocal speech, used modified signs and gestures</td>
<td>SIB and tantrums</td>
</tr>
<tr>
<td>Dawson</td>
<td>M</td>
<td>7</td>
<td>Private school for children with ASD</td>
<td>No vocal speech, used picture-based exchange system to mand</td>
<td>Vocal and motor stereotypy, flopping, elopement, and</td>
</tr>
<tr>
<td>Felicity</td>
<td>F</td>
<td>2</td>
<td>Private therapy clinic for children with ASD</td>
<td>Emerging echoic repertoire, used one-word utterances</td>
<td>Motor stereotypy and tantrums</td>
</tr>
<tr>
<td>Joey</td>
<td>M</td>
<td>3</td>
<td>Public preschool program for children with disabilities</td>
<td>Some one-word utterances, rarely emitted vocal speech when prompted by adults</td>
<td>Stereotypy, flopping, chin pressing, and tantrums</td>
</tr>
<tr>
<td>Lewis</td>
<td>M</td>
<td>3</td>
<td>Private therapy clinic for children with ASD</td>
<td>No vocal speech, used gestures to mand</td>
<td>Disruptive behavior, noncompliance, and tantrans</td>
</tr>
<tr>
<td>Pacey</td>
<td>M</td>
<td>4</td>
<td>University-based clinic for children with ASD</td>
<td>Some intraverbals (e.g., &quot;ready, set, go), produced mostly non-intelligible</td>
<td>Flopping, scratching, pinching, and tantrums</td>
</tr>
</tbody>
</table>

Note. * = Age at beginning of study
CHAPTER 3
EXPERIMENT 1

Purpose

The objective of Experiment 1 was to compare the rate of acquisition of imitative responses by children with ASD when the therapist used a delayed-model $S^D$ presentation, similar to a delayed match-to-sample arrangement and consistent with the standard arrangement, versus when the therapist used an ongoing-model $S^D$ presentation, as is more consistent with a standard match-to-sample procedure. We sought to replicate and extend the findings of Valentino et al. (2017) by comparing the effects of these two types of $S^D$ presentation on rates of acquisition of gross motor imitative responses while controlling for the effects of a second therapist.

Experimental Design

We used a concurrent multiple probe across targets with an embedded multi-element design to compare acquisition of imitative responses under three experimental conditions. We selected six gross motor imitation targets for each subject; three targets were assigned to Set A and three targets were assigned to Set B. Following baseline, training was introduced in a staggered fashion to Set A and then to Set B. Each session consisted of 10 discrete trials (with the exception of prompt phase sessions which were preceded by an initial probe trial). We presented trials in mass trial format except during the interspersed trials phase.

The criterion to progress through the training phases was 90% correct responding on independent trials for two consecutive sessions across days. In other words, the subject needed to meet this criterion to move a target from the 6:4 prompt phase to the 3:7 prompt phase. For a target to meet the terminal mastery criteria (and move to maintenance) the subject also had to respond correctly on the initial probe during two consecutive sessions with 90% correct
responding. Subjects could meet terminal mastery criteria in any of the training phases. We conducted maintenance sessions for mastered targets regularly to ensure skill retention. If correct responding decreased to 0% for five consecutive sessions in any phase, we returned the subject to the previous phase (this only occurred for one subject, Dawson). If a subject was not making sufficient progress on a target in a given condition (while other conditions had proven to be effective), that target was moved to the most effective condition for that subject. Dawson was the only subject for whom this was necessary.

We made one modification to our trial procedures after the start of this study to address an issue that arose during the training phase. One of our subjects (Pacey) began responding prior to delivery of the SD during training sessions. To prevent responding before the SD and to ensure that he was attending to the entire SD we added a handholding component to our trial procedures at session 39. Shortly after this modification was added to Pacey’s trial procedures, Dawson also began responding prior to the SD; therefore, the same component was added to Dawson’s trial procedures at session 43. Because we had not started baseline sessions with Joey when we added the handholding component to Dawson and Pacey’s trial procedures, we used handholding during all of Joey’s sessions as a preventive measure. At the start of each trial, the therapist gently held the subjects’ hands in their laps until after the SD was presented. For target responses that only required one hand (e.g., wave), both of the subjects’ hands were placed in their lap and the therapist gently held them using one hand during the SD presentation. This allowed the therapist to use her free hand to model the response. For target responses that required two hands (e.g., arms up), subjects’ hands were placed in his or her lap and the therapist gently placed a leg (bent at the knee) over subjects’ lap, like a seatbelt, during the SD presentation. For all targets, after the therapist presented the SD, the therapist released the subjects’ hands to allow them to
respond (independent trials) or to allow the therapist to deliver a programmed prompt (prompted trials).

Experiment Phases

Baseline

Baseline sessions consisted of 10 independent trials. No reinforcers were present during baseline sessions. The therapist delivered social praise following correct responses. The therapist did not deliver prompts or implement error correction procedures following incorrect responses. A second therapist sat behind the subject during all sessions for targets assigned to two-person conditions.

Training

At the beginning of each training session, the therapist presented the top three items from the preference assessment and the subject selected one item. The therapist held up the selected item and stated, “You are working for [item].” Training consisted of different phases: the Independent phase, the 6:4 prompt phase, and the 3:7 prompt.

Maintenance

Maintenance sessions consisted of four independent trials of a mastered target response. The session procedures were identical to the Independent phase except that we discontinued handholding during this phase.

Interspersed Trials

Interspersed trial sessions consisted of 12 independent trials of all targets (two trials of each mastered target). We randomized trials prior to sessions. We never used handholding during interspersed trials. The therapist delivered the reinforcer following correct responses but did not provide error correction following incorrect responses.
Experimental Conditions

One-Therapist Delayed-Model

A single therapist implemented all of the session procedures (handholding, SD presentation, prompts, error correction, and reinforcement delivery). The therapist used a delayed-model SD presentation, the model was presented for 3 s and then discontinued before the child was permitted to respond or the therapist delivered any prompts.

Two-Therapist Ongoing-Model

Session procedures were identical to the two-therapist delayed-model condition except that therapist used an ongoing-model SD presentation. After the SD was presented, the therapist continued to model the target response until the subject responded correctly or until the end of the trial. In other words, the model continued throughout the subject’s opportunity to respond. Therefore, the model could last up to 8 s (3-s SD model + 5 s response interval).

Two-Therapist Delayed-Model

A second therapist was seated behind the subject in a small chair or on the floor and assisted the therapist with session procedures. The (primary) therapist presented the SD and delivered praise and reinforcement. The second therapist was responsible for handholding and delivering prompts and error correction. Similar to the one-therapist condition, the therapist used a delayed-model SD presentation. The purpose of this condition was to isolate the effects of a second prompter without an ongoing-model SD presentation.

Results

For all Experiment 1 figures, the subject’s percentage of correct responding on independent trials is displayed for Set A (top three panels) and Set B (bottom three panels). Filled data points represent sessions in which subjects responded correctly on the initial probe trial. BL stands for the baseline phase, MAINT stands for the maintenance phase, and INT stands
for the interspersed phase. Figure 3-1 depicts Joey’s results. Joey did not emit any correct responses for any of the six imitative responses during baseline. Joey met the terminal mastery criteria for the target in the one-therapist delayed-model condition (tap legs) in Set A after four sessions in the 6:4 prompt training phase. We then introduced training to Set B. Joey met the mastery criteria for the 6:4 prompt phase for the other two Set A targets (hands on cheeks and touch elbow) and those targets moved to the 3:7 prompt phase after five and seven sessions, respectively. Although these two targets were moved to the 3:7 prompt phase, Joey never experienced the 3:7 prompt phase because he always responded correctly on the initial probe. Joey met the terminal mastery criteria for these two targets in the 3:7 prompt phase. For Set B, Joey met the terminal mastery criteria for all three targets within four training sessions. After we moved all six targets to maintenance, we introduced interspersed trials. Correct responding remained high during interspersed trials for all six targets.

Figure 3-2 displays Pacey’s results. Pacey did not emit any correct responses for the Set A targets during baseline. Early during the training for Set A, Pacey began responding (correctly and incorrectly) prior to the S^D so we introduced handholding at session 39 to prevent early responding and promote attending to the S^D. The target in the one-therapist delayed-model condition (hands on cheeks) was the first target to reach mastery in the 6:4 prompt phase. Correct responding increased slowly throughout the 3:7 prompt phase and eventually reached the terminal mastery criteria in the independent phase. The target in the two-therapist delayed-model condition (tap legs) required 19 sessions in the 6:4 prompt phase before finally moving to the 3:7 prompt phase and reaching terminal mastery criteria. We observed variable responding for the target in the two-therapist ongoing-model condition (clap hands) during the 6:4 prompt phase until the terminal mastery criteria were met at session 68. Pacey’s responding during baseline for
Set B targets was low and stable for the targets in the two-therapist delayed and ongoing-model conditions. We observed some correct responding for the target in the one-therapist delayed-model condition (tap head) prior the introduction of training. Terminal mastery criteria were met for all three Set B targets during the 6:4 prompt phase. Terminal mastery criteria were met in 10, eight, and eight sessions in the one-therapist delayed, two-therapist delayed, and two-therapist ongoing-model conditions, respectively. We observed high levels of correct responding for all targets during the interspersed trials phase.

Figure 3-3 depicts Dawson’s results. Dawson engaged in low to zero levels of correct responding during baseline across all six targets. Shortly after the 6:4 prompt phase was introduced to Set A, Dawson began emitting correct responses for the target in the two-therapist delayed-model condition (touch head). However, similar to Pacey, Dawson began responding prior the SD during sessions 37 and 40 so we introduced handholding at session 39. We conducted a few additional sessions before moving this target to maintenance to ensure that correct responding would maintain without handholding. At session 65, we moved touch head to maintenance and introduced training to Set B. The emergence of correct responding in Set B was associated with a decrease in correct responding in the maintenance phase for touch head. After five sessions with zero correct responses, we reinstituted the 3:7 prompt phase and subsequently the 6:4 prompt phase. Eventually, Dawson met the terminal mastery criteria for touch head in the second 3:7 prompt phase at session 227. Correct responding for the target in the two-therapist ongoing-model condition (stomp feet) was met in the 6:4 prompt phase after 32 sessions. Correct responding was not observed for the target in the one-therapist delayed-model condition (wave) until this target was switched to a more effective condition (described below). We observed low to zero levels of correct responding during baseline for Set B targets. We introduced the 6:4
prompt phase to Set B at session 61. Dawson quickly met mastery criteria for the targets in the two-therapist ongoing-model condition (touch toes) and two-therapist delayed-model condition (clap) in the 6:4 prompt phase and subsequently met the terminal mastery criteria for those targets in the 3:7 prompt phase.

After Dawson met terminal mastery criteria for touch head at session 237, the only targets still in training were the two targets in the one-therapist delayed-model condition (wave and arms up). Additionally, Dawson was not making sufficient progress on these two targets. Thirty-six sessions of wave were conducted with zero instances of a correct response. To increase the likelihood of acquisition we switched the targets from the one-therapist delayed-model condition to the two-therapist ongoing-model condition. We selected the ongoing-model condition rather than the delayed-model condition because the targets in the two-therapist ongoing-model condition met terminal mastery criteria in fewer sessions. Following this switch, correct responding for both targets increased immediately and both targets met terminal mastery within five and four sessions respectively. We observed high levels of correct responding for all six targets during the maintenance and interspersed trials phases.

Table 3-1 summarizes the number of sessions needed to reach mastery for each subject across the three conditions as well as which condition was most efficient (fewest trials to mastery) for each Set. If targets were mastered within two sessions of each other, we considered the conditions equivalent with respect to efficiency.

**Discussion**

Across all replications within and across all three subjects, the two-therapist ongoing-model condition was the most efficient condition or tied for the most efficient in all but one case (i.e., for 5 of 6 sets). The one exception was Joey’s first set, in which the first target acquired was in the standard, one-therapist delayed-model condition. It should be noted that very few training
sessions were necessary in any of the conditions for Joey. That is, in Joey’s case, it seems that all conditions were more or less equal. However, for the remaining two subjects, the differences between the conditions were more marked.

Our results suggest that, for some children with ASD, an ongoing-model $S_D$ presentation might be more efficient (i.e., targets may be acquired more rapidly) than a delayed-model $S_D$ presentation when teaching imitation. There are a number of implications to consider in light of our findings. Similar to Valentino et al. (2017), we used a second therapist to facilitate the use of an on-going model $S_D$ presentation. In some settings, strategic planning might be necessary to ensure two therapists are available for imitation training sessions. In the case of home-based therapy, parents might be able to assist therapists during imitation training sessions. If the assistance of a second therapist is not feasible, there are a few other teaching strategies that could facilitate the use of an on-going model $S_D$ presentation. First, simple, one-handed imitative responses could be targeted during the initial stages of training. This would allow therapists to prompt the child while continuing to present the model. Future research could compare the effects of a one-person ongoing model arrangement to the two-person ongoing model arrangement on the acquisition of one-handed imitative responses. Second, some researchers have used mirrors during imitation training (Du & Greer, 2014; Miller et al., 2015). A mirror could facilitate the use of an ongoing model; however, as Avelar (2017) pointed out, for some children, the presence of a mirror might evoke responses that compete with training (i.e., touching the mirror, making faces). Future researchers could compare the effects of a one-person mirror ongoing model arrangement to a two-person ongoing model arrangement on acquisition as well as the frequency of competing responses during training. Finally, there is promising research on the use of video models during imitation training (Cardon & Wilcox, 2010,
McDowell et al., 2015). A substantial body of research indicates that video modeling can be an effective intervention for teaching new skills to children with ASD (see Delano, 2007 for a review). Additionally, some evidence suggests that children with ASD may demonstrate increased visual attention to video stimuli relative to live stimuli (Cardon & Azuma, 2012).

Our results suggest that the use of an ongoing-model $S^D$ presentation during gross motor imitation training might be superior to the traditional, delayed-model $S^D$ presentation for some children with ASD. We replicated and extended the findings of Valentino et al. (2017) by isolating the effects of the ongoing-model $S^D$ presentation. We found that the differential acquisition we observed in the two-person ongoing model condition may have been a result of the ongoing model $S^D$ presentation, rather than the use of a second therapist. Our findings are also in alignment with outcomes from basic research that suggest that standard match-to-sample arrangements produce higher levels of correct responding relative to delayed match-to-sample arrangements (Blough, 1959; Davidson & Osborne, 1974; Grant, 2011).
Figure 3-1. Results for Joey in Experiment 1. Filled data points indicate sessions in which the subject responded correctly on the initial probe trial.
Figure 3-2. Results for Pacey in Experiment 1. Filled data points indicate sessions in which the subject responded correctly on the initial probe trial.
Figure 3-3. Results for Dawson in Experiment 1. Filled data points indicate sessions in which the subject responded correctly on the initial probe trial.
Table 3-1. Results summary for Experiment 1.

<table>
<thead>
<tr>
<th>Subject</th>
<th>One-therapist delayed</th>
<th>Two-therapist delayed</th>
<th>Two-therapist ongoing</th>
<th>Best condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set A</td>
<td>28</td>
<td>23</td>
<td>15</td>
<td>Two-therapist ongoing</td>
</tr>
<tr>
<td>Set B</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>Equivalent</td>
</tr>
<tr>
<td>Dawson</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set A</td>
<td>N/A</td>
<td>38*</td>
<td>32</td>
<td>Two-therapist ongoing</td>
</tr>
<tr>
<td>Set B</td>
<td>N/A</td>
<td>14</td>
<td>11</td>
<td>Two-therapist ongoing</td>
</tr>
<tr>
<td>Joey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set A</td>
<td>4</td>
<td>7</td>
<td>8</td>
<td>One-therapist delayed</td>
</tr>
<tr>
<td>Set B</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>Equivalent</td>
</tr>
</tbody>
</table>

*Includes first round of maintenance sessions
CHAPTER 4
EXPERIMENT 2

Purpose

Our findings from Experiment 1 indicated that the type of $S^D$ presentation used during gross motor imitation training may influence rates of acquisition. Another factor to consider when designing an imitation training program for a child with ASD is instructional sequence. The instructional sequence outlined in a skill acquisition program should progress according to difficulty. To date, there are no published studies investigating the types of imitative responses that are most readily acquired by children with autism. As a first step in this area of research, we elected to focus on object imitative responses. More specifically, the objective of Experiment 2a was to compare rates of acquisition for object imitative responses that did and did not produce permanent products in a simple discrimination arrangement. The objective of Experiment 2b was to compare rates of acquisition for object imitative responses that did and did not produce permanent products in a conditional discrimination arrangement. The objective of Experiment 2c was to conduct a preliminary investigation of the features of object imitative responses that do not leave products that may influence rates of acquisition.

Experimental Design

We used a multiple baseline across targets with an embedded multi-element design to compare acquisition of imitative responses that did and did not produce permanent products. We selected six or eight object imitation targets for each subject. Half of the targets were assigned to the permanent product (P) condition and half of the targets were assigned to the no permanent product (No P) condition. One target from each condition was assigned to a Set. In Experiment 2a, the two targets in a Set involved different objects (e.g., placing a block in a bucket and rolling a car back and forth). In Experiment 2b, the two targets in a Set involved the same object (e.g.,
stacking two blocks and clapping two blocks together repeatedly). In Experiment 2c, the two targets in a Set involved the same object but we kept the auditory stimuli produced by the action consistent across the two conditions and the target without a permanent product was not presented in a repetitive fashion (e.g., stacking two blocks and clapping two blocks together once).

Training was introduced in a staggered fashion across Sets A, B, C (and D if eight targets were selected) following a baseline condition. During baseline and training, the two targets in a given set were conducted in an alternating fashion; we used http://www.random.com to randomize the sessions in each series. We presented trials in mass trial format except during the interspersed trials phase. Our criterion to progress through the training phases and our terminal mastery criteria were the same as Experiment 1 with one exception. Technically, terminal mastery could be met during the baseline phase. To meet terminal mastery in baseline, the subject had to respond correctly on 100% of trials for two consecutive sessions. If a target met terminal mastery in baseline, we kept the target in baseline. The minimum criteria to move from maintenance to interspersed trials was two consecutive sessions of both targets at 80% correct in maintenance phase (one exception was Set D for Beckham).

**Experiment Phases**

**Baseline**

Baseline sessions consisted of five independent trials. No reinforcers were present during baseline sessions. The therapist delivered social praise following correct responses. The therapist did not deliver prompts or implement error correction procedures following incorrect responses.

**Training**

Training sessions consisted of 10 trials (with the addition of an initial probe trial during prompt phases). At the beginning of each training session, the therapist presented an array of top
items from the preference assessment. The therapist held up the selected items and stated, “You are working for [items].” When the subject responded correctly, the therapist presented the array of items and the subject selected one item. Training consisted of different phases: the Independent phase, the 6:4 prompt phase, and the 3:7 prompt.

**Maintenance**

Maintenance sessions consisted of five independent trials of a mastered target response. The session procedures were identical to the Independent phase.

**Interspersed Trials**

Interspersed sessions consisted of 10 independent trials (five trials of each mastered target from a Set). The order of target presentation was quasi-randomized (with no more than four consecutive trials of a given target). Session procedures were identical to the Independent phase. We made one additional manipulation for Beckham during the interspersed phase. We began using a timer to ensure that the intertrial interval was 30-sec in duration following both correct and incorrect responses.

**Intensive Training**

We only conducted intensive training (IT) with Lewis. During the course of our study, there was an extended break from sessions due to a conflict between Lewis’s therapy provider and his health insurance company. Lewis was not able to attend therapy for more than a month and his attendance at the therapy center became sporadic. Additionally, it was unclear whether his therapy was going to be discontinued altogether. Because of the uncertainty regarding Lewis’s attendance at the therapy center, we conducted two days of IT training with him. Intensive training sessions were identical to the interspersed trials phase (five trials of each target in a Set were presented in random order) with one exception. We used an across-session prompt fading procedure in which the same prompt was delivered during all trials of a session. The
across-session prompt fading went as follows: full-physical prompt, forearm prompt, elbow prompt, and independent (no prompts). In other words, during the first session of intensive training a full-physical prompt was delivered during all 10 trials. We progressed from one prompt level to the next prompt level following one session at 90% correct responding. Due to time constraints, we only conducted three independent sessions for each Set.

**Experimental Conditions**

**Permanent Product (P)**

During the SP presentation, the therapist picked up the object from the starting position on the table, modeled the target response, and left the product on the table until the end of the trial. For example, if the target response was stacking one block on top of another, the therapist left the stacked blocks on the table until the end of the trial.

**No Permanent Product (No P)**

During the SP presentation, the therapist picked up the object from the starting position on the table, modeled the target response, and returned the object to the starting position on the table. During Experiments 2a and 2b, the target response was presented in a repetitive fashion (as is typical in clinical practice). For example, if the target response was tapping drum sticks together, the therapist tapped the drumsticks together multiple times when presenting the model. During Experiment 2c, the target response was not presented repeatedly, it was presented only once (the therapist tapped the drumsticks one time).

**Error Analysis**

Although subject errors were not a primary variable of interest, in many sessions, we collected data on subject errors during Experiments 2b and 2c. Following incorrect responses during training, maintenance, and interspersed sessions, we recorded what action the subject had performed with the object. Our error analysis for each subject in Experiments 2b and 2c
consisted of two calculations: (a) the percentage of recorded errors, and (b) the percentage of discrimination errors. To calculate the percentage of recorded errors, we divided the total number of incorrect trials in which we wrote a description of the error by the total number of incorrect trials and multiplied the result by 100. Because subject errors were not a primary variable of interest there were some trials in which we did not record the type of error. A discrimination error was defined as any instance in which the subject emitted the wrong target response from a Set. Each Set consisted of two imitative responses using the same object or objects (i.e., stacking blocks and clapping blocks together). If, for example, the therapist modeled stacking blocks and the child clapped the blocks together, the therapist recorded a discrimination error. To calculate the percentage of discrimination errors, we divided the total number of discrimination errors by the total number of recorded errors and multiplied the result by 100.

Results

For all Experiment 2 figures, the subject’s percentage of correct responding on independent trials is displayed for Set A (top panel), Set B (second panel), Set C (third panel), and Set D (fourth panel; Felicity, Experiment 2b only). BL stands for the baseline phase and TRAINING stands for the training phase, and INT stands for the interspersed phase (Experiments 2b and 2c only). Arrows indicate when mastery criteria were met and targets were moved to maintenance. For ease of visual analysis, a separate maintenance phase is not depicted. However, an arrow indicating mastery and a break in the data path denote that a target was mastered and moved to maintenance.

Experiment 2a

Figure 4-1 shows Avi’s results. Avi did not emit any correct responses during baseline for Set A. After training was introduced, Avi met terminal mastery criteria in three sessions for the No P target (slide puzzle piece back and forth) and in five sessions for the P target (stack
Correct responding remained high during maintenance sessions in both conditions. During baseline for Set B, Avi initially engaged in low levels of correct responding in both conditions. Shortly after training was introduced to Set A, correct responding increased in the No P condition (clap blocks) and Avi met mastery during the sixth baseline session for that target. Correct responding remained low and variable in the P condition (put bowl on top of plate) until training was introduced to Set B. After training began, Avi met terminal mastery criteria for the P condition within four sessions. Correct responding remained high in both conditions during the maintenance phase. Initially, Avi engaged in low levels of correct responding during baseline for the targets in Set C. After training was introduced to Set A, correct responding increased in both the P (flip cup) and No P (tap stick on foam circle) conditions and Avi met mastery for both target in baseline. High levels of correct responding continued in baseline until the completion of the study.

Figure 4-2 depicts Felicity’s results for Experiment 2a. During the first few sessions of baseline for Sets A, B, and C, Felicity engaged in low levels of correct responding. After training was introduced to Set A, correct responding increased in both conditions and Felicity met terminal mastery criteria in four and five sessions for the P (raise doll arm) and No P (stir spoon) conditions, respectively. Correct responding for both targets in Set A continued in the maintenance phase. After the introduction of training to Set A, correct responding increased in the No P condition for the targets in Sets B (tap shovel) and C (clap blocks). Both targets met mastery in baseline. However, correct responding remained at zero for the targets in Set B and C in the P condition. After training was initiated, Felicity met terminal mastery criteria for the Set B target in the P condition (blanket on bear) in two sessions. After training began for the Set C
target in the P condition (stick toy fruit together), Felicity met terminal mastery criteria in three sessions. High levels of correct responding continued in the maintenance phase for Sets B and C.

Table 4-1 summarizes Avi and Felicity’s results for Experiment 2a. Table 4-1 shows the number of training sessions required to reach terminal mastery for each of the targets in the two conditions as well as which condition was most efficient for each Set. If one of the targets in a Set was mastered in baseline and the target in the other condition was mastered in training, the former was considered more efficient.

The objective of Experiment 2a was to compare rates of acquisition for imitative responses that did and did not produce permanent products in a simple discrimination arrangement. Across the two subjects in Experiment 2a, the No P condition was more efficient than the P condition for three Sets and the two conditions were equivalent for three Sets. Thus, in a simple discrimination object imitation training arrangement, targets that left products were never acquired more readily than the targets that did not. One drawback of a simple discrimination arrangement during object imitation training is the potential for faulty stimulus control to develop. In other words, the subject’s response could be under stimulus control of the object, not the therapist’s model. In a conditional discrimination arrangement, it is more probable that the subject’s response is at least partially under the control of the therapist’s model. After completing Experiment 2a, we wondered if we would obtain similar results using a conditional discrimination procedure. Thus, the objective of Experiment 2b was to compare rates of acquisition for imitative responses that did and did not produce permanent products in a conditional discrimination arrangement.

**Experiment 2b**
Figure 4-3 depicts Beckham’s results for Experiment 2b. Although Beckham responded correctly during two sessions for Set A, correct responding was generally low across all three Sets during baseline. After we introduced training to Set A Beckham mastered the target in the No P condition (jump baby) in three sessions and the target in the P condition (put baby to bed) in six sessions. After we moved both targets to maintenance, Beckham’s correct responding became variable in both conditions until session 204 when we introduced a 30-sec intertrial interval procedure. This procedure consisted of using a timer to ensure that the interval between trials was 30 seconds in duration regardless of whether Beckham responded correctly or incorrectly. We wanted there to be a salient, discriminable difference between a 30-sec intertrial interval following correct and incorrect responses (the presence of praise and a preferred food item vs. an absence of those stimuli). The goal of this procedure was to improve Beckham’s attending to the therapist’s S^D. After this procedure was introduced, Beckham’s correct responding stabilized in both conditions. Correct responding in Set A remained high during the interspersed phase. When we introduced training to Set B, correct responding increased in both conditions. The target in the P condition (put ring on stick) reached terminal mastery in seven sessions and the target in the No P condition (tap ring with stick) reached terminal mastery in nine sessions. Correct responding remained high during maintenance and interspersed sessions. As a result of experimenter error, we introduced training to Set C at the same time as Set B rather than in a staggered fashion. When we began training on Set C, correct responding increased in both conditions. Beckham mastered the target in the No P (wave flag) in eight sessions and the target in the P condition (put flag in book) in 10 sessions. We observed variable levels of correct responding after we moved both targets to maintenance, so we began the 30-sec intertrial interval
procedure with Set C. Correct responding remained variable following the implementation of this procedure. However, correct responding increased during the interspersed phase.

Figure 4-4 depicts Felicity’s results for Experiment 2b. Felicity engaged in low levels of correct responding during baseline for Sets A and B. After we began training for Set A, Felicity met terminal mastery criteria in five sessions in the P condition (ring on stick) and seven sessions in the No P condition (roll stick). Following the introduction of training to Set B, Felicity met terminal mastery criteria in three sessions in the No P condition (kiss token) and nine sessions in the P condition (put token under bowl). After training was introduced to Set A, correct responding increased for the targets in the No P condition in Sets C and D. Felicity met mastery for the No P target in Set C (tap rulers) during baseline; however, she did not exhibit any correct responses for the targets in the P condition for Sets C and D. After training began, Felicity met terminal mastery criteria in three sessions for the Set C target in the P condition (stack rulers).

When training began for Set D, Felicity met terminal mastery criteria in two sessions in the No P condition (drive car) and three sessions in the P condition (park car). Correct responding was somewhat variable in all four Sets following the introduction of the Interspersed phase. Felicity’s correct responding eventually stabilized at or above 80% correct in all four Sets. It is important to note that all objects used in a given Set were presented to the subject in an identical manner during each trial, regardless of whether both objects were used for a target response. For example, during all trials for Set A, both the stick and the foam ring were presented to Felicity even though the target in the No PP condition (roll stick back and forth) did not require her to manipulate the foam ring.

Table 4-2 summarizes Beckham and Felicity’s results for Experiment 2b. Table 4-2 is formatted in the same fashion as Table 4-1. For the two subjects in Experiment 2b, the No P
condition was more efficient than the P condition for three Sets and the two conditions were
equivalent for four Sets. Prior to conducting Experiments 2a and 2b, we hypothesized that
subjects would acquire the P targets faster than the No P targets because the product might serve
as a prompt. Thus, our findings that the P targets were never acquired more readily than the No P
targets were unexpected. Upon further consideration, we realized that the No P targets shared
topographical features that may have given rise to differential rates of acquisition. Most of the
No P targets that we used in Experiments 2a and 2b (and that are commonly used in clinical
practice) produced some form of accompanying auditory stimuli and were presented in a
repetitive fashion (tapping together, shaking, rolling back and forth). They were, in a sense,
dynamic in nature. To determine if these variables contributed to faster acquisition we sought to
design an experiment in which those features were held constant across the P and No P
conditions. The objective of Experiment 2c was to conduct a preliminary investigation of the
features of targets without permanent products that may influence rates of acquisition.

**Experiment 2c**

Figure 4-5 displays Avi’s results for Experiment 2c. Avi did not respond correctly in
either condition during baseline for Set A. When we introduced training to Set A, Avi mastered
the target in the No P condition (tap sticks) in three sessions and the target in the P condition
(turn sticks) in 11 sessions. During baseline for Set B, Avi exhibited low levels of correct
responding in both conditions. Training produced increases in correct responding and Avi
reached terminal mastery for the target in the No P condition (tap cup with knife) in four sessions
and for the target in the P condition (knife on cup) in 10 sessions. At the beginning of baseline
for Set C, Avi occasionally responded correctly during the P condition. Correct responding in the
P condition increased after the introduction of training to Sets A and B and terminal mastery
criteria for that target (raise doll arm) were met after 10 baseline sessions. Conversely, correct responding in the No P condition remained low throughout baseline. The introduction of training increased correct responding and Avi mastered the target in the No P condition (kiss baby) after eight training sessions. During the interspersed phase, correct responding remained high for all three Sets.

Figure 4-6 depicts Charlie’s results for Experiment 2c. During baseline for Set A, Charlie engaged in low levels of correct responding. Training produced increases in correct responding in both conditions. Charlie met terminal mastery for the target in the P condition (stack rulers) in 12 sessions and the target in the No P condition (tap rulers) in 15 sessions. After we moved both targets to maintenance, correct responding in both conditions was variable until session 97 when correct responding stabilized in both conditions. During the interspersed phase for Set A, we observed high levels of correct responding. Charlie never responded correctly during baseline for Set B. When we introduced training to Set B, correct responding increased in both conditions. Charlie mastered the target in the PP condition (raise doll arm) in five sessions and the target in the No P condition (hug doll) in eight sessions. After correct responding stabilized in both conditions, we moved these targets to the interspersed phase. Correct responding was high but variable during the interspersed phase. At the beginning of baseline for Set C, Charlie occasionally responded correctly in the No P condition. After we started training Set A, correct responding increased in the No P condition for Set C and that target (hit ring with stick) met terminal mastery after seven baseline sessions. In addition, after we introduced training to Set B, Charlie’s correct responding also increased in the P condition for Set C and he met mastery for the target in the P condition (ring on stick) after 10 sessions. However, improvement in the P condition was accompanied by decreases in correct responding for the target in the No P
condition. We introduced training to both targets to increase correct responding in the No P condition and to ensure that correct responding remained high in the P condition. After we observed high levels of correct responding in both conditions, we moved both targets to the interspersed phase where correct responding remained high.

Figure 4-7 depicts Lewis’s results for Experiment 2c. Lewis never responded correctly during baseline for Set A. When we introduced training to Set A, correct responding increased in both conditions. Lewis reached terminal mastery for the target in the No P condition (clap legos) in five sessions and the target in the P condition (stack legos) in eight sessions. After we moved the Set A targets to maintenance, correct responding remained relatively stable in the P condition but was variable in the No P condition for approximately 20 sessions. During baseline for Set B, Lewis never responded correctly in either condition. When we began training on Set B, correct responding increased in both conditions. Lewis reached terminal mastery for the target in the P condition (cover block with bowl) in 10 sessions and the target in the No P condition (hop block onto bowl) in 16 sessions. When we moved Set B targets to maintenance, correct responding was variable in both conditions until session 127. Lewis’s correct responding remained low during the interspersed phase for Set B. During baseline for Set C, we observed increases in correct responding in the P condition following the introduction of training to Set A. Lewis met mastery criteria for the target in the P condition (place knife on cup) after 12 baseline sessions. For reasons explained below, Lewis never met mastery for the target in the No P condition (tap cup with knife).

At session 148, there was an extended break from sessions due to the conflict between Lewis’s therapy provider and his health insurance company. Following the break, we observed low levels of correct responding from session 149 to 159. We began the two days of IT at session
160. For Set A, Lewis’s correct responding remained high during the sessions at the full-
physical, forearm, and elbow prompt levels. During the three independent sessions, his correct
responding stabilized at 70-80%. We observed a similar pattern of responding for Set B; correct
responding was relatively high during the sessions at the full-physical, forearm, and elbow
prompt levels and remained stable at 70-80% correct during the three independent sessions. For
Set C, Lewis’s correct responding was high during the sessions with prompting; however, correct
responding decreased to chance levels during the three independent sessions.

Table 4-3 summarizes Avi, Charlie, and Lewis’s results for Experiment 2c. Table 4-4 is
formatted in the same fashion as Table 3. Across the three subjects in Experiment 2c, the No P
condition was more efficient for five out of nine Sets. The P condition was more efficient for
four out of nine Sets. Results suggest that in Experiment 2c, the No P condition and the P
condition were equally efficient. These findings stand in contrast to the findings of Experiments
2a and 2b; both earlier experiments suggested that the No P targets were usually acquired faster
than the P targets.

Table 4-4 depicts the results of our error analysis. Our analysis reveals that we recorded
subject errors at least 80% of the time for the five subjects across Experiments 2b and 2c. Our
analysis also indicates that the proportion of discrimination errors was high \( M = 71\% \), although
there was variation across individual subjects.

**Discussion**

Across Experiments 2a and 2b, the No P condition was more efficient for six of 14 Sets
and equivalent to the P condition for remaining eight Sets. In other words, across all 14 Sets of
targets, the P condition was never more efficient than the No P condition. Collectively, the
results of Experiments of 2a and 2b suggest that when No P targets are presented in a manner
consistent with clinical practice (i.e., repetitive), they may be more readily acquired by some
children with ASD during imitation training. In Experiment 2c, the No P condition was more efficient for approximately half of the Sets and the P condition was more efficient for approximately half of the Sets. In other words, when repetition and auditory feedback were controlled across the P and No P conditions, rates of acquisition were equivalent. These findings suggest that these two variables could be the features of No P targets that were responsible for the differential acquisition we observed in Experiments 2a and 2b. A more detailed analysis of repetition and auditory feedback during imitation training can be found in the Experiment 3 discussion.

These outcomes are especially interesting, given that, prior to these experiments, we hypothesized that the P condition would be more efficient because the product could potentially serve as a prompt for the correct response. It is not possible to determine if the product did or did not serve as a prompt for the subjects in our experiments. However, our results suggest that in the context of object imitation training, the presence of a product did not enhance acquisition.

Many curriculums designed to help practitioners develop skill programs for children with ASD (Maurice et al., 1996; Partington, 2008; Sundberg, 2008) suggest that imitation training should begin with object motor imitation or gross motor imitation. Ledford and Wolery (2011) also concluded that imitation training should begin with object imitation training. More research is needed to determine if, in fact, it is advantageous to begin imitation training with objects. Our findings suggest that object imitation training might present some unique risks with respect to stimulus control that could have implications for clinical practice.

In a simple discrimination arrangement, a single stimulus exerts control over responding. For example, in an operant chamber, lever pressing can be brought under the control of a light. In the presence of the light, lever presses produce food and in the absence of the light, lever presses
do not produce food. During Experiment 2a, the programmed $S^D$ was the therapist’s model (and vocal instruction) of the target response using an object. However, because only one target response was modeled with each object, it is possible correct responding was under the control of the object, rather than the model. Thus, relying solely on simple discrimination arrangements when teaching object imitation in clinical practice could be problematic. If a child learns 20 different actions with 20 different objects, we might mistakenly conclude that the child has “mastered” object imitation when in fact the child’s responding is not imitative. Only one of the three curriculum guides commonly used by practitioners to develop skill programs for young children with ASD specifies that children should be taught more than one response with each object (Partington, 2008).

The results of our error analysis for Experiments 2b and 2c, suggest that faulty stimulus control can also develop during conditional discrimination arrangements. In a conditional discrimination arrangement, two stimuli exert control over responding. Reinforcement is, in a sense, conditional on the second stimulus. For example, in an operant chamber, lever pressing can be brought under the control of a blue and yellow lights. Lever presses produce food only in the presence of both lights. Lever presses do not produce food in the presence of the blue light only, the yellow light only, or in the absence of both. During training, we used a massed trials format in which only a single response was targeted in each session. The high proportion of discrimination errors during this phase suggests that, for at least a portion of the training phase, subject responding was likely under control of the object and not therapist’s model.

Thus, for some of the Sets in Experiments 2a, 2b, and 2c, it may be more precise to describe our outcomes in terms of object motor responses rather than object motor imitative responses. In other words, when faulty stimulus control is present, the child’s responding is not
imitative. Rather, the child is emitting one of the two responses (with a given object) that have been prompted and followed by the reinforcer delivery. For the Sets in which faulty stimulus control was present (as evidenced by a high proportion of discrimination errors) it may be more precise to describe our findings in the context of learning motor responses (i.e., No P object motor responses may be learned more readily) rather than in the context of imitation training. It is possible that the development of faulty stimulus control during object imitation training might be less likely if: (a) simple discrimination procedures are eschewed in favor of conditional discrimination procedures (i.e., multiple responses are taught with each object), and (b) an interspersed trial format is used at the start of training. It might be beneficial for future researchers to compare rates of acquisition for No P and P targets when object imitation is taught with these considerations in mind.

Another limitation of these experiments concerning stimulus control is that it is possible that the position of the objects on the table could have served as unprogrammed S\textsuperscript{D}s for target responses. In the case of the No P condition, responding could have been under control of the starting position. In the case of the P condition, responding could have been under control of the final product. Thus, subject responding would not have been imitative.

Despite these limitations, the results from Experiments 2a, 2b, and 2c may have important implications for clinical practice. As Ledford and Wolery (2011) point out, an empirically validated instructional sequence for imitation training does not exist. There are no evidenced-based guidelines for determining which subtype(s) of imitation (gross motor vs. vocal) should be taught first or how target responses should be selected and sequenced. Although preliminary, our findings suggest that object imitative responses that do not leave products may be acquired more readily by some children with ASD.
Figure 4-1. Results for Avi in Experiment 2a.
Figure 4-2. Results for Felicity in Experiment 2a.
Figure 4-3. Results for Beckham in Experiment 2b.
Figure 4-4. Results for Felicity in Experiment 2b.
Figure 4-5. Results for Avi in Experiment 2c.
Figure 4-6. Results for Charlie in Experiment 2c.
Figure 4-7. Results for Lewis in Experiment 2c.
Table 4-1. Results summary for Experiment 2a.

<table>
<thead>
<tr>
<th>Subject</th>
<th>No PP</th>
<th>PP</th>
<th>Best condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set A</td>
<td>3</td>
<td>5</td>
<td>Equivalent</td>
</tr>
<tr>
<td>Set B</td>
<td>BL</td>
<td>4</td>
<td>No P</td>
</tr>
<tr>
<td>Set C</td>
<td>BL</td>
<td>BL</td>
<td>Equivalent</td>
</tr>
<tr>
<td>Felicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set A</td>
<td>5</td>
<td>4</td>
<td>Equivalent</td>
</tr>
<tr>
<td>Set B</td>
<td>BL</td>
<td>2</td>
<td>No P</td>
</tr>
<tr>
<td>Set C</td>
<td>BL</td>
<td>3</td>
<td>No P</td>
</tr>
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Table 4-2. Results summary Experiment 2b.

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<th>Subject</th>
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</tr>
</thead>
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<td>Beckham</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Set A</td>
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<td>6</td>
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</tr>
<tr>
<td>Set B</td>
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<td>7</td>
<td>Equivalent</td>
</tr>
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<td>Set C</td>
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<td>10</td>
<td>Equivalent</td>
</tr>
<tr>
<td>Felicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set A</td>
<td>7</td>
<td>5</td>
<td>Equivalent</td>
</tr>
<tr>
<td>Set B</td>
<td>3</td>
<td>9</td>
<td>No P</td>
</tr>
<tr>
<td>Set C</td>
<td>BL</td>
<td>3</td>
<td>No P</td>
</tr>
<tr>
<td>Set D</td>
<td>2</td>
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<td>Equivalent</td>
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Table 4-3. Results summary for Experiment 2c.

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<th>Set C</th>
<th></th>
<th></th>
<th>Best condition</th>
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<tr>
<td></td>
<td>4</td>
<td>10</td>
<td>No P</td>
<td></td>
<td></td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>BL</td>
<td>BL P</td>
<td></td>
<td></td>
<td>P</td>
</tr>
<tr>
<td>Charlie</td>
<td>15</td>
<td>12</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>5</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BL</td>
<td>BL</td>
<td>No P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lewis</td>
<td>5</td>
<td>8</td>
<td>No P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>16</td>
<td>No P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>BL</td>
<td>P</td>
<td></td>
<td></td>
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Table 4-4. Results summary for error analysis.

<table>
<thead>
<tr>
<th>Subject</th>
<th>% of recorded errors</th>
<th>% of discrimination errors</th>
</tr>
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<tbody>
<tr>
<td>Experiment 3b</td>
<td>Felicity 89%</td>
<td>61%</td>
</tr>
<tr>
<td></td>
<td>Beckham 81%</td>
<td>89%</td>
</tr>
<tr>
<td>Experiment 3c</td>
<td>Avi 90%</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Lewis 95%</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Charlie 94%</td>
<td>45%</td>
</tr>
<tr>
<td>Overall mean</td>
<td>90%</td>
<td>71%</td>
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</table>
CHAPTER 5
EXPERIMENT 3

Purpose

The results of Experiment 2 suggested that object imitative responses that are repetitive may be acquired more quickly by some children with ASD than responses that are not repetitive. When a therapist models a repetitive response, they are in a sense, repeatedly demonstrating the target action very quickly. In other areas of research such as instructional design, moving or rapidly changing stimuli are characterized as “dynamic” stimuli. Dynamic stimuli can be contrasted with static stimuli which do not involve rapid movement. Based on our findings from Experiment 2, we sought to examine the acquisition of dynamic and static imitative responses without objects. The purpose of Experiment 3 was to replicate and extend the findings of Experiment 2 and to determine if dynamic or static imitative responses are more readily acquired by children with ASD during gross motor imitation training.

Experimental Design

We used a concurrent multiple baseline across targets with an embedded multi-element design to compare acquisition of static and dynamic gross motor imitative responses. We selected six gross motor imitation targets that each subject, three static targets and three dynamic targets. To allow us to use an ongoing model (explained below), we selected targets that only required the movement of one arm or one leg so that the therapist could model the response while simultaneously delivering prompts. One static target and one dynamic target were assigned to a Set. We presented trials in mass trial format across all phases. Following baseline, training was introduced in a staggered fashion to Sets A, C, and C. During baseline and training, the two targets in a given set were conducted in an alternating fashion; we used http://www.random.com to randomize the sessions in each series.
Based on our findings from Experiment 1, we used an ongoing model during both conditions and across all phases of this experiment. After the SD was presented, the therapist continued to model the target response until the end of the trial. In other words, the model continued throughout the subject’s opportunity to respond. Therefore, the model could last up to 6 s (3-s SD model + 3 s response interval). We also used the hand holding procedure from Experiment 2. During the SD presentation, the therapist held the child’s hands (or legs) still and upon finishing the SD, the therapist released the subjects’ hands. We did this to ensure that SD presentation was equivalent across the two conditions (the model was presented for a full 3 s before the subjects were given the opportunity to respond). Our criterion to progress through the training phases and our terminal mastery criteria were the same as Experiment 2.

**Experiment Phases**

**Baseline**

Baseline sessions consisted of ten independent trials. The therapist did not deliver prompts or implement error correction procedures. The therapist delivered a neutral statement following each trial. Three times per session, between randomly selected trials, the therapist presented a trial for a mastered task (i.e., matching colors). If the child responded correctly, the therapist delivered a reinforcer. If the child responded incorrectly, the therapist re-presented the trial, prompted a correct response, and delivered a reinforcer.

**Training**

Training sessions consisted of 10 trials (with the addition of an initial probe trial during prompt phases). At the beginning of each training session, the therapist presented an array of top items from the preference assessment. The therapist held up the selected items and stated, “You are working for [items].” When the subject responded correctly, the therapist presented the array
and the subject selected one item. Training consisted of different phases: the Independent phase, the 6:4 prompt phase, and the 3:7 prompt.

**Maintenance**

Maintenance sessions consisted of five independent trials of a mastered target response. The session procedures were identical to the Independent phase.

**Experimental Conditions**

**Static**

Targets in the static condition did not involve repetitive movement. For example, if the target imitative response was “touch head,” the therapist placed their hand on their head and kept it still for the duration of the model presentation.

**Dynamic**

Targets in the dynamic condition were presented in a repetitive manner. For example, if the target imitative response was “rub tummy,” the therapist placed their hand on their stomach and moved it up and down repeatedly (approximately 1 repetition per second) for the duration of the model presentation.

**Results**

For all Experiment 3 figures, the subject’s percentage of correct responding on independent trials is displayed for Set A (top panel), Set B (second panel), and Set C (third panel). BL stands for the baseline phase and TRAINING stands for the training phase. Arrows indicate when mastery criteria were met and targets were moved to maintenance. For ease of visual analysis, a separate maintenance phase is not depicted. However, an arrow indicating mastery and a break in the data path denote that a target was mastered and moved to maintenance.
Figure 5-1 depicts Ace’s results for Experiment 3. During baseline for Set A, Ace never responded correctly during either condition. After training was introduced to Set A, correct responding increased in both conditions and Ace met terminal mastery criteria for the dynamic target (pat shoulder) in nine sessions and the static target (raise arm) in 14 sessions. During baseline for Sets B and C, Ace’s correct responding remained at zero across both conditions for many sessions. However, we observed increases in correct responding during baseline for both dynamic targets in Sets B and C when Ace began to acquire the dynamic target that we were training in Set A. The dynamic target in Set B (rub tummy) and the dynamic target in Set C (slide foot) were both mastered in baseline. We also observed increases in correct responding for the static target in Set C (extend leg) at the same time that correct responding for the static target being trained in Set A increased. The static target in Set C was also mastered in baseline. We did not observe similar increases in correct responding during baseline for the static target in Set B (touch toes) so we introduced training to that target. Ace mastered the static target in Set B after three training sessions.

Figure 5-1 shows Beckham’s results for Experiment 3. During baseline for all Sets, Beckham engaged in low levels of correct responding. Following the introduction of training to Set A, he met terminal mastery for the dynamic target (rub tummy) after five sessions and the static target (touch shoulder) after 12 sessions. When we began training for Set B, we observed an immediate increase in correct responding for the static target (hand on waist) which met mastery after five sessions. However, after the static target was moved to maintenance we observed variability prior to the end of the experiment. Beckham did not acquire the dynamic target (flap arm) in Set B during the course of this experiment. An analysis of his errors for this target suggest that a previously learned response (wave) with topographical similarity to flap arm
may have interfered with the acquisition of the flap arm response. It is possible that with continued training, Beckham could have acquired this response. However, his learning history appeared to compete with the acquisition of the target response and he did not learn the dynamic target for Set B within the course of this experiment. After we introduced training to Set C, Beckham mastered the dynamic target (slide foot) after four sessions and the static target (touch toe) after five sessions.

**Discussion**

Ace’s results suggest that for him, dynamic targets were acquired more readily than static targets during gross motor imitation training. Beckham’s results suggest that for him, dynamic and static targets were acquired at similar rates. Given these mixed findings, additional subjects are needed before we can draw conclusions about how readily dynamic and static targets are acquired during gross motor imitation training.

Although additional subjects are needed for Experiment 3, Ace’s results are consistent with results from Experiment 2 as well as findings from other research areas. Research on pedestrian and vehicle safety suggests that dynamic (flashing) beacons are more effective at producing behavior change than static beacons (Hunter, Srinivasan, & Martell, 2012; Shurbutt, Van Houten, & Turner, 2008; Van Wagner, Van Houten, & Betts, 2011). Samuels (1985) found that 3-month old infants were more likely to attend (as measured by gaze fixation) to faces in motion and eyes that were blinking relative to stationary faces and non-blinking eyes. In addition, a review of dynamic and static instructional presentations found that dynamic visual displays (e.g., videos) produce improved learning outcomes when compared to static displays (e.g., two-dimensional graphics; Park & Hopkins, 1993). Van Wagner et al. (2011) suggested that dynamic discriminative stimuli might produce changes in behavior more readily than static discriminative stimuli because they are more salient. Although it is important for children to
learn to imitate both static and dynamic responses (Partington, 2008), our results and the findings from other researchers suggest that it may be beneficial for practitioners to begin gross motor imitation training with dynamic responses rather than static responses.

**Motor Imitation Scale**

We assessed subjects’ pre-experiment and post-experiment imitation skills using the MIS (Stone et al., 1997) for Experiments 2 and 3. The results of these assessments are depicted in Table 5-2. Imitation scores increased for all subjects with the exception of Avi’s scores prior to and following Experiment 2c. It is unclear why his MIS score decreased following Experiment 2c; it is possible that motivational variables might have influenced responding. Due to experimenter error, we failed to conduct the MIS with Felicity following Experiment 2c. In addition, we were unable to complete the post-experimental MIS with Lewis.
Figure 5-1. Results for Ace in Experiment 3.
Figure 5-2. Results for Beckham in Experiment 3.
Table 5-1. Results summary for Experiment 3.

<table>
<thead>
<tr>
<th>Subject</th>
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<th>Static</th>
<th>Best condition</th>
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<tbody>
<tr>
<td>Ace</td>
<td>Set A</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Set B</td>
<td>BL</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Set C</td>
<td>BL</td>
<td>BL</td>
</tr>
<tr>
<td>Beckham</td>
<td>Set A</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Set B</td>
<td>N/A</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Set C</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 5-2. Results for Motor Imitation Scale.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Pre</th>
<th>Post</th>
</tr>
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<tr>
<td>Experiment 2a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avi</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Felicity</td>
<td>9</td>
<td>13</td>
</tr>
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<td>Experiment 2b</td>
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<tr>
<td>Beckham</td>
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<td>14</td>
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This series of studies aimed to serve as a first step toward identifying efficient strategies for teaching imitation to children with ASD and to conduct preliminary investigations of the types of imitative responses that are most readily acquired. Our findings from Experiment 1 indicate that using an ongoing-model $S^D$ presentation during imitation training may influence rates of acquisition, especially for children who exhibit substantial difficulties learning imitation.

**$S^D$ Presentation**

Results from Experiment 1 suggest that, for some children, an ongoing-model $S^D$ presentation might be more efficient (i.e., targets may be acquired more rapidly) than a delayed-model $S^D$ presentation when teaching gross motor imitation to children with ASD. Our findings replicate those of Valentino et al. (2017) who also found that an ongoing-model $S^D$ presentation was superior to a delayed-model $S^D$ presentation for one subject during imitation training. We also extended the findings of Valentino et al. by isolating the effects of an ongoing-model $S^D$ presentation. Our results indicate that the ongoing-model $S^D$ presentation, not the use of a second therapist, may have been responsible for the obtained difference in rates of acquisition.

Research indicates that delayed match-to-sample tasks are more difficult than standard match-to-sample tasks (Davidson & Osborne, 1974; Grant, 2011) and that correct matching decreases as a function of delay (Blough, 1959). The longer the delay between the sample stimulus and the presentation of the comparison stimuli, the larger the decrements in correct matching. Imitation differs from match-to-sample tasks because there are no comparison stimuli from which to select for the subject. Nevertheless, the conditions in our experiment are analogous to standard and delayed match-to-sample tasks. Our delayed-model conditions are similar to a delayed match-to-sample arrangement in that the model is no longer present during
the response interval and our ongoing-model condition is similar to a standard match-to-sample arrangement because the model is present during the response interval. This conceptualization is further supported by our findings, which are consistent with previous match-to-sample research. Thus, the use of an ongoing-model $S^0$ presentation during gross motor imitation training might be a beneficial strategy for some children with ASD.

**Difficulty of Imitative Responses (targets)**

Our results from Experiments 2 and 3 indicate that there are topographical features of imitative responses that may influence acquisition during imitation training for children with ASD. The findings from Experiment 2 suggest that object imitation responses that do not leave products may be acquired by some children with ASD more quickly than responses that do leave a product. We also found that repetition and auditory feedback may be the variables responsible for the differential rates of acquisition we observed. The findings from Experiment 3 suggest that dynamic, rather than static responses may be more readily acquired by some children during gross motor imitation training.

Research has suggested that children with ASD attend to environmental stimuli differently than typically developing children. Overselectivity, underselectivity, attentional shifting deficits, and a lack of sensitivity to social stimuli (Brown & Bebko, 2012; Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Dawson et al., 2004; Renner, Klinger, & Klinger, 2006) have all been noted. Dawson et al., (1998) reported that when compared with typically developing children and children with Down Syndrome, children with ASD were less likely to orient to nonsocial stimuli and far less likely to orient to social stimuli. Failing to orient to stimuli is now considered to be an early indicator of ASD (Robins, Fein, & Barton, 2009). According to the social motivation theory framework of ASD, impairments in responsivity to social stimuli result in decreased learning opportunities during early childhood and, ultimately,
abnormal developmental trajectories (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012). Decreased responsiveness to social stimuli has also been reported during imitation tasks (Gonsiorowski, Williamson, & Robins, 2015; Hobson & Hobson, 2007). Orienting to social stimuli (a model) is an essential pre-requisite skill for imitation. Therefore, strategies that increase the likelihood that a child with ASD will orient to a model could be useful. As noted earlier, research across a number of areas suggests that dynamic stimuli might evoke attending responses and produce behavior change more readily than static stimuli. Taken together with our findings that dynamic responses with and without objects may be acquired more readily by children with ASD, these outcomes suggest that using dynamic responses at the start of imitation training programs might be a useful strategy when teaching imitation to children with ASD.

**Generalization and Other Theories**

Our results from Experiments 2 and 3 give rise to a number of interesting considerations regarding the emergence of imitative behavior. Many researchers (Baer et al., 1967; Baer & Sherman, 1964; Brigham & Sherman, 1968; Garcia et al., 1971; Poulson, Kyparissos, Andreatos, Kymissis, & Parnes, 2002; Young et al., 1994) have demonstrated that as long as some imitations are reinforced, every single response does not need to be reinforced in order for imitative behavior to persist. These findings support the conceptualization of generalized imitation as a higher-order response class (Catania, 2007; Peterson, 1968). An individual is said to have a generalized imitative repertoire when a wide variety of discriminative stimuli (a stimulus class) evoke imitative responding. The majority of subjects in Experiments 2 and 3 mastered target responses during baseline. A number of mechanisms could account for the acquisition of imitative responses in the absence of training.

The development of generalized imitation is one possible mechanism that could account for the emergence of correct responding to untrained targets. However, this account is cogent
only when correct responding emerges for multiple targets (rather than just one target or in one condition). We observed three instances of this pattern of responding (Avi, Experiment 2a, Charlie Experiment 2c, and Ace Experiment 3). Ace is the only subject who may have developed generalized imitation during the course of the Experiment. For Ace, we observed increases in three untrained targets, across two different conditions. In addition, the marked improvement from Ace’s pre-experiment MIS to his post-experiment MIS also support this account. Ace’s results can be contrasted with the results obtained for Avi in Experiment 2a and Charlie in Experiment 2c. Given the score of Avi’s post-experiment MIS and his initial baseline performance in Experiment 2c, it is unlikely his correct responding in baseline during Experiment 2a can be accounted for by generalized imitative responding. Similarly, Charlie’s post-experimental MIS score and his performance in the later phases of Experiment 2c suggest that it is unlikely that he developed generalized imitation during the course of the experiment.

Another potential mechanism that could account for the acquisition of imitative responses in the absence of training is a form of generalization that is different from the development of a generalized imitation. An individual with a generalized imitative repertoire can imitate a seemingly endless number of novel, untrained responses under a variety of different antecedent conditions. The formation of a broad, all-encompassing functional response class does not develop immediately when children begin exhibiting imitative responses. There is some evidence that there may be subclasses of imitation that are distinct from one another along topographical boundaries (Baer & Deguchi, 1985). For example, if a child learns to imitate a number of movements involving their arms, generalization to untrained arm movements may be observed but generalization to vocal responses is unlikely. In other words, the emergence of new imitative responses in the absence of training or direct reinforcement may be function of the topographical
similarity of trained responses to untrained responses. Several studies have demonstrated that when imitative behavior is emerging in children, generalization is sometimes constrained to a subclass (Garcia et al., 1971; Poulson et al., 2002; Young et al., 1994). These studies, conducted with typically developing children and children with ASD, have reported generalization within but not across subclasses.

Historically, the boundaries of these topographical subclasses have been defined by the body parts involved in the imitative responses (gross motor vs. fine motor vs. vocal) or the presence or absence of objects. In other words, imitative responses that are similar to each other with respect to these features have been grouped together by imitation researchers and clinicians. However, topography may not be the only feature or dimension by which subclass boundaries can be drawn. It may be more useful to think about the development of subclasses in terms of a generalization gradient. A generalization gradient is obtained by taking repeated measurements of a response in the presence of an initial $S^D$ as well as in the presence of $S^D$s which differ from the initial $S^D$ along some dimension (i.e., the brightness of a light in an operant chamber). Higher levels of responding are obtained in the presence of $S^D$s that differ only slightly from the initial $S^D$ and lower levels of responding are obtained in the presence of $S^D$s that differ markedly from the initial $S^D$.

To apply the generalization gradient concept to the emergence of a subclass of imitative responses, consider an example. If the first imitative response that a child learns is waving a flag back and forth, we might observe an increase in imitative responses that: (a) involve the child’s dominant arm, or (b) involve objects that resemble a flag, or (c) involve moving a limb back and forth, or (d) involve dynamic, repetitive movement, or (e) any combination of these features. It is
possible that we could observe generalization to new responses along any one of these dimensions of the trained response.

Thus, it is possible that within-subclass generalization could account for the remaining instances for which we observed correct responding emerge during baseline (Felicity, Experiments 2a and 2b, Avi Experiments 2a and 2c, Charlie, Experiment 2c, and Lewis Experiment 2c). The results of Experiment 2c suggested that repetition and auditory feedback could be the features of No P targets that accounted for differential acquisition in Experiments 2a and 2b. All but one of the No P targets in Experiments 2a and 2b shared those features. It is possible that, for some subjects, a subclass formed consisting of dynamic movements with objects. This could account for the fact that increases in correct responding to untrained responses were limited to members of that subclass (No P targets).

One limitation of all of the experiments was that although we tried to counterbalance target difficulty across conditions, we cannot be certain that the targets were perfectly equal with respect to difficulty. However, this limitation is not specific to our study and is a general limitation of studies aimed at comparing effective treatment strategies for teaching new skills. Replication of our findings would provide additional support to our preliminary conclusions. Another limitation of the current study is that we did not do a formal analysis of subject characteristics and outcomes. For example, the results of Experiment 1 indicated that the two-therapist ongoing-model condition had the larger effect for the participant who, prior to the study, had failed to acquire imitation despite previous imitation instruction (Dawson). Future research could evaluate whether participant characteristics influence the effects of S\textsuperscript{D} presentation and the types of imitative responses targeted.
The long-term goal of this research is to develop a comprehensive, empirically based set of guidelines for teaching imitation to children with ASD. This series of studies is an important step toward that goal. We evaluated two types of SD presentation and found that an ongoing-model SD presentation might be a useful strategy for practitioners to use during imitation training with children with ASD. We also investigated the types of imitative responses that are most readily acquired by children with ASD. The results of these investigations suggest that for some children with ASD, dynamic responses might be acquired faster than static responses (both with and without objects). The outcomes from this series of studies, although preliminary, are in alignment with research from a variety of other areas including match-to-sample research, pedestrian and vehicle safety research, and instructional design research. Thus, our findings could be a useful step in the development of empirically based guidelines for teaching imitation to children with ASD.
LIST OF REFERENCES


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BIOGRAPHICAL SKETCH

Meghan received her bachelor’s degree in Communication Sciences from the University of Vermont in 2005. She completed her master’s degree in education at the University of Massachusetts Lowell in 2011 and her doctoral degree in psychology with an emphasis on the experimental analysis of behavior in 2018 from the University of Florida.