EFFECTS OF REINFORCEMENT HISTORIES ON COMMUNICATION MODALITY PREFERENCE

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Abstract

Autism Spectrum Disorder (ASD) is characterized by deficits in communication. Training in vocal approximations and/or augmentative and alternative communication (AAC) modes may be required to overcome these deficits. Because it may be difficult to determine a best communication fit for each student, one solution is to assess students' preference for the different communication topographies. Several factors have been found to influence preference, including parameters of reinforcement, parameters of a response, reinforcement histories, and stimulus cues. The present investigation specifically examined the effects of reinforcement histories and associative salient stimuli on communication modality preference in two students with autism. The two modalities under investigation were vocal approximations and a speech-generating device (SGD). After acquiring labels of items with the two modalities, both participants showed an initial preference for the SGD. One participant continued to label items with the SGD, even when he did not access reinforcement for responding with that modality. For another participant, when reinforcement histories were established with the different modalities—first vocals, then the SGD—his preference shifted to match whichever modality was most recently reinforced. His preferences were unaffected by the presence of salient cues, suggesting that reinforcement histories alone may influence students' preference for different communication topographies.

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TABLE OF CONTENTS

LIST OF FIGURES

Effects of Reinforcement Histories on Communication Modality Preference

Introduction

Autism Spectrum Disorder (ASD) is characterized by deficits in communication. Approximately 25%-50% of children with ASD do not develop spoken language (Anderso, Oti, Lord, & Welch, 2007; Frankel, Leary & Kilman, 1987; Peeters & Gillberg, 1999; Tager-Flusberg & Kasari, 2013). One strategy to overcome these deficits includes training vocal speech/vocal approximations (e.g., Carr & Durand, 1985). Additionally, in instances where vocal speech remains absent, extremely limited, or unintelligible, augmentative and alternative communication (AAC) modes may be used (Beukelman & Mirenda, 2005; Schlosser, 2003). AACs include speech-generating devices (SGDs; Lancioni et al., 2007); picture exchange (PE; Bondy & Frost, 1994; Bondy & Frost, 2001); and the use of manual sign language (MS; Lloyd, Fuller, & Arvidson, 1997). In addition to providing a mode of communication where it may otherwise be absent, research indicates that using AACs may help to facilitate spoken language (e.g., Ganz & Simpson, 2004; Iacono & Duncum, 1995; Tincani, 2004).

A number of studies have looked at acquisition rates for the different communication modalities (e.g., Beck et al., 2008; Iacono, Mirenda, & Beukelman, 1993; Tincani, 2004). Findings from these comparison studies indicate that rates of acquisition for different communication topographies (e.g., PE versus MS) may vary as a function of individual student characteristics. For example, Tincani (2004) compared the acquisition rates of mands using MS and PE in two children with autism. Prior to intervention, participants were able to imitate words and/or phrases, but neither engaged in spontaneous speech, and gesturing was their primary mode of communication. Additionally, before treatment, participants' motor imitation skills were assessed to ascertain the relationship between preexisting motor imitation abilities and

subsequent acquisition of PE and MS. Participants' appropriate vocal productions were also assessed throughout the intervention. Tincani (2004) found that one participant acquired PE more rapidly than MS; the other participant acquired MS more rapidly than PE. Notably, the participant acquiring MS more rapidly than PE had moderate motor imitation skills prior to intervention. However, the participant acquiring PE more rapidly than MS had weak hand-motor imitation skills, suggesting that motor imitation skills may be one individual student characteristic influencing acquisition of different communication modalities. Finally, the researcher found that vocalizations increased for both participants during sign language training (e.g., saying "cookie" after independently signing the item), and vocalizations during PE training increased for one participant after a reinforcement delay was incorporated into the procedure. The latter finding again underscores the importance of teaching AACs, as these alternative modalities may facilitate spoken language.

Because there is no single identifiable modality that works best across individuals, and because acquisition of different modalities may differ as a function of individual student characteristics (e.g., Tinani, 2004), researchers have advocated assessing individual student preference as a factor for determining communication fit (e.g., LaRue et al., 2016; Sigafoos, O'Reilly, Ganz, Lancioni, & Schlosser, 2005; Van der meer et al., 2012). Importantly, providing choice and assessing preference is consistent with the principle of self-determination – an educational outcome that may improve students' quality of life into adulthood (Sigafoos et al., 2005; Wehmeyer & Schwartz, 1997). Wehmeyer (1996) defined self-determination as "acting as the primary causal agent in one's life and making choices and decisions regarding one's quality of life free from undue external influence or interference" (p.22). In a follow-up study using self and parent-reports, Wehmeyer and Schwartz (1997) measured adult outcomes of adolescent high

school students with intellectual and learning disabilities. The researchers found that students with high, compared to low, self determination scores were more likely to want to live outside their family home, to have a bank account, to be employed for pay, and to earn more money one year after graduating from high school. Because preference is consistent with self-determination (Sigafoos et al., 2005), their study supports the value of assessing student preference for different activities within an educational context, which includes students' preferred mode of communication.

Assessing Communication Modality Preference

Researchers have examined student preference for different communication modalities. For example, Sigafoos et al. (2005) utilized a choice-making paradigm to assess student preference for different communication modalities. Two adolescents with developmental disabilities were taught to mand using three different types of VOCAs. After acquisition, all three VOCAs were available simultaneously, and participants were allowed to choose which one to use. When given the opportunity to choose, both participants demonstrated a clear preference for using one of the three VOCAs. After the choice assessment, participants were taught to mand using a communication board. After acquisition, they were given the choice to mand using either the previously preferred VOCA or the communication board. Both participants preferred the VOCA to the choice board, though one participant intermittently selected the choice board. In both investigations, participants demonstrated a clear modality preference; however, factors influencing their preference remained unclear.

LaRue et al. (2016) developed a brief assessment model to determine which communication modalities represent a "best fit" for individuals with ASD. The researchers evaluated the rate of acquisition and preference for three communication modalities (i.e., card

touch, manual sign, and vocal approximation) for three students. The models consisted of three phases: pre-assessment, acquisition of labels, and choice analysis. During the pre-assessment, items were probed and selected if they were not already in the learner's repertoire. During the acquisition phase, participants were taught to label the unfamiliar items using all three modalities. Finally, during the choice analysis, participants were concurrently presented with all three communication options and were allowed to select their preferred modality when labeling the acquired items. The researchers found that participants acquired labels at different rates across the different modalities. Additionally, they found that rate of acquisition corresponded to preference; specifically, when given a choice, students tended to select the topography associated with fastest acquisition.

Van der meer et al. (2012), also examined the relationship between response acquisition and communication preference. They compared acquisition of three different modes of AAC— SGD, PE, and MS— among four participants with developmental disabilities. Rather than assessing preference only after acquisition of the different modalities, the researchers assessed student preference throughout the intervention. Two participants reached criterion for all of the modalities and showed a preference for communicating with the SGD. Additionally, during follow up, these participants maintained responding with their preferred modality. Two participants achieved acquisition for the SGD and PE, but failed to achieve criterion for the MS option. One participant demonstrated a preference for the SGD; the other demonstrated a preference for the PE. One possibility for their failure to acquire manual sign responding may have been due to their lack of preference for the MS option, which interfered with their motivation to learn to use that form of communication. This highlights the importance of assessing preference even during the early stages of the intervention process. Specifically, while

rate of acquisition may influence preference (LaRue et al., 2016), the inverse may also be true: Lack of preference may inhibit motivation to learn. In conclusion, though learners may demonstrate a preference for one modality over another, it is important to investigate the variables that might influence their preferences.

Review of Variables Influencing Preference

Examining how a student allocates responding among simultaneously available response options (i.e., choice) provides an indicator of student preference (Fisher & Mazur, 1997). Therefore, in order to understand student preference, it is important to assess factors influencing response allocation. Basic and applied research has demonstrated that a number of factors influence response allocation. Factors include different reinforcer parameters, such as rate, quality, immediacy, and magnitude of reinforcement (Catania, 1963; Fisher & Mazur, 1997). Response parameters – specifically, response effort – have also been shown to influence choice (Fisher & Mazur, 1997). Finally, reinforcement histories and salient associative stimuli (i.e., stimulus control) may influence student responding under current conditions (St. Peter Pipkin & Vollmer, 2009). Below is an overview of the different parameters affecting response allocation, and, by extension, preference.

Regarding the first reinforcement parameter—rate of reinforcement— basic (e.g., Herrnstein, 1961) and applied (e.g., Baum, 1975; Conger & Killeen, 1974; Schroeder & Holland, 1969) research has demonstrated that response allocation is often influenced by different schedules of reinforcement for concurrently available response options. Specifically, according to the matching law, when an organism is presented with concurrent variable interval schedules of reinforcement, responding will be distributed such that the relative rate of one response will approximate its relative reinforcement rate (Herrnstein, 1961). Conger and Killeen (1974) found

similar effects in a natural setting. During a group discussion involving college students, they found that the proportion of time students spent talking to different confederates was proportional to the positive statements delivered by each confederate.

In another study involving a human operant procedure, St. Peter Pipkin, Vollmer, and Sloman (2010) used an analogue differential reinforcement of alternative behavior (DRA) treatment to examine the effects of different types of DRA treatment integrity failures on response allocation. DRA integrity failures include errors of omission (i.e., failing to reinforce appropriate responses); errors of commission (i.e., reinforcing inappropriate responses); and combined errors (i.e., both omission and commission errors). In one experiment investigating the impact of combined errors on response allocation, participants were exposed to a task that simulated DRA procedures. They looked at a blank computer screen containing one red circle and one black circle that moved in random directions. Also on the computer screen was a cumulative point score. Clicking on the black circle equated to engaging in problem behavior and clicking on the red circle was analogous to engaging in appropriate behavior. Participants were exposed to different conditions in a reversal design. Conditions included baseline, full-integrity DRA, and four treatment integrity failure phases—80%, 60%, 40%, and 20% integrity. During baseline, clicking on the black circle (analogous to problem behavior) was reinforced on an FR 1 schedule; clicking on the red circle (analogous to appropriate behavior) produced no reinforcement. During full integrity DRA, clicking on the black circle produced no reinforcement, and clicking on the red circle was reinforced on an FR 1 schedule. During treatment integrity failure conditions investigating combined errors, the different responses were reinforced on random ratio schedules, such that the higher the integrity, the denser the reinforcement for appropriate responses, and lower the integrity, the richer the reinforcement for

inappropriate responses. For example, in the 80% integrity phase for combined omission and commission errors, there was an 80% probability that clicking the red circle (i.e., appropriate behavior) was reinforced and a 20% probability that clicking the black circle (i.e., inappropriate behavior) was reinforced, equating to few omission and commission errors.

St. Peter Pipkin et al. (2010) found that participants' rates of problem behavior were high and appropriate behavior low during baseline phases, with a reversed pattern during full-integrity DRA conditions. Additionally, participants engaged in high rates of appropriate behavior and low rates of inappropriate behavior when treatment integrity was at 60% or higher. However, when treatment integrity dropped to 40% or lower, participants' response allocation switched: They engaged in more inappropriate responses than appropriate responses. These results may be explained by different rates of reinforcement for the two response types: Participants allocated responding toward the response producing denser reinforcement. These results were replicated in a follow up experiment with a student with autism exposed to a real DRA treatment for off task behavior (St. Peter Pipkin et al., 2010). The participant engaged in more on task behavior and less off task behavior, and completed more tasks per minute, when treatment integrity was at 80% or 60%. When treatment integrity was at 20% or 40%, she engaged in more off task than on task behavior. These results further suggest that response allocation may be affected by different rates of reinforcement for the different responses. Participants may prefer engaging in responses leading to denser reinforcement than responses in which reinforcement is thinned.

In addition to rate of reinforcement affecting response allocation, quality of reinforcement is another dimension affecting choice. Neef, Mace, Shea, and Shade (1992) investigated the impact of rate and quality of reinforcement on response allocation in three students in a special education program. Consistent with the matching law, they found that

students allocated responding across two concurrently available tasks in proportion to the rate of reinforcement received for those tasks. However, for two of the participants, when quality of reinforcement varied across the two schedules, responding shifted in favor of the task earning the higher quality reinforcer, even when the higher quality reinforcer was paired with the leaner reinforcement schedule. In another applied study, Piazza et al. (1997) demonstrated that, for two participants with severe behavior problems, access to higher quality reinforcement for compliant behavior (i.e., breaks and tangibles) compared to destructive behavior (i.e., break alone) led to preference for and response allocation toward compliance.

In addition to quality and rate of reinforcement, immediacy of reinforcement is another parameter influencing choice. Basic research has demonstrated an inverse relationship between rate of responding and delay to reinforcement (Chung, 1965; Chung, 1967). That is, when delay to reinforcement for one response increases relative to another response, frequency of engagement in that response decreases relative to the response leading to more immediate reinforcement. Researchers with human and nonhuman subjects have defined the term self-control as preference for a larger, more delayed reinforcer over a smaller, more immediate reinforcer, whereas, impulsivity is defined as making the opposite choice (Ainslie, 1974, 1975; Grosch & Neuringer, 1981; Logue, 1988; Mischel, 1966; Rachlin & Green, 1972). Solnick, Kannenberg, Eckerman, and Waller (1980) investigated impulsivity in human subjects. When participants were given the choice to immediately terminate an aversive sound for 90 seconds or terminate the sound for 120 seconds after a delay of 60 seconds, they often chose the immediate, smaller reinforcer. Logue and King (1991) investigated preference for a smaller, more immediate primary reinforcer (i.e., juice) versus a larger, more delayed reinforcer in 19 typically developing adult females. The researchers found substantial between-subject variability in responding, with

some subjects exhibiting complete self-control and others preferring to respond impulsively. Specifically, subjects who were currently dieting were more likely to respond impulsively.

Additionally, magnitude (i.e., duration, quantity, or intensity) of reinforcement is a parameter influencing response allocation. In basic research, Catania (1963) used a concurrent procedure and found a positive linear relationship between response rate and duration of reinforcement. Applied research has yielded similar results with concurrent arrangements. For example, Hoch, McComas, Johnson, Faranda, and Guenther (2002) examined the effects of magnitude and quality of reinforcement on student choice between two play areas – one with and one without a peer. When both areas contained equal magnitude reinforcers (i.e., 50 second access to same high quality toy), one student with autism consistently preferred the room without his peer. However, when magnitude of reinforcement was altered such that the room with the peer led to longer access to the high quality reinforcer (i.e., 90 seconds versus 10 seconds), the student chose to play in the room with his peer for the majority of sessions.

Thus far, the effects of reinforcement parameters on preference have been examined. An additional factor influencing preference involves the parameters of the response— in particular, response effort. Basic (e.g., Chung, 1965) and applied (e.g, Horner & Day, 1991) research has examined the effect of response effort on preference. For example, in basic research with pigeons, Chung (1965) found that, when pigeons were required to peck a single key, rate of responding decreased as force requirement moved from low to high. Chung (1965) also examined the effect of various response force requirements on rate of responding on concurrent schedules of reinforcement, which are relevant to choice making. When force requirements to access reinforcement on one key were increased or decreased relative to the other key, no contrast effects were observed. That is, response rates did not increase on the lower weight key

(e.g., 25 g) when the weight of the other key increased (e.g., to 150g). These effects were observed when reinforcement schedules for both responses were on the same VI schedule. However, Chung (1965) then examined the interactive effect of response effort and rate of reinforcement on response allocation. While the matching law predicts that relative distribution of responding on concurrent schedules matches relative rate of reinforcement, Chung's (1965) research found an interactive effect between response effort and rate of reinforcement on response allocation. Specifically, when force requirements systematically and simultaneously increased on both schedules, rate of responding on the leaner schedule decreased more than would be predicted by the matching law. In fact, response suppression on the leaner schedule was observed at the extreme value of force required to make the response.

In applied research, Horner and Day (1991) investigated the impact of response efficiency (i.e., schedule of reinforcement, latency, and physical effort) on functional equivalence training. For one individual with severe mental retardation and escape-maintained aggression, the researchers manipulated the physical effort of functionally equivalent mand responses in order to assess effect on aggression. When given the choice between aggression and a high effort appropriate mand (signing "I want to go, please"), the participant overwhelmingly preferred aggression (e.g., hitting, biting, or scratching). However, when given the choice between aggression, a high effort appropriate mand (signing "I want to go, please."), or a low effort appropriate mand (signing "break"), the learner overwhelming preferred to engage in the socially appropriate, low effort response. This suggests that, when presented with a choice, students may prefer to engage in the response requiring the least amount of effort.

In addition to examining immediate reinforcement and response parameters, it is important to examine how a student's reinforcement history influences behavioral assessments

and interventions. Specifically, an individual's exposure to different schedules of reinforcement in the past may have an impact on current behavioral responding, despite exposure to new contingencies (St. Peter Pipkin & Vollmer, 2009). Relatedly, the effects of reinforcement history may, by extension, have an impact on choice responding under current conditions.

The impact of recent reinforcement histories on response allocation is elucidated in another subset of St. Peter Pipkin et al.'s (2010) experiments described under rate of reinforcement. In this subset, the researchers again investigated the impact of combined errors on participants' response allocation during an analogue DRA task. However, unlike the other subsets involving varying degrees of integrity failures, participants within this subset were exposed to 50% integrity on each component—i.e., omission and commission errors. That is, 50% of appropriate responses (i.e., clicking on the red circle) went unreinforced, and half of all inappropriate responses (i.e., clicking on the black circle) were reinforced. Baseline and full-integrity phases were identical to those within the other subsets. Clicking on the red circle (i.e., analogous to appropriate behavior) produced no reinforcement and clicking on the black circle (i.e., analogous to problem behavior) produced reinforcement on an FR 1 schedule during the baseline phase. In the full integrity DRA phase, clicking on the black circle produced no reinforcement, and clicking on the red circle was reinforced on an FR 1 schedule. Participants were exposed to the error phase following two baseline phases and two full-integrity DRA phases. The purpose of this design was to investigate sequence effects, or carryover between phases as a result of exposure to specific schedules of reinforcement. The researchers found that for some participants, their responses during the error phases matched their responses during the previous baseline or full-integrity DRA phase—whichever phase came immediately before it. That is, sequence effects were observed for these participants. They continued to allocate

responding toward the response that was mostly recently reinforced: Following baseline, they engaged in high rates of problem behavior (i.e., allocated responding toward clicking the black circle); following full-integrity DRA, they engaged in high rates of appropriate behavior (i.e., allocated responding toward clicking the red circle). Of note, no session-correlated stimuli were associated with the different conditions.

In a follow up applied experiment, St. Peter Pipkin et al.'s (2010) findings were replicated with a participant classified as mentally handicapped, who engaged in high rates of aggressive behaviors maintained by attention. He was exposed to the same conditions as participants in the analogue DRA experiment: Baseline, full integrity DRA, and 50% integrity failure. During baseline, his aggressions were reinforced on an FR 1 schedule, and all appropriate greetings were ignored. During full integrity DRA, appropriate greetings were reinforced on an FR 1 schedule and all aggressions were ignored. During the 50% integrity failure phases, both aggressions and appropriate greetings had an equal probability of accessing reinforcement. Integrity failure phases followed two baselines and two full integrity phases. Consistent with findings from the human operant experiment, high rates of aggressions and low rates of greetings occurred during baseline conditions; higher rates of greetings and lower rates of aggressions occurred during full integrity DRA. Furthermore, the participant demonstrated far more aggressions than greetings during 50% integrity failure phases following baseline phases than following full integrity DRA phases, again elucidating the impact of sequence effects on response allocation. Overall, these human operant and applied experiments suggest that recent reinforcement histories may influence how participants allocate responding under current conditions, even when they are exposed to new contingencies.

Although St. Peter Pipkin et al.'s (2010) investigation found that recent reinforcement histories affect preference under current conditions, an experimental study by Weiner (1969) found that remote reinforcement histories may exert more control over rate of responding under current conditions than more recent histories. Weiner (1969) examined the effects of reinforcement history schedules on button pressing during target schedules. Participants were first exposed to one of three different schedules of reinforcement: an FR 40, a DRL 20-sec, or a DRL 20-sec followed by an FR 40 schedule. The FR 40 schedule yielded high rates of responding; the DRL 20-sec schedule yielded low rates of responding; and the DRL 20-sec followed by FR 40 schedules yielded low and high rates of responding, respectively. After, participants were conditioned under an FI target schedule (e.g., FI 600 sec). Participants with the FR 40 reinforcement history continued to respond at high rates during the FI target schedule. Participants with a DRL 20-sec history consistently responded at low rates during the FI target schedule, and the rate of responding for participants in the compound group (i.e., DRL 20 sec followed by FR 40 schedule history) was just as low as participants in the DRL 20-sec alone group. The latter finding suggests that intervening reinforcement histories may not override the effects of more remote schedules of reinforcement on current behavior, despite substantial exposure to intervening and target schedules.

While non-human research also suggests that reinforcement history influences responding, there is some evidence contradicting Weiner's (1969) findings on the durability of reinforcement history effects. For instance, LeFrancois and Metzger (1993) conditioned rats to respond using bar presses. One group of rats was assigned to a DRL history schedule; another group of rats was assigned to a DRL followed by an FR history schedule. Next, both groups of rats were exposed to an FI target schedule to determine the effects of reinforcement history on

current responding. Consistent with Weiner's (1969) findings, rats in the DRL alone condition responded at low rates during the history condition and continued to respond at low rates during the target FI condition. Additionally, rats in the compound condition responded at low rates during the DRL history condition followed by high rates during the FR history condition. During the FI target condition, however, they continued to respond at relatively high rates, which contradicts Weiner's (1969) findings that remote learning histories may exert more control over current behavior than immediate learning histories. LeFrancois and Metzger (1993) postulated different possibilities for these discrepant results, including procedural differences (e.g., reinforcer type), pre-experimental histories, and differences in verbal behavior between non-humans and humans.

These discrepant results may also be attributable to differences in schedule-correlated stimuli. Specifically, a remote history schedule may exert more control over responding during a target schedule if the same salient stimulus is present during both conditions. For example, Ono and Iwabuchi (1997) exposed pigeons to a multiple DRH DRL schedule, with a different stimulus associated with each schedule (i.e., red or green keys). After, they exposed pigeons to a VI baseline schedule with a different associated stimulus (i.e., white key), and then exposed the pigeons to the same VI schedule, but alternated the key color between white, green, and red. Pigeons responded at higher rates in the presence of the stimulus associated with the previous DRH schedule and at lower rates in presence of the stimulus associated with the DRL schedule, despite receiving reinforcement on a VI schedule. In another cycle, pigeons also responded at differentially higher and lower rates during the test condition when a six-month gap was introduced between the DRH DRL training schedule and the VI baseline schedule. This suggests that, in the presence of discriminative stimuli, the effects of reinforcement history maintain over

long periods of time. These findings have relevance to application. Specifically, when students respond differently to the same behavioral intervention, differences in their reinforcement history schedules and corresponding discriminative stimuli associated with these schedules should be considered (St. Peter Pipkin & Vollmer, 2009).

Related to the previously described impact of salient discriminative stimuli on current behavioral responding, applied research has explicitly examined the impact of stimulus control on response allocation. When the frequency, latency, duration, or amplitude of a response alters depending upon the presence or absence of a discriminative stimulus, then the response is said to be under control of that stimulus (Cooper, Heron, & Heward, 2014). Below is a review of two studies that have examined the impact of stimulus control on response allocation (i.e., Fisher, Kuhn, & Thompson, 1998; Winborn-Kemmerer et al., 2010).

In an applied study, Fisher et al. (1998) examined the impact of stimulus control on functional communication. Two participants with severe problem behavior maintained by access to attention and/or tangibles were taught to make appropriate requests for attention and tangibles using vocals or signs. After, they were taught to emit the target communication response only in the presence of a discriminative stimulus and not in its absence, thus bringing the communication responses under stimulus control. Specifically, a picture of preferred toys indicated the availability of toys following an appropriate request; a picture of physical/verbal interactions indicated the availability of attention following an appropriate mand for attention. Emission of the correct response resulted in access to reinforcement on an FR1 schedule. When the discriminative stimulus was absent, communication led to no consequence. After discrimination training, both participants' rates of appropriate requests were high in the presence of the target discriminative stimulus (e.g., They manded for attention in the presence of the picture of

attention.). Their requests for a particular reinforcer (e.g., attention) did not occur in the absence of the picture signaling its availability. For example, they did not mand for attention in the presence of the picture of toys. Additionally, rates of destructive behavior remained at zero or low levels when reinforcement was available for an appropriate communicative response. Overall, their study elucidates the impact of stimulus control on response allocation: Preference for a particular reinforcer, and preference to engage in an appropriate mand for that reinforcer, may shift in the presence of certain discriminative stimuli.

In another applied study, Winborn-Kemmerer et al. (2010) investigated the impact of stimulus control on mand topography preference in two individuals with developmental disabilities and severe problem behavior. Specifically, they examined whether the topography of mand selection would change in the presence of two stimulus conditions: one condition contained a play card and the other condition contained no card. Prior to the investigation, the participants' existing mand topographies included pointing to preferred items, vocal speech, or manual signs. As part of the investigation, they were taught to touch the play card as their novel mand. After acquisition, when participants were given the choice between using an existing mand topography or the novel topography, both participants overwhelmingly preferred the novel mand (i.e., touching the play card). In the absence of the play card, however, they made requests using their existing topographies (i.e., manual signing or vocal speech), and they did so at even higher rates than during baseline. This suggests that the play card served as a discriminative stimulus that prompted the topography of card touching, despite having other mand forms within their existing repertoire.

Present Study

In conclusion, several variables influence response allocation; how an individual allocates responding amongst concurrently available options yields important data on preference. Factors influencing preference include immediate reinforcement parameters, response parameters, and reinforcement histories and corresponding salient stimuli (i.e., stimulus control). Previous research has examined student preference for different communication topographies (e.g., Sigafoos et al.; 2005; LaRue et al., 2016; Van der meer et al., 2012). However, factors influencing preference for one communication modality over another remained unclear. As such, the present study sought to extend the work of previous researchers by manipulating specific variables shown to influence preference. While all parameters are worthy of investigation, the current study focused specifically on the impact of reinforcement histories and session correlated stimuli on communication modality preference in students with autism.

In clinical practice, it has been observed that students with multiple communication topographies within their existing repertoire (e.g., AACs and vocals) may exhibit preference for one modality over another in the presence of different individuals. For instance, a student may engage in high rates of manding using his iPad, and low rates of manding using vocal approximations, in the presence of his lead teacher. On the other hand, he may engage in high rates of manding using vocal approximations, and low rates of manding using his iPad, in the presence of his speech therapist. The research presented herein would predict that his preference for using one modality over the other may be related to differences in reinforcement histories associated with each individual; these individuals serve as the salient discriminative stimuli associated with these reinforcement schedules (St. Peter Pipkin & Vollmer, 2009; Fisher et al., 1998; Winborn-Kemmerer et al., 2010). Specifically, certain caregivers may reinforce the use of

one communication modality at higher rates than other modalities. As such, the individual will choose to respond at high rates using that modality, even if reinforcement is available for different topographies under current conditions. Importantly, the individual will engage in higher rates of responding using one communication form only in the presence of the caregiver associated with the denser reinforcement history schedule, suggesting that the caregiver serves as the salient stimulus (i.e., stimulus control) impacting preference. The present study specifically examined these variables.

To assess communication modality preference, and shifts in preference related to reinforcement histories and associative discriminative stimuli, the current investigation used similar procedures to those used by Van der meer et al. (2012) and St. Peter Pipkin et al.'s (2010) investigation on 50% treatment integrity failures, but with the addition of session correlated stimuli to serve as teacher analogues. Two forms of communication were targeted and compared for preference— vocal approximations and an SGD—in two students with autism. Additionally, in order to avoid the risk of satiation or fluctuations in motivating operations (LaRue et al., 2016), participants were taught to label target stimuli, rather than make requests, using the two modalities. Participants' acquisition of, and preference for, the two modalities were compared, and preference assessments (with and without session correlated stimuli) were included throughout the intervention process. Following acquisition of the modalities and an initial preference assessment, reinforcement histories in the presence of associative discriminative stimuli were established for each modality to measure subsequent effect on preference. Two salient stimuli were used to serve as analogues to teachers. Specifically, a distinctive tablecloth (placed over the instructional table) was paired with the SGD trials, and a distinctive tablecloth was paired with vocal approximations trials. Instructors also wore correlated T-shirts to signal

SGD and vocal approximation trials. Session correlated stimuli were also present during the acquisition phase for the different modalities. Additionally, efforts were made to keep all other parameters affecting preference consistent throughout the study (e.g., keeping quality and magnitude of reinforcement consistent between the two communication responses).

Based on previous findings, we hypothesized that students would acquire skills at different rates across the two modalities (LaRue et al., 2016). Furthermore, we predicted that students would show a preference for using one modality over the other (Van der meer et al., 2012). Finally, we predicted that preference for a specific modality would correspond to the presence of the color of the tablecloth and t-shirt that were present during acquisition and reinforcement histories trials for the selected modality. When the stimuli associated with the vocal approximation trials were present during preference assessments, we predicted that participants would be more likely to prefer the vocal modality; when the stimuli associated with the SGD trials were present during preference assessments, we predicted that participants would be more likely to prefer the SGD.

Methods

Participants

Two Participants were recruited from the Douglass Developmental Disabilities Center (DDDC). Both participants were under the age of 18 and were diagnosed with Autism Spectrum Disorder (ASD). Both had limited communication skills but sufficient motor skills to use the SGD; neither participant had any auditory or visual impairment that would interfere with their ability to use the SGD. Both participants engaged in vocal and motor stereotypy. For Jake, his stereotypy was redirectable; for Seth, his vocal stereotypy often interfered with completion of trials and appeared related to fluctuations in motivating operations.

Seth was a 14-year-old boy who communicated vocally using single words, which were often unintelligible according to staff reports. Seth used his own iPad, containing Proloquo2Go software, to request items using three word sentences: "I want" (one icon) and then the name of the item (one icon). Seth's speech therapist reported that Seth had approximately 20-25 labels within his existing vocal repertoire, all single word nouns. Seth did not label items using his SGD, but only used his iPad for requesting items. Though Seth generally had poor fine motor abilities, he was able to touch icons on his own iPad to request items, and he was able to touch pictures on the iPad provided during the present investigation for purposes of labeling.

Seth also engaged in high levels of motor and vocal stereotypy throughout the school day. During sessions for the present investigation, his motor stereotypy primarily consisted of hand flapping against the table. Notably, his motor stereotypy did not interfere with his ability to respond using the SGD, as it was easily redirected through listener instructions (e.g., "hands down") or simply waiting for the motor stereotypy to terminate independent of vocal redirection. Seth's vocal stereotypy was more disruptive to sessions. In addition to engaging in repetitive non-contextual vocalizations, Seth engaged in saliva play, during which he used his oral muscles to repeatedly move spit in and out of his mouth. Though the instructor waited for Seth to have a quiet and calm mouth before delivering instructions, Seth occasionally engaged in vocal stereotypy or saliva play after instructions were delivered. His vocal stereotypy and saliva play did not interfere with his ability to respond using the SGD, though it did interfere with responses requiring vocal approximations. Additionally, his vocal stereotypy and saliva play appeared to be related to fluctuations in motivating operations. When Seth was highly motivated for a tangible item, he requested it clearly using single word vocalizations and engaged in clear vocal labels to access the preferred item. On the other hand, when Seth's motivation for items decreased— often

evidenced by Seth merely gesturing toward an item during informal preference assessments, or selecting the item with his iPad alone— his vocal stereotypy increased and correct task completion decreased. Because Seth's vocal stereotypy and saliva play also interfered with task completion throughout his school day, an independent functional analysis was conducted at the time the present investigation was underway. It was determined that Seth's vocal stereotypy and saliva play were maintained by automatic reinforcement.

Jake is a nine-year-old boy who communicated vocally using single word sentences, which were occasionally unintelligible per staff reports. Like Seth, Jake was able to request items on his own SGD (an iPad containing Proloquo2Go software) using three word sentences: The "I want" carrier phrase (one icon) plus the name of the item (one icon). Jake's speech therapist reported that Jake had approximately 10 single word nouns within his existing vocal label repertoire. Jake labeled a minimum of 20 one-word nouns using his SGD. Jake's fine and gross motor abilities were age-typical, per teacher reports. Like Seth, Jake engaged in vocal and motor stereotypy. His vocal stereotypy consisted of non-contextual, repetitive sounds, which were often paired with motor stereotypy. His motor stereotypy consisted of pressing the palms of his hands together and rubbing back-and-forth rapidly and repeatedly. His motor stereotypy was easily redirected through listener instructions or light physical prompts. When Jake's motor stereotypy was redirected, his vocal stereotypy simultaneously stopped and neither interfered with his completion of trials throughout the investigation.

Setting and Intervention Context

Participants were the first and only two individuals recruited from the Douglass Developmental Disabilities Center (DDDC)—a school for individuals with ASD. Sessions with Seth took place within a private research room down the stairs from his main classroom. These

sessions took place during regular morning or afternoon instructional time, or during his regular lunch break. Jake's sessions took place within his main classroom during afternoon instructional or snack time. The trainer (study's main author) implemented all study procedures in a one-to-one context with each participant.

Stimuli

Target stimuli for labeling. Target stimuli were pictures of three Moshi Monster characters, the names of which were one syllable in length: Kook, Pip, and Scamp. Moshi monster characters were selected due to the their novelty and limited possibility of participants' exposure to these stimuli outside the study's sessions. All three images were printed in color against a white background, laminated, and then cut into approximately 2.5 x 2.5 inch square shapes.

Teacher analogues. Distinctive stimuli associated with the different modalities included blue and yellow tablecloths and t-shirts. Specifically, a light blue rain poncho and blue buttoned down t-shirt were paired with vocal approximations acquisition and reinforcement histories sessions, as well as specific preference assessment sessions. During these sessions, the blue rain poncho covered the instructional table and the instructor wore the blue t-shirt. A light yellow rain poncho and yellow t-shirt were paired with SGD sessions (i.e., SGD acquisition and reinforcement histories sessions), and pre-determined preference assessment sessions. The yellow rain poncho covered the instructional table and the instructor wore the yellow t-shirt during target sessions.

Speech-Generating Device (SGD). The SGD modality was present on the instructional table during all sessions incorporating the SGD option. The SGD was an iPad with Proloquo2Go software. Touching the Proloquo2Go app on the iPad's main page brought up a single page

containing pictures of all three Moshi Monster Characters: Kook, Pip, and Scamp. Each character was 1.8 x 1.8 inches and the position of each character on the page was randomly rotated throughout the investigation. Touching each character activated corresponding speech output: The spoken word "Kook" was produced when the picture of Kook was touched; "Scamp" when the picture of Scamp was touched; and "Pip" when the picture of Pip was touched. The pictures of the Moshi Monster characters on the SGD were identical to the sample pictures presented during labeling trials, with the exception of size. When presented with the SGD, participants were only exposed to the single page containing the three characters.

Vocal approximations. A picture signaling the *vocal approximations* modality was present during target sessions. The picture was a 4x4 inch laminated photo of an open cartoon mouth and a speech bubble against a solid white background. The tail of the speech bubble was pointed toward the open mouth. The speech bubble consisted of a black outline containing solid white in the middle, which matched the solid white background of the photo.

Reinforcers. Preferred items used as reinforcement for correct responding varied throughout the study due to participant fluctuations in motivating operations. Items were determined by informal preference assessments conducted immediately prior to every trial (described under Procedures). Preferred stimuli selected by Seth primarily included edible items, such as cookies, skittles, and Pop-Tarts. Non-edible items were selected periodically and included a squishy ball, beads, and video games on a separate iPad. For Jake, preferred items consisted of edible and non-edible items and physical play with the instructor. Indian snack rolls were the preferred edible item. Non-edible items selected included lotion, a pink pop tube, putty, a maraca, and watching videos and playing puzzles on a separate iPad. Physical play requests were for tickles, specifically. In order to avoid satiation and maintain motivation across trials,

edible items were delivered in small portions following correct responses (e.g., one skittle or edible portions approximating .5 inches in diameter). Non-edible items were delivered for approximately 10 seconds.

Response Definitions and Measurement

During *vocal approximations* trials, correct responding was defined as independently labeling each target stimulus using appropriate vocal approximations. Correct responding during *SGD* trials was defined as independently touching the correct target symbol on the screen when presented with the sample stimulus and all three characters present on the SGD. When Kook was presented as the sample stimulus, the correct response was defined as touching the comparison picture of Kook on the screen, which activated corresponding speech output, "Kook." Similarly, when Scamp or Pip were presented, the correct response was defined as correctly touching the picture of Scamp or Pip on the SGD, which immediately activated corresponding synthetic speech outputs "Scamp" or "Pip."

Acquisition phase measurements. Percentage of correct responses was calculated during all acquisition sessions. Percentage of correct prompted responses was calculated by dividing the total number of correct prompted responses by the total number of trials and then multiplying by 100 (i.e., (correct prompted responses/total number of trials) X 100) for each session. The percentage of correct independent responses was calculated by dividing the total number of correct independent responses by the total number of trials and then multiplying by 100 (i.e., (correct independent responses/total number of trials) X 100) for each session. Finally, the percentage of total correct responses was determined by adding the number of correct prompted and independent responses, dividing that number by the total number of trials, and then multiplying by 100 (i.e., ((correct prompted + correct independent)/total number of trials) X 100)

for each session. The percentage of total correct responses was used to inform progression through the prompting hierarchy (described under Procedures). Only percentage of independent correct responses per session was graphed and used to determine mastery of each modality. Mastery criterion for each modality was defined as 80% or higher correct responding at the independent level across three consecutive sessions (i.e., (correct independent responses/total number of trials) X 100 ≥ 80% across three consecutive sessions).

Preference phase measurements. For all preference assessment (with and without stimuli) and reinforcement histories sessions, percent modality selected was calculated. For each session, the total number of trials a specific modality was selected was divided by the total number of trials, and then multiplied by 100 (i.e., (number trials specific modality selected/total number of trials) X 100). Specifically, to calculate percent SGD selected per session, the following formula was used: (total trials SGD selected/total number of trials) X 100. To calculate percent vocal modality selected, the formula was (total trials vocals selected/total number of trials) X 100. Finally, during preference assessment and reinforcement histories sessions, participants often labeled items using both modalities (either simultaneously or one immediately after the other) within a single trial. As such, percent both modalities were selected per session was calculated using the following formula: (total trials SGD and vocals selected/total number of trials) X 100.

Preference was determined when the participant achieved 80% or higher responding with a single modality—SGD, vocal, or both—across three consecutive sessions (i.e., (Total SGD or Total Vocal or Total Both/Total Trials) X 100 ≥ 80% across three consecutive sessions). Finally, establishing reinforcement histories with a specific modality was determined when the participant achieved 80% or higher correct responding with the target modality across three

consecutive sessions. If reinforcement histories were established with the SGD, discontinuation of the reinforcement histories condition occurred when the participant selected the SGD during 80% of trials across three consecutive sessions: (total trials SGD selected/total number of trials) X 100 ≥ 80% across three consecutive sessions. Finally, if reinforcement histories were established with vocal approximations, discontinuation of the reinforcement histories condition occurred when the participant responded using only vocal approximations during 80% of trials across three consecutive sessions: (total trials vocal selected/total number of trials) X 100 ≥ 80% across three consecutive sessions.

Experimental Design

The study consisted of two phases: Acquisition and Preference. An alternating treatments design was embedded within the Acquisition phase of the investigation to compare participants' performance with the vocal modality and the SGD. During the Preference phase, a reversal design was utilized to assess student preference for the different modalities before and after reinforcement histories were established, and to compare preference in the presence and absence of salient stimuli. The Preference phase included the following conditions: Preference Assessments (No Stimuli), Reinforcement Histories (With Stimuli), and Preference Assessments (With Stimuli).

Session Schedule

Two to 16 sessions were conducted two to three days per week. Trials per session ranged from four to 12. Sessions per day did not exceed 45 minutes of students' regular instructional time. For all sessions, the participant and trainer were seated side-by-side at the student's regular instructional table (Jake), or across from one another at a table in a separate research room (Seth). During 37.3% of sessions, an independent observer was located within five feet of the

trainer and participant to collect data on interobserver agreement (IOA) and, during 34.9% of those sessions, to also collect data on treatment integrity (TI). During the Acquisition phase, once a participant achieved acquisition with one AAC, maintenance sessions were conducted on that modality every three to eight sessions with the modality still under acquisition.

Procedures

Informal preference assessments. With the exception of baseline and pre-assessment sessions, informal preference assessments were conducted prior to all trials within both phases of the investigation. Informal preference assessments were conducted in order to determine potential reinforcers for correct responses throughout the different phases.

During these preference assessments, the instructor placed three-to-four items directly on the instructional table within the participant's reach, or presented two items at a time— one in each of the instructor's hands, both of which hovered just above the instructional table. With items presented, the instructor asked, "What do you want to work for?" or "What do you want to earn?" Potential reinforcers were selected if the participant manded for an item using vocal approximations, a gesture toward a preferred item, or their separate iPad containing Proloquo2Go software. If the participant did not select one of the items presented, the instructor rotated through different items until a selection was made. Additionally, in the case of physical play, the instructor presented the option by stating the name of the activity—e.g., "tickles"—and positioning her hands in such a way as to represent the activity. The participant made the selection of a physical activity through vocal approximations or touching the correct item on his SGD. Occasionally, participants selected items using pure mands. That is, when motivation for an item was high but had not yet been presented by the instructor, participants requested the item

using vocal approximations or their SGD. When participants made these requests, the instructor immediately retrieved the item and delivered it contingent on correct responding to trials.

Pre-assessment. Prior to baseline, pre-assessments were conducted to ensure participants were able to discriminate between the distinctive stimuli to be paired with the different modalities. Pre-assessments consisted of an identical math-to-sample conditional discrimination task. Solid blue, yellow, and red color cards were used as sample and comparison stimuli. All three comparison stimuli were placed randomly on the participant's instructional table. Each trial consisted of the instructor presenting a sample stimulus and instructing the participant to "match" the sample to its identical stimulus on the instructional table. Correct responding was defined as the participant placing the sample stimulus on top of, or directly next to, its identical comparison stimulus. No reinforcement was provided for correct responding. Both participants responded correctly to all three trials. Blue and yellow were selected as the session correlated salient stimuli to be used during the investigation due to existing stimuli at the DDDC. Descriptions of the stimuli are described above under "Teacher analogues."

In addition to match-to-sample tasks, echoic probes were conducted to ensure participants were able to approximate the names of target items. Echoic trials consisted of the instructor telling the participant to say, "Pip," "Scamp," and "Kook." Reinforcement in the form of social praise was provided for correct responding. Seth correctly imitated all three echoic targets during the pre-assessment. For Jake, the investigators accepted "Koo" as an appropriate approximation for "Kook."

Acquisition Phase

Baseline. Baseline consisted of one SGD session and one vocal approximations session. These sessions were held to ensure participants were unable to engage in the response prior to

teaching. No session-correlated stimuli (i.e., blue or yellow t-shirt and tablecloth) were present during baseline sessions.

Each baseline session consisted of 12 trials, with four trials of each Moshi Monster character presented in counterbalanced order. Each trial consisted of the trainer presenting a picture of the target Moshi Monster and asking, "Who is it?" No corrective feedback was provided for correct or incorrect responding. During the SGD session, only the SGD was present on the instructional table. The instructor varied the position of the SGD on the table, which was always within reach of the participant. Additionally, the instructor intermittently rotated the three comparison stimuli on the main screen of the SGD. During the vocal approximations session, only the laminated picture indicating the vocals option was present on the instructional table, the position of which also varied throughout the baseline session.

Teaching procedures. Both vocal approximations and corresponding SGD responses were taught in this condition. Teaching trials for both modalities were paired with distinctive stimuli: The vocal trials were paired with the blue stimuli and the SGD trials were paired with the yellow stimuli. Sessions for each modality were alternated in counterbalanced order to prevent order effects. Each session consisted of 12 trials, with all three targets presented four times in counterbalanced order (as in baseline). Mastery criterion was defined as 80% or higher correct responding across three consecutive sessions (i.e., (Correct Independent/Total Trials) X $100 \geq 80\%$ per session, across three consecutive sessions).

Vocal approximations. During all vocal approximations sessions, the instructor wore the blue t-shirt, and the blue rain poncho covered the instructional table. Additionally, the laminated photo indicating the vocals options was present in various positions on the instructional table throughout all vocal approximations sessions.

Each trial consisted of the instructor presenting a picture of the target stimulus and asking, "Who is it?" (i.e., the discriminative stimulus, or SD) followed immediately by the predetermined prompt for that session. The prompting hierarchy consisted of a full echoic prompt, followed by a five-second delay, followed by the independent level. With the full echoic prompt, the instructor provided the full vocal model immediately after presenting the SD. When the five-second delay prompt was utilized, the instructor presented the SD, then waited five seconds before providing the full vocal model if the participant failed to respond within the five second time frame. Prompts were faded when the participant engaged in 80% or higher correct responding at one prompt level across two consecutive sessions (i.e., (correct prompted + correct unprompted)/total trials X 100 ≥ 80%). Specifically, if the participant responded correctly during 10/12 or more trials across two consecutive sessions when provided with a full echoic prompt, then the instructor faded to a five-second delay. If the participant responded correctly during 10/12 or more trials across two consecutive sessions with a five-second delay, then the instructor faded to the independent level. Finally, if the participant engaged in 50% or lower correct responding across two consecutive sessions ((correct prompted + correct unprompted)/total trials X 100 ≤ 50%) at one prompt level, the instructor returned to the previous prompt level. Reinforcement in the form of social praise and a preferred item or activity was delivered on a fixed ratio of one (FR1) schedule for correct responding on all prompted and unprompted trials.

Regarding error correction, if a participant responded incorrectly during a prompted or independent trial, the instructor immediately vocalized the name of the item (i.e., "It's Scamp," "It's Pip," or "It's Kook"), and then immediately presented the next trial. During prompted trials, if the participant did not respond within five seconds of the prompt, then the instructor

immediately vocalized the name of the item (i.e., “It’s Scamp,” “It’s Pip,” or “It’s Kook”), and then immediately presented the next trial. During independent trials, if the participant did not respond within five seconds of the delivery of the SD (i.e., “Who is it?”), then the instructor vocalized the name of the item (e.g., “It’s (name of item)”) and then immediately presented the next trial. No reinforcement was provided for incorrect or no responses.

SGD. During all SGD sessions, the instructor wore the yellow t-shirt, and the yellow rain poncho covered the instructional table. The SGD was present in various positions on the instructional table, within reach of the participant, throughout all SGD sessions.

Each trial consisted of the instructor presenting a picture of the target stimulus and asking, “Who is it?” followed immediately by the predetermined prompt for that session. The prompting hierarchy consisted of a gesture prompt, followed by a five-second delay (to gesture toward correct item on SGD), followed by the independent level. Prompts were faded when the participant engaged in 80% or higher correct responding at one prompt level, across two consecutive sessions (i.e., (correct prompted + correct unprompted)/total trials X 100 ≥ 80%). Specifically, if the participant responded correctly during 10/12 or more trials across two consecutive sessions when provided with a gesture prompt, then the instructor faded to a five-second delay. If the participant responded correctly during 10/12 or more trials across two consecutive sessions with a five-second delay, then the instructor faded to the independent level. If the participant engaged in 50% or lower correct responding across two consecutive sessions ((correct prompted + correct unprompted)/total trials X 100 ≤ 50%) at one prompt level, the instructor returned to the previous prompt level. Finally, after every one to four trials, the instructor randomized the position of the comparison stimuli on the SGD in order to prevent acquisition of side biases (Sidman, 1992). Reinforcement in the form of praise and a preferred

item or activity was delivered on a fixed ratio of one (FR1) schedule for correct responding on all prompted and unprompted trials.

If a participant responded incorrectly during a prompted or independent trial, the instructor immediately touched the target stimulus on the screen and said, “That’s the one,” or “That’s (name of item),” and then immediately presented the next trial. During prompted trials, if the participant did not respond within five seconds of the prompt, the instructor immediately touched the correct item on the screen and said, “That’s the one,” or “That’s (name of item),” and then immediately presented the next trial. During independent trials, if the participant did not respond within five seconds of the delivery of the vocal SD (i.e., “Who is it?”), then the instructor touched the correct item on the screen (e.g., “That’s (name of item)”) and then immediately presented the next trial. No reinforcement was provided for incorrect or no responses.

Procedural modifications. When utilizing a five-second delay prompt during vocal approximations acquisition sessions, Seth frequently engaged in incorrect responding during the five-second interval between the instructor’s delivery of the instruction and vocal model of the correct response (e.g. approximated “Scamp” when presented with the stimulus, “Pip.”). As such, after the seventh vocal approximations session utilizing a five-second prompt delay, the five-second delay was replaced with an immediate partial echoic prompt.

After switching to the partial echoic, however, Seth remained unable to acquire the targets with the vocal modality. When presented with a target item, Seth failed to respond at all; responded with an unrelated word (e.g., “yes”); or mixed up the names of the items (e.g., labeled “Scamp” when presented with “Pip,” “Kook” when presented with “Scamp,” etc.). In order to ensure acquisition of the vocal modality, the experimenters modified the procedure to target only

one stimulus for acquisition, instead of three. From the 23rd vocal approximations session onward, only the stimulus Kook was taught. The instructor began the session using a full echoic, then faded to a partial echoic, then moved to the independent level within the same session. Thereafter, every vocal approximations session began at the independent level, and the previously described error correction procedure was implemented. (For Seth, the Acquisition phase of the investigation was reinstated for stimuli Pip and then Scamp, respectively. See below under Preference phase Procedural modifications.)

Due to delays in obtaining consent, training commenced with Jake approximately two months after training began with Seth. As such, the Preference phase of the investigation was already underway with Seth, and the study procedures were already modified such that they switched from conditional discriminations to simple discriminations—i.e., only Kook was targeted. To maintain consistency between participants, only stimulus Kook was targeted throughout all phases of the investigation for Jake, beginning with the Acquisition phase. Study procedures during the Acquisition phase for Jake were identical to the procedures described above, the only difference being that Kook was the only stimulus presented during all 12 trials per session per modality. For SGD trials for both participants, all three characters remained present and in random positions on the main screen of the device, but only touching Kook produced the correct response.

Preference Phase

Preference assessments (no stimuli). After participants acquired the label using both modalities, preference assessments were conducted. The first condition consisted of preference assessments without session-correlated stimuli in order to assess student preference in the absence of salient discriminative stimuli.

During the preference assessment (no stimuli) condition, the SGD and picture indicating the vocals option were both present in random positions on the instructional table. Each session consisted of six trials, with the stimulus Kook targeted during each trial. At the beginning of each trial, the instructor stated, "You can tell me or you can show me," and then presented the picture of Kook and asked, "Who is it?" The participant was given 10 seconds to choose an option. No prompts were provided. Immediately after the participant correctly labeled Kook using one of the two modalities, reinforcement was delivered in the form of praise and a preferred item. Importantly, reinforcement was delivered for either modality selected. Preference assessments were run until a clear preference for one modality emerged, as determined by the participant choosing one modality during a minimum of 80% of trials per session, across three consecutive sessions (e.g., participant selected the SGD during 5 out of 6 or 6 out of 6 of the trials, across three sessions).

Reinforcement histories with stimuli. After a clear preference for a single modality emerged, reinforcement histories with session-correlated stimuli were established for the non-preferred modality. If the SGD was preferred during preference assessments without stimuli, then reinforcement histories were established for the vocal modality, and stimuli present during acquisition trials for the vocal modality were present during all vocal reinforcement histories trials (i.e., blue). If vocal approximations were preferred during preference assessments without stimuli, then reinforcement histories were established for the SGD, and stimuli present during acquisition trials for the SGD were present during all SGD reinforcement histories trials. All sessions consisted of 12 trials, with the stimulus Kook targeted every trial. As with the Acquisition phase, all three Moshi Monsters were present on the main screen of the SGD.

Vocal Approximations. During all trials in which reinforcement histories were established for the vocal modality, the instructor wore the blue T-shirt and the blue rain poncho covered the instructional table. Additionally, both the SGD and the laminated photo indicating the vocals option were present in random positions on the instructional table. Both modalities were placed equidistant from the participant and within his reach. Prior to every trial, the instructor stated the rule: "When blue is present, you have to tell me." Immediately after stating the rule, the instructor presented the picture of Kook and asked, "Who is it?" If the participant responded using the vocal modality, reinforcement in the form of praise and a preferred item were delivered, and the instructor moved to the next trial. If the participant responded using the SGD, the instructor repeated the name, "Kook" until the participant vocalized "Kook." Immediately after the participant stated the name of the item, the instructor provided no reinforcement and moved to the next trial. The condition was terminated when the participant selected the vocal modality during 80% or more trials per session (i.e., 10 out of 12 or greater) across three consecutive sessions.

SGD. The instructor wore the yellow T-shirt and the yellow rain poncho covered the instructional table during all trials in which reinforcement histories were established for the SGD. Additionally, both the SGD and the laminated photo indicating the vocals option were present in random positions on the instructional table. Both modalities were placed equidistant from the participant and within his reach. Prior to every trial, the instructor stated the rule: "When yellow is present, you have to show me." Immediately after stating the rule, the instructor presented the picture of Kook and asked, "Who is it?" If the participant responded using the SGD, praise and a preferred item were delivered, and the instructor moved to the next trial. If the participant responded using the vocal modality, the instructor provided no reinforcement,

immediately touched the picture of Kook on the screen, and stated, “That’s the one” before moving to the next trial. The condition was terminated when the participant selected the SGD during 80% or more trials per session (i.e., 10 out of 12 or greater) across three consecutive sessions.

Preference assessments (with stimuli). After reinforcement histories were established for one modality, preference assessments were reinstated. These preference assessments were nearly identical to the initial preference assessments described above; the only difference was the salient stimuli associated with the previous reinforcement histories condition were present during all sessions. Each session consisted of six trials, with the stimulus Kook targeted during each trial.

Vocal approximations. If reinforcement histories were established for the vocal modality, then the instructor wore the blue T-shirt and the blue rain poncho covered the instructional table during preference assessment with stimuli sessions. The SGD and picture indicating the vocals option were both present in random positions on the instructional table. At the beginning of each trial, the instructor stated, “You can tell me or you can show me,” and then presented the picture of Kook and asked, “Who is it?” The participant was given 10 seconds to choose an option. No prompts were provided. Immediately after the participant correctly labeled Kook using one of the two modalities, reinforcement was delivered in the form of praise and a preferred item. Importantly, reinforcement was delivered for either modality selected. Preference assessments were run until a clear preference for one modality emerged, as determined by the participant choosing one modality during a minimum of 80% of trials per session, across three consecutive sessions (e.g., participant selected vocals during 5 out of 6 or 6 out of 6 of the trials, across three sessions).

SGD. If reinforcement histories were established for the SGD, then the instructor wore the yellow T-shirt and the yellow rain poncho covered the instructional table during preference assessment with stimuli sessions. The SGD and picture indicating the vocals option were both present in random positions on the instructional table. At the beginning of each trial, the instructor stated, "You can tell me or you can show me," and then presented the picture of Kook and asked, "Who is it?" The participant was given 10 seconds to choose an option. No prompts were provided. Immediately after the participant correctly labeled Kook using one of the two modalities, reinforcement was delivered in the form of praise and a preferred item. Importantly, reinforcement was delivered for either modality selected. Preference assessments were run until a clear preference for one modality emerged, as determined by the participant choosing one modality during a minimum of 80% of trials per session, across three consecutive sessions (e.g., participant selected SGD during 5 out of 6 or 6 out of 6 of the trials, across three sessions).

Procedural modifications. For both participants, modifications were made to the above-described procedures. Seth was unable to complete the Preference phase of the investigation because he was unable to switch modalities during the Reinforcement histories with stimuli condition. Modifications to procedures for Seth are described below. Jake successfully completed all conditions within the Preference phase of the investigation; these conditions were completed in the following order: preference assessment no stimuli, reinforcement histories with stimuli, preference assessment with stimuli, preference assessment no stimuli, reinforcement histories with stimuli, preference assessment no stimuli. Slight modifications were made to procedures within certain conditions, however, which will also be described below.

Seth. Due to difficulties teaching Seth to respond exclusively using the modality targeted—i.e., the vocal modality— during the initial Reinforcement histories with stimuli

condition for Kook, the experimenters provided reinforcement for responses in which Seth used both the SGD and vocal approximations within a single trial (simultaneously or one immediately following the other). Despite accessing reinforcement for responding using both modalities and accessing no reinforcement for responding using only the SGD, Seth continued to respond almost exclusively using the SGD. As such, the Preference phase of the investigation was terminated after the initial Reinforcement histories with stimuli condition was instated. To determine whether results with stimulus Kook could be replicated, acquisition training recommenced with stimulus Pip. Acquisition sessions for Pip were identical to procedures described above under the Acquisition phase of the investigation, except only Pip was targeted for acquisition. Additionally, only probe data were taken using the SGD due to Seth maintaining labeling Pip with the SGD.

Seth was unable to acquire the vocal modality for Pip due to consistent mispronunciation of the item, even when full echoic prompts were used. In fact, Seth was unable to progress through the prompting hierarchy beyond a full echoic. Following pre-established termination criteria, acquisition sessions with Pip were terminated when he engaged in less than 60% correct responding across five consecutive sessions (i.e., (prompted + unprompted trials)/total trials < 60%). Notably, Seth provided the correct pronunciation of Pip during pre-assessment echoic trials and the Acquisition phase of the investigation targeting all three stimuli simultaneously. He failed to maintain the echoic skill, however.

When acquisition trials for Pip were terminated, training commenced with Scamp. Only the vocal modality was targeted for acquisition during this part of the investigation; Seth maintained the correct label of Scamp using the SGD, so only probe data were collected with the device. Procedures for training Scamp using the vocal modality were identical to procedures

described above under Acquisition phase of the investigation, when all three stimuli were simultaneously targeted for acquisition. However, only the stimulus Scamp was targeted for acquisition, and a partial echoic prompt was initially used in the prompting hierarchy, rather than a five-second delay. Incorporation of the partial echoic was consistent with earlier modifications to the investigation, when conditional discriminations were targeted. Seth often vocalized an incorrect item during the five-second interval between the instructor's presentation of the instruction and vocal model of the correct response However, because Seth often vocalized "Sky" when a partial echoic for "Scamp" was used, the investigator reincorporated a five-second delay into the prompting hierarchy and removed the partial echoic after a partial echoic was used for three consecutive sessions. Additionally, even when a full echoic prompt was used, Seth experienced difficulties progressing through the prompting hierarchy due to difficulties with sustaining motivation. Specifically, though Seth correctly demonstrated the echoic skill on multiple trials, he often failed to respond to the SD due to lack of motivation and concomitant vocal stereotypy and saliva play. To address the issue of motivation, the instructor reduced the number of trials per session from 12 to four for stimulus Scamp.

After Seth acquired the stimulus Scamp, training commenced with the Preference phase of the investigation for that stimulus. Because Seth was unlikely to switch modalities using the standard error correction and reinforcement procedures described above, modifications were made to the Reinforcement histories with stimuli condition during this part of the investigation. Specifically, at the start of this condition for stimulus Scamp, 10 booster trials were implemented (10 was the predetermined limit). Because the modality being trained was the vocal modality, each booster trial consisted of the instructor first stating the rule, "It's blue. Say, 'Scamp,'" and then immediately presenting the picture of Scamp, asking, "Who is it?", and providing the full

vocal model, "Scamp." Reinforcement was delivered in the form of praise and a preferred item for responding using the vocal modality or both modalities simultaneously (or one immediately after the other). No reinforcement was delivered for responding using exclusively the SGD. A predetermined maximum of 10 booster trials were run; Seth responded with the SGD during six trials, vocals during one trial, and both modalities during three booster trials. Immediately after, reinforcement histories training commenced following standard procedures described under the Reinforcement histories with stimuli condition. However, two modifications were made to the procedures: Reinforcement was provided when both modalities were selected and, due to difficulties with establishing and maintaining Seth's motivation to complete trials, the number of trials per session was reduced from 12 to 6. Despite these modifications, Seth continued to experience difficulties switching to the vocal modality. As such, the instructor incorporated a five second delay between Seth responding exclusively using the SGD and implementation of error correction procedures. To demonstrate experimental control, the delay was eventually removed and standard Reinforcement histories procedures were re-implemented (i.e., immediate error correction for responding exclusively using the SGD). After patterns were re-established, the Preference phase of the investigation for stimulus Scamp concluded with the final preference assessments no stimuli condition.

Jake. During the initial Preference assessments no stimuli condition, an independent observer collecting IOA and TI data noted that the instructor was inadvertently providing differential reinforcement for vocal responses. Specifically, it was observed that the instructor delivered tickles and social praise with greater enthusiasm following responses in which only the vocal modality was selected. To ensure consistency of all parameters of reinforcement, tickles were omitted from informal preference assessments conducted prior to each trial. If the

participant manded for tickles using his device or vocalizations, the instructor neutrally stated, "Later," and instructed the participant to choose an item from the existing array. Tickles were delivered intermittently between trials to maintain motivation for session completion. Tickles were not delivered contingent on trial completion, however.

Additionally, during the initial Reinforcement histories with stimuli condition, Jake continued to engage in both modalities. The instructor followed the standard error correction procedure when Jake responded using exclusively the SGD and standard reinforcement procedures when Jake responded exclusively using the vocal modality (described under the Reinforcement histories with stimuli condition). To maintain consistency with modifications for Seth during this condition, the instructor also provided reinforcement when Jake responded using both modalities. Because Jake demonstrated responding using exclusively the vocal modality during initial preference assessment trials as well as reinforcement histories trials, it is possible that using both modalities was adventitiously reinforced. The instructor modified procedures in order to teach exclusive responding using the vocal modality. Specifically, immediately prior to the 7th initial reinforcement histories session (i.e., 25th session in the Preference phase), the instructor ran seven booster trials. Each trial consisted of the instructor stating the rule, "It's blue. Say Kook. Who is it?" and then immediately presenting the picture of Kook and providing the full vocal model, "Kook." During all seven booster trials, Jake responded exclusively using the vocal modality. Immediately after the booster sessions, the instructor began the next reinforcement histories session and followed standard procedures.

Immediately prior to the start of the second Reinforcement histories with stimuli condition for Jake, when the SGD was the target modality, booster trials were incorporated in an effort to teach responding using exclusively the SGD. During these booster sessions, the

instructor stated the rule, “It’s yellow. You have to show me,” and then presented the picture of Kook, asked, “Who is it?” and provided an immediate gesture prompt toward the SGD along with a finger placed over her mouth to indicate quiet voice. Reinforcement in the form of praise and a preferred item was provided for responding with exclusively the SGD. No reinforcement was provided for responses including both modalities. The therapist ran approximately 25 booster trials; with the exception of three trials in which he responded using exclusively the SGD, Jake consistently responded using both the SGD and vocals, despite accessing no reinforcement for responding using both modalities. As such, the instructor began running reinforcement histories sessions following standard procedures, with the addition of reinforcing responses including both modalities.

Interobserver Agreement

During the Acquisition phase, the trainer collected data on type of prompt used and correct and incorrect responses per trial. For each trial during the Preference phase of the investigation, the trainer collected data on modality selected. To assess reliability, an independent observer also collected data on type of prompt used, correct and incorrect responses, and modality selected during 37.3% of total sessions. For each session, percentage of agreement between the trainer and an independent observer were calculated using the following formula: Agreements/(Agreements + Disagreements) X 100%. IOA ranged from 92 to 100% with a mean of 99.9%. To derive mean IOA, the following formula was used: (Percent Agreement Session 1 + Percent Agreement Session 2 +…)/Total Number Sessions With IOA.

Treatment Integrity

To assess TI, an independent observer used a Yes/No checklist to ensure the trainer accurately implemented procedures during both phases of the investigation. Treatment integrity

was assessed during 34.9% of total sessions. Percentage of correct implementation of steps per sessions ranged from 83 to 100% (Formula: (number of steps implemented correctly/number of steps total) X 100). The overall mean was 99.7% (Formula: (Percentages Correct Implementation Session 1 + Percentage Correct Implementation Session 2 +…)/Total Number Sessions With TI).

Results

Seth

Figures 1 through 5 show the results for Seth. Figures 1, 3, and 4 show percent correct labeling target stimuli with the two modalities during the Acquisition phase. Figures 2 and 5 show results from the Preference phase of the investigation, which indicate percent modality selected across the different conditions. During the initial Acquisition phase (Figure 1), Seth was unable to label Kook, Pip, or Scamp using either the SGD or the vocal modality during baseline sessions. Seth acquired all three labels using the SGD on his seventh SGD training session. He maintained the conditional discriminations using the SGD during three follow-up probe sessions while the vocal modality was still being taught. When all three stimuli were targeted simultaneously, Seth was unable to acquire the vocal modality. After 22 vocal training sessions in which all three stimuli were targeted, vocal training commenced with Kook only (beginning 35th session in Figure 1). Thereafter, Seth acquired Kook using the vocal modality in nine training sessions. Seth maintained labeling Kook during two SGD probe sessions while the vocal modality was under acquisition.

Figure 2 displays the results of the Preference phase for stimulus Kook. During preference assessments without stimuli, Seth selected the SGD during 100% of trials across three consecutive sessions. When reinforcement histories with the vocal modality were trained, Seth continued to choose the SGD during the vast majority of sessions. Percent SGD selected ranged

from 75 to 100% of trials per session across nine total reinforcement histories sessions. Seth selected to use the vocal modality alone during 8% of trials in the seventh session of the Preference phase; otherwise, he did not respond with exclusively the vocal modality during any other reinforcement histories session. Seth selected to use both modalities during five reinforcement histories sessions, but his selection of both modalities did not exceed 25% of trials per session.

Figure 3 displays the results for the Acquisition phase for stimulus Pip. Seth maintained labeling Pip using the SGD during the baseline probe session and during four probe sessions while the vocal modality was being taught. Seth was unable to acquire labeling Pip using the vocal modality.

Figure 4 displays the results of the Acquisition phase for stimulus Scamp. Seth maintained labeling Scamp with the SGD and was unable to label Scamp using the vocal modality during baseline sessions. During training sessions with the vocal modality, Seth was unable to acquire the label for Scamp when 12 teaching trials were included per session. On the 19th session (after 14 vocal training sessions), the total number of trials per session was reduced from 12 to four. Seth then acquired the vocal modality in 14 vocal training sessions that included four trials per session. Seth maintained labeling Scamp using the SGD during all four probe sessions.

Figure 5 displays the results of the Preference phase for stimulus Scamp. During the first preference assessments no stimuli condition, Seth chose to label Scamp using the SGD between 83% and 100% of trials per session, across three consecutive sessions. He selected the vocal modality only during 17% of trials in the first session. During the first seven sessions of the reinforcement histories with stimuli condition in which the vocal modality was targeted, Seth

continued to select the SGD during the majority of sessions. Percent SGD selected ranged from 67 to 100%, with an average selection of 86% across seven sessions. The vocal modality was never selected during these sessions. Both modalities were selected during four sessions, with a total selection ranging from 0 to 33% trials per session and an average of 14% both modalities selected. On the 8th reinforcement histories session, a five second delay was incorporated between Seth responding using only the SGD and the trainer implementing error correction procedures. The five second delay was incorporated during 25 consecutive reinforcement histories sessions. With the delay, Seth continued to respond using only the SGD during the majority of sessions. However, the percent the SGD alone was selected dropped to 33% during two sessions; percent both modalities were selected increased to 67% during two sessions and 50% during six sessions. Additionally, the average the SGD was selected across sessions with the five second delay dropped to 71%; the average both were selected increased to 29% across sessions with the delay. Percent vocal modality alone was selected with the five second delay remained at 0% across all sessions. On the 33rd reinforcement histories session, the five second delay between selection of the SGD alone and implementation of error correction procedures was removed for nine consecutive sessions. During these nine sessions, percent SGD alone was selected increased to an average of 89%, with percent selection per session ranging from 50 to 100%. Percent both modalities were selected ranged from 0 to 50% of trials per session, dropping to an average of 11% across all nine sessions. The vocal modality again was never selected in isolation. Finally, on the 45th session for stimulus Scamp, preference assessments without stimuli were reinstated. Seth chose the SGD during 100% of sessions, across three consecutive sessions. Neither the vocal modality nor both modalities were selected.

Jake

Figures 6 and 7 display the results for Jake. Figure 6 shows percent correct labeling Kook with the two modalities during the Acquisition phase. During baseline, Jake was unable to label Kook using the vocal modality and achieved 25% correct responding labeling Kook with the SGD. During acquisition, Jake acquired both the vocal modality and the SGD in six training sessions each (12 acquisition sessions total).

Figure 7 shows results from the Preference phase of the investigation, which indicate percent modality selected across the different conditions. During the initial sessions of the preference assessment no stimuli condition, Jake's selection of the different modalities was variable. His selection of the SGD ranged from 0% to 83% of trials per session; his selection of the vocal modality ranged from 17% to 100% of trials per session; and his selection of both modalities ranged from 0% to 33% of trials per session. On average, he selected the SGD during 38% of the first 11 sessions, the vocal modality during 55% of the first 11 sessions, and both modalities during 8% of the first 11 sessions. On the 12th session, tickles were removed as reinforcement for correct responses using any modality. After tickles were removed, a preference for the SGD alone emerged. Without tickles, the average selection of the SGD was 74%, the average selection of vocals dropped to 10%, and the average selection of both modalities was 17%. The first preference assessments without stimuli sessions were terminated when Jake chose the SGD during more than 80% of trials per session, across three consecutive sessions. During the first six reinforcement histories sessions in which the vocal modality alone was targeted, Jake increasingly chose to use both modalities, with three sessions ranging from 83 to 100% selection of both modalities. Though exclusive selection of the SGD decreased to 0%, selection of the vocal modality alone remained low and did not exceed 25% of trials per session.

However, when booster trials were implemented immediately prior to the 7th reinforcement histories session, Jake selected the vocal modality alone during 92% of trials in the 7th session and he exclusively selected the vocal modality during 100% of trials per session across the next two sessions and the condition was terminated. We then implemented the preference assessment with stimuli condition. Jake initially showed a preference for both modalities. However, his preference for both modalities decreased as his preference for the vocal modality alone increased. In the final three sessions of this condition, his selection of the vocal modality alone increased to 100%. We then removed the stimuli and again conducted the preference assessment no stimuli condition. During these preference assessments, Jake chose the vocal modality alone during 100% of trials per session, across all three sessions. We then conducted reinforcement histories with stimuli to increase responding using the SGD. Notably, Jake also accessed reinforcement for responding using both modalities during these sessions, as booster trials indicated that the vocal response could not be placed on extinction (see Methods section). Though selecting the vocal modality alone remained at 0% across all except for one session, overall Jake continued to respond using the vocal modality with the SGD. One session reached 50% responding with the SGD alone, but the remaining sessions ranged from 0% to 33% selection using exclusively the SGD. This condition was terminated when Jake responded using both modalities during 83% of trials per session across the final three consecutive sessions. We again conducted preference assessments without stimuli. During these final sessions, Jake showed a preference for using both modalities. His selection of the SGD alone was mostly at or below 33% of trials per session, with the exception of four sessions, which ranged from 50% to 100% of total trials per session. The vocal modality alone was selected during two sessions—both at only 17% of total trials per session. Otherwise, the vocal modality was never selected in

isolation. With the exception of one session, both modalities were selected at or above 50% of trials per session, with the final three sessions ranging from 83% to 100% and reaching termination criterion for establishment of preference.

Discussion

The present investigation examined the effects of reinforcement histories on communication modality preference in two students with autism. Additionally, salient stimuli were paired with the different modalities to determine whether shifts in preference would be influenced by salient color cues associated with the different communication topographies.

Students, Seth and Jake, were taught to label single syllable nouns using vocal approximations and a speech-generating device (SGD). Items targeted for acquisition were the Moshi Monster characters Kook, Pip, and Scamp; these items were initially trained simultaneously for Seth, and then one-by-one. Due to modifications made for Seth, Jake was only taught to label Kook. Salient stimuli were paired with all acquisition trials: A blue tablecloth covered the instructional table and the instructor wore a blue t-shirt during all vocal trials; a yellow tablecloth and t-shirt were paired with all SGD teaching trials. After acquisition, preference assessments were conducted with the two modalities in order to determine student preference in the absence of salient stimuli, and prior to establishing reinforcement histories with a single modality. When a clear preference for one modality emerged, reinforcement histories were established with the non-preferred modality; associative stimuli were present during all reinforcement histories sessions. Then, more preference assessments were conducted, first with and then without associative stimuli. These preference assessments were conducted in order to measure shifts in preference as a result of reinforcement histories alone, or as a consequence of cues associated with the different modalities.

Acquisition and Initial Preference

The results of the present investigation support previous findings that students demonstrate a clear preference for a single modality. (LaRue et al., 2016; Sigafoos et al.; 2005; Van der meer et al., 2012). After acquisition, both participants showed an initial preference for the SGD; their preference was measured prior to any experimental manipulations in reinforcement histories with the different modalities.

Seth. For Seth, his initial preference for the SGD may have been related to differences in acquisition rates between the two modalities (e.g., LaRue et al., 2016), such that his preference for the SGD corresponded to faster acquisition of that modality. When three items were simultaneously being taught, Seth acquired the SGD in only seven teaching sessions; he was unable to acquire conditional labels using the vocal modality. When the number of target stimuli was reduced to a simple discrimination—i.e., single item, Kook—Seth acquired the vocal modality in nine teaching sessions, which was still greater than the number of sessions required to learn conditional discriminations using the SGD. Furthermore, Seth was unable to acquire Pip using the vocal modality when the item was trained in isolation, though he maintained labeling Pip using the SGD during all probe sessions for that item. Finally, when stimulus Scamp was trained in isolation, Seth only acquired the label with the vocal modality when the number of trials per session was reduced by two thirds. Seth maintained responding with the SGD during all probe sessions with stimulus Scamp. Seth preferred to label both Kook and later Scamp using the SGD.

Jake. Jake acquired the label for Kook within the same number of sessions for both the SGD and vocal modality. During initial preference assessments, he ultimately chose to label Kook using the SGD. Though Jake acquired both modalities within the same number of sessions,

his initial preference for using the SGD may be related to his extraexperimental history of reinforcement with that modality. Jake's speech therapist reported that she requires students to communicate more often using the modality in which the longest mean length of utterance (MLU) is produced. For Jake, his longest utterances are three word requests with the SGD (i.e., "I want" plus name of desired item). As such, prior to the investigation, Jake's speech therapist likely established a denser reinforcement history with the SGD than with the vocal modality, which may have contributed to his initial preference for the SGD.

Reinforcement Histories and Other Variables Influencing Preference

After initial preferences were determined, reinforcement histories were established with the non-preferred modalities. For both Seth and Jake, the non-preferred modality targeted during the first reinforcement histories condition was the vocal modality. Paired with these reinforcement histories sessions were associative stimuli—the same blue stimuli present during acquisition trials for the vocal modality. Below is an overview of Seth and Jake's responding during the first reinforcement histories condition and subsequent conditions. Variables influencing participants' preferences and overall patterns of responding within the different conditions are also examined.

Seth. For Seth, the trainer was unable to establish reinforcement histories for the vocal modality for either stimulus Kook or Scamp (i.e., the two stimuli acquired using both the SGD and vocal approximations). For stimulus Kook, despite never accessing reinforcement for responding with the SGD alone, he continued to respond almost exclusively using the SGD. In an effort to increase vocal responding, reinforcement was provided for selecting both modalities within a single trial. Despite these efforts, Seth's responses using both the SGD and vocals never exceeded one quarter of the total trials per session for stimulus Kook.

For Seth, in order to account for difficulties with stimulus Kook, a number of modifications were made to the reinforcement histories condition for the vocal modality for stimulus Scamp. First, the number of trials was reduced by half, and booster trials were run immediately prior to the onset of the condition— during which Seth accessed reinforcement for prompted vocal responses—in an effort to enhance responding with the vocal modality. With these modifications, Seth continued to choose the SGD during the majority of reinforcement histories sessions. As such, a further modification was made: incorporating a 5-second delay between selection of the SGD and trainer implementation of error correction. When the delay was incorporated, Seth's selection of both modalities within a single session increased: It reached 50% selection during six sessions and actually exceeded selection of the SGD alone during two sessions. Overall, however, even with the delay, Seth continued to choose the SGD during the majority of sessions. When the delay was removed, responding with the SGD alone increased, and when final preference assessments were run, Seth always preferred the SGD.

A number of factors may have contributed to Seth's inability to switch to the vocal modality during reinforcement histories sessions for both Kook and Scamp, despite failing to access reinforcement for responding with the SGD alone. Factors may have included response parameters—i.e., effort to engage in the vocal response— which influenced choice responding, as well as certain parameters of reinforcement—specifically, quality and magnitude of reinforcement. Another explanation is that the presence of the SGD itself during reinforcement histories sessions for the vocal modality exerted control over Seth's responses.

Regarding response effort, Seth may have failed to respond using the vocal modality during reinforcement histories sessions because of the effort required to engage in the correct vocal response. This is consistent with previous research indicating that, when given a choice

between two or more response options, participants may select the response requiring the least amount of effort (e.g., Horner & Day, 1991). Indeed, Seth acquired the SGD in far fewer teaching trials than the vocal modality, and he was unable to acquire the vocal response at all for one item. These difficulties in acquisition may be related to effort to engage in the vocal response, which in turn contributed to both his initial preference for the SGD, as described previously, and his inability to switch modalities even when responding with the SGD no longer produced reinforcement. Of note, while students may prefer the modality associated with fastest acquisition (LaRue et al., 2016), lack of preference for a specific modality may inhibit motivation to learn that modality (Van der meer et al., 2012). Along these lines, Seth's inability to switch modalities during reinforcement histories conditions may have been related to his preference to engage in vocal stereotypy and saliva play during these trials, which competed with his ability to produce the correct, non-preferred vocal response—a pattern that actually emerged during acquisition sessions.

Though Seth's slow acquisition rate for the vocal modality may have been related to effort to produce the correct vocalization, there is evidence that it may have been related to competing reinforcers. Specifically, Seth demonstrated the ability to produce the correct vocal response during several acquisition trials, but he often failed to produce the correct response due to engaging in vocal stereotypy and saliva play immediately after instructions were delivered. A separate functional analysis conducted around the time of the present investigation indicated that Seth's vocal stereotypy and saliva play were maintained by automatic reinforcement. Of note, Seth's tendency to engage in vocal stereotypy appeared to increase when his motivation for tangible and social reinforcement—delivered contingent on correct vocal responses— decreased. As such, when given the choice to engage in the correct vocal response to access tangible items

and social praise or to engage in vocal stereotypy—maintained by automatic reinforcement—Seth more frequently chose to engage in vocal stereotypy.

Seth's preference for vocal stereotypy may be related to specific parameters of reinforcement influencing choice—such as quality and magnitude (i.e., duration, quantity, or intensity) of reinforcement. Regarding quality of reinforcement, vocal stereotypy may be a higher quality reinforcer than tangible items and social praise, leading to his preference to engage in vocal stereotypy over the correct vocalization (e.g., Neef et al., 1992). Regarding magnitude of reinforcement, given that Seth produced and, therefore, controlled his own vocal stereotypy, it lasted for longer durations than the tangible items delivered contingent on correct vocal responses (i.e., tangible items delivered for 10 seconds; small edible portions led to short durations of consumption). This is consistent with previous research indicating that students may prefer to engage in responses leading to longer durations of reinforcement (e.g., Hoch et al., 2002) than responses producing reinforcers lasting shorter durations. Importantly, when Seth's motivation for a tangible item increased—often indicated by independent requests for the item using clear single word vocalizations—he did not engage in vocal stereotypy and produced clear vocal labels in response to the trainer's questions. To control for Seth's rapid satiation on tangible reinforcers, the number of teaching trials per session was reduced, and Seth was finally able to acquire the vocal modality for stimulus Scamp. During reinforcement histories sessions for stimulus Scamp, the number of trials per session was also reduced, but Seth was still unable to switch to the vocal modality during these sessions. All reinforcement histories sessions were similar to vocal modality training sessions in that Seth did not access therapist-delivered reinforcement unless he produced the correct vocal response. Similarly to acquisition sessions,

however, he seemed to prefer engaging in vocal stereotypy and saliva play over engaging in a response that would lead to socially mediated consequences.

During reinforcement histories sessions for both Kook and Scamp, Seth almost never engaged in the correct vocal response alone. During all except for one trial during one session, he responded using the SGD, and he predominately responded using the SGD in the absence of the correct vocal response, which led to no tangible or social reinforcement. If Seth's response with the SGD led to no therapist-delivered reinforcement, and his engagement in vocal stereotypy occurred independent of responding with the SGD, then why did Seth select the SGD at all during reinforcement histories sessions? One explanation is that features of the device itself may have been reinforcing, such as the production of vocal output contingent on touching the icon. Another explanation for his continued labeling with the SGD is that the response was under the control of the presence of the device itself, which is consistent with previous research on stimulus control and preference (e.g., Fisher et al., 1998; Winborn-Kemmerer et al., 2010). For example, in the investigation by Winborn-Kemmerer et al. (2010), participants' preference for engaging in different mand topographies shifted in the presence of a play card, such that they manded by touching the card in its presence and manded using different mand topographies in its absence. Similarly, Seth may have labeled the item using the SGD during reinforcement histories sessions simply because the SGD was present. Contingencies and stimuli in reinforcement histories sessions with the vocal modality were the same as during vocal approximations sessions. Apart from the stated rule in the reinforcement histories sessions (i.e., "It's blue. You have to tell me."), the only other difference between the two conditions was the presence of the SGD. Notably, as described previously, Seth was eventually able to acquire the vocal response for Kook and Scamp during vocal approximations sessions. He was unable to switch to the vocal

modality during reinforcement histories sessions, however—suggesting that the SGD may have been more salient and had more control over his behavior than either the associative colored stimuli (i.e., blue tablecloth and t-shirt) or the vocal approximations card.

Finally, Seth's responding with the vocal modality during reinforcement histories sessions for stimulus Scamp increased when a delay was incorporated between selection of the SGD and trainer-delivered error correction or reinforcement. This is consistent with findings from a previous investigation indicating that, when a reinforcement delay is incorporated into procedures for PE training, participant vocalizations may increase (Tincani, 2004). Seth's increased vocal responding during the delay may be attributable to a history of accessing reinforcement for delayed vocal responses to vocal verbal antecedents. Specifically, staff reported that Seth had longstanding difficulties producing vocal responses: He either did not respond despite having the responses within his repertoire, or his vocal responses were unintelligible. As such, in order to shape correct vocalizations, staff may have historically delivered reinforcement contingent on delayed, rather than immediate, vocal responses. The effects of reinforcement delays on increasing vocalizations in students exhibiting difficulties with spoken language may be a fruitful area for future research.

Jake. Though reinforcement histories were not established with the vocal modality for Seth due the above-described difficulties, reinforcement histories were established with the vocal modality for Jake. As such, for Jake, the investigation proceeded as designed. During the first reinforcement histories condition, though the vocal modality was targeted, Jake initially responded using both modalities. Indeed, the trainer provided reinforcement on an FR 1 schedule for responding using both modalities or the vocal modality alone, and provided no reinforcement for responding using the SGD alone. (The trainer used similar procedures with Jake as with Seth

to maintain consistency across participants.) However, because Jake demonstrated the ability to select only the vocal modality, the trainer modified procedures after the sixth reinforcement histories session, and ultimately reinforcement histories were established with the vocal modality in isolation.

Immediately after reinforcement histories were established with the vocal modality, preference assessments with associative stimuli were conducted. Jake's pattern of selections during these preference assessments were strikingly similar to his pattern of responding during the previous reinforcement histories condition, despite being able to access reinforcement for responding using any modality under that condition. Specifically, he initially chose to respond using both modalities, and then switched to responding with exclusively the vocal modality, demonstrating a final preference for vocal responding. In order to determine whether Jake's new preference for the vocal modality was the result of establishing recent reinforcement histories with that modality, or the result of associative stimuli cueing vocal modality selection, more preference assessments were conducted in the absence of salient stimuli. During these preference assessments, Jake continued to respond using exclusively the vocal modality, suggesting that establishing reinforcement histories with the vocal modality exerted more control over Jake's preference than salient stimuli associated with that modality.

After these preference assessments without stimuli, during which the vocal modality was selected, new reinforcement histories were established with the SGD. Immediately prior to these reinforcement histories sessions, booster trials were run in an effort to extinguish Jake's responding with the vocal modality and establish his selection of the SGD in isolation. Despite accessing no reinforcement for using the vocal modality—with or without the SGD— the vocal response continued to occur during these booster trials. Given time constraints, reinforcement

histories sessions commenced, and Jake accessed reinforcement for responding using both modalities simultaneously, and in the presence of associative yellow stimuli paired with the SGD. Reinforcement histories were ultimately established with both modalities during this condition. After, more preference assessments without stimuli were conducted. Jake's preferences were again strikingly similar to his responses during the previous reinforcement histories condition: He demonstrated an overall preference for communicating using both modalities, which replicates earlier findings that recent reinforcement histories influence communication preference, irrespective of associative stimuli.

Jake's pattern of responding in the current investigation also replicates findings from previous experiments examining the impact of recent reinforcement schedules on response allocation. In a series of experiments investigating varying degrees of treatment integrity failures on response allocation, St. Peter Pipkin et al. (2010) found that when a reinforcement schedule produces denser reinforcement of one response over another, then the sequence of conditions is less important in determining how a participant allocates responding. However, when reinforcement schedules do not select for a particular response, such that there is an equal probability of accessing reinforcement for engaging in either response option, then the sequence of conditions may play a role in determining how a participant allocates responding. Whatever response was reinforced in the previous condition continues to be preferred in the current condition, even if either response leads to an equal probability of reinforcement under current conditions. Similarly for Jake, there was carryover between the two different reinforcement histories conditions— during which one response option led to reinforcement and the other response option led to no reinforcement— and subsequent preference assessment conditions— during which any communication topography led to reinforcement on an FR 1 schedule. For

example, during the final two conditions—reinforcement histories for the SGD and final preference assessments without stimuli—Jake primarily allocated responding toward both modalities throughout both conditions. His responding throughout the final preference assessments condition matched the response most recently reinforced within the preceding histories condition, consistent with St. Peter Pipkin et al.'s (2010) findings.

Jake's initial responses during the preference assessments following the first reinforcement histories condition for the vocal modality did not, however, match the response most recently reinforced within the previous condition. The responses most recently reinforced in the previous condition were vocal responses; the responses initially selected during the preference assessments that followed were both modalities. Notably, Jake's pattern of selections during these preference assessments matched his overall pattern of responding during the preceding condition: First he showed a preference for both modalities (initially reinforced in the preceding reinforcement histories condition) before switching to ultimately prefer the vocal modality (reinforced in isolation at the end of the preceding reinforcement histories condition). Relatedly, though some participants in St. Peter Pipkin et al.'s (2010) investigation consistently demonstrated carryover between conditions when reinforcement schedules did not select for a particular response, the opposite effects were observed for other participants. Specifically, for some participants, as the experiment progressed, their preferences actually switched from the preceding condition, rather than carried over. The researchers attributed these findings to the potential impact of the first reinforced or unreinforced response in the 50% integrity condition exerting control over responding during the remainder of the condition. The researchers also speculated that the passage of time may have served as a cue for participants to switch responses.

Jake's pattern of responses supports both of these hypotheses. Consistent with the researchers first hypothesis—that the first reinforced response may exert control over responding during the rest of the condition—Jake's first reinforced response during preference assessments immediately following the first reinforcement histories condition was both modalities. He initially showed a preference for both modalities within this condition before switching to a preference for responding using vocals alone. Consistent with the researchers second hypothesis—that the passage of time may serve as a cue to switch responses—the amount of time and number of sessions between the first reinforcement histories condition and subsequent preference assessments condition was roughly the same (i.e., 9 and 10 sessions and 7 days total for both conditions). In both conditions, Jake ultimately switched to vocals during the last three sessions, indicating that perhaps he generated a rule to "switch to vocals" after a certain amount of time elapsed during this preference assessments condition, based on schedules of reinforcement within the preceding condition. It is also worth noting that his average responses using both modalities and using vocals alone were nearly identical between the two conditions.

Limitations and Future Directions

The present study both replicates and extends the findings of St. Peter Pipkin (2010) by examining the additional impact of session-correlated stimuli on response allocation. Contrary to expectations, results indicated that session-correlated stimuli did not affect outcomes; rather, reinforcement histories alone affected Jake's communication preference. These findings contrast findings from previous research indicating that salient stimuli associated with remote history schedules influence responding during target schedules if the same salient stimulus is present during both conditions (e.g., Ono & Iwabuchi, 1997). It is important to note the differences in outcome measures and schedules of reinforcement between Ono and Iwabuchi's (1997) study

and the present study, however, which may have contributed to different findings. Ono and Iwabuchi's (1997) experiment included a multiple DRH DRL remote history schedule and VI intervening and target schedules. Additionally, the behavior of interest was a single key peck. In the present investigation, the reinforcement histories conditions consisted of concurrent schedules of reinforcement: Engaging in one response produced no reinforcement, and engaging in the other response was reinforced on an FR 1 schedule. Furthermore, the test conditions in the present investigation—i.e., preference assessments—also consisted of ratio schedules, during which either response produced reinforcement on an FR 1 schedule. Had the test conditions in the current experiment been designed to assess rate of responding with modalities during interval schedules, rather than percent modality selected with either modality reinforced on the same ratio schedule, perhaps salient associative stimuli would have had more of an impact on the participant's response allocation. Future research should examine the impact of reinforcement histories on communication preference when participants are exposed to interval schedules.

Furthermore, differences in the testing environment and organisms studied between the present investigation and Ono and Iwabuchi's (1997) experiment cannot be overlooked. Ono and Iwabuchi's (1997) investigation involved pigeons within an isolated chamber. The isolated environment may have made the schedule correlated stimuli more salient. The present investigation involved human subjects, and all sessions were conducted in large rooms with several extraneous stimuli present, which may have made session-correlated cues less salient. Furthermore, the same trainer ran all sessions across all conditions within the present investigation. Had different trainers been paired with the different modalities during Acquisition and Preference phases, perhaps discrimination between conditions would have been enhanced and the impact of session-correlated stimuli on preference would have been observed. To address

these difficulties with stimulus salience and enhance discrimination between conditions, future investigations should actually pair different teachers with the different modalities, rather than use color cues as teacher analogues.

For Jake, an additional limitation of the study was that the trainer was unable to extinguish responding with the vocal modality during booster trials immediately prior to the final reinforcement histories conditions—during which the SGD was targeted. As such, responses including both modalities, rather than the SGD alone, produced reinforcement during the final reinforcement histories condition. Notably, Jake accessed large amounts of reinforcement for responding with the vocal modality across several of the sessions preceding these booster trials. Vocal responding was targeted during the first histories session, and he continued to respond using the vocal modality across the two preference assessments following the histories session; all of these responses produced reinforcement. When Jake suddenly no longer accessed reinforcement for choosing the vocal modality, with or without the SGD, vocal responding had already been associated with large amounts of reinforcement; amount of reinforcement can influence resistance to extinction (e.g., Perin, 1942). Furthermore, Jake always accessed reinforcement for responding with the vocal modality, which placed vocal responding on a continuous schedule of reinforcement. Notably, when response rates during extinction are measured as a proportion of response rates during baseline, resistance to extinction may actually be greater following exposure to continuous reinforcement schedules than intermittent schedules (e.g., Lerman, Iwata, Shore, & Kahng, 1996; Nevin, 1988). Were it not for time constraints, perhaps responding with the vocal modality would have finally been extinguished during these booster trials, and the SGD alone could have been targeted during the final reinforcement histories condition. Future studies could account for difficulties with extinguishing

communication topographies by attempting to run prompted trials until target responses are finally extinguished. This would also yield valuable information on the effects of reinforcement histories on extinction.

Another limitation of the present investigation was related to trainer implementation of initial preference assessments following acquisition of the two modalities for Jake. During these first preference assessments, Jake's selections were initially variable, though he leaned towards preferring the vocal modality. When an independent observer noted that the trainer inadvertently paired tickles with greater enthusiasm contingent on vocal selections than SGD selections, tickles were no longer available for reinforcement throughout the remainder of the investigation. When they were removed from these initial preference assessments, Jake demonstrated a final preference for the SGD. However, It is unclear whether enthusiastic tickles were in fact more reinforcing for Jake. Despite common assumptions, findings from previous research indicate that teacher enthusiasm may not actually be reinforcing for many students with ASD; in fact, it may be punishing for some students, or it may have no impact on skill acquisition (e.g., Clausen, Alden-Anderson, Stephenson, Mueller, & Klatt, 2007.). Though Jake continued to request to earn tickles even after they were no longer available, it may have been tickles alone that were reinforcing to him, irrespective of teacher enthusiasm. Furthermore, SGD selections were on an increasing trend, and vocal modality selections were on a decreasing trend, even prior to the removal of tickles. As such, it is unclear whether Jake's pattern of responding would have continued in that direction had tickles not been removed from the array of reinforcer options. Future research examining specific factors influencing communication preference should keep all parameters consistent throughout their experiment, apart from the specific parameter under investigation.

Additional methodological issues within the present investigation may have affected outcomes. First, given the difficulties experienced with capturing and sustaining Seth's motivation, the number of teaching trials for stimulus Scamp were reduced halfway through the Acquisition phase for that stimulus. Additionally, the number of trials per session during the reinforcement histories condition for stimulus Scamp was reduced by half. The lack of trial consistency throughout phases for Seth may have impacted results. Future studies should keep trials consistent across all phases, and address difficulties with participant motivation through more formal reinforcer assessments prior to the onset of the actual investigation. Furthermore, Seth was unable to acquire conditional discriminations during the Acquisition phase of the investigation; as such, procedures were modified such that only simple discriminations were taught. When acquisition training commenced with Jake, these modifications were already made for Seth; to maintain consistency between participants and account for time constraints, Jake was only taught a simple discrimination task with the two modalities. Future studies should investigate participants' acquisition of labels using conditional discriminations, and their preference for different modalities when labeling these varied stimuli. This may yield important information on whether features of the stimulus itself impact communication modality preference. A final limitation of the present investigation involves potential differences in the difficulty of acquiring the label between the vocal approximation and SGD conditions. Labeling in the SGD condition involves point-to-point correspondence between the target stimulus and response (i.e., stimulus and response are identical pictures, such as in match-to-sample tasks). There is no point-to-point correspondence, however, between the target picture and the vocal label (which may have contributed to Seth's inability to acquire the vocal modality during conditional discriminations). Future investigations can account for this limitation by comparing

labels using modalities that do not have point-to-point correspondence with target stimuli, such as labeling pictures using vocal approximations and sign language.

Conclusion

In conclusion, the present investigation replicates and extends previous research on the acquisition of, and preference for, communication modalities in students with autism. In addition to examining preference for two modalities—SGD and vocal approximations—the present study manipulated reinforcement histories with the different communication topographies to measure effects on preference. Furthermore, manipulations in session-correlated stimuli associated with the different modalities were included to measure the additional impact of associative stimuli on communication preference. One participant's initial preference for the SGD appeared to be related to faster acquisition rates for that modality. The second participant acquired both modalities within the same number of sessions, but showed an initial preference for the SGD. When reinforcement histories were established with the different modalities, however, his preference shifted such that he continued to allocate responding toward whichever modality was reinforced in the previous reinforcement histories condition. Furthermore, session-correlated stimuli were not found to affect how the participant allocated responding between the two modalities; rather, recent reinforcement histories alone affected his preference.

These results have important implications for clinical practice. When students have multiple communication topographies within their existing repertoire and have simultaneous access to the different modalities, their preference to respond with one modality over the other may be influenced by their recent reinforcement history with that modality. As such, if instructors wish to increase students' responding with particular communication topographies, they can differentially reinforce responses with that modality, while temporarily placing other

topographies on extinction. This may be particularly useful for students with autism who experience difficulties with spoken language. For one participant, when reinforcement histories were established with the vocal modality, not only did he subsequently prefer to communicate using vocal approximations, his responding with the vocal modality was also unable to be placed on extinction during prompted reinforcement histories trials targeting the SGD. As such, responses consisting of both topographies were reinforced during these reinforcement histories sessions, and the participant subsequently preferred both modalities during preference assessments. In a population with severe communication deficits, applying similar procedures may not only enhance preference for communicating with a more socially recognized modality (i.e., vocals), but it may also enhance preference for simultaneous responding with multiple communication topographies. Communicating with multiple topographies simultaneously may, by extension, broaden their listener base and enhance the reinforcing value of their social interactions.

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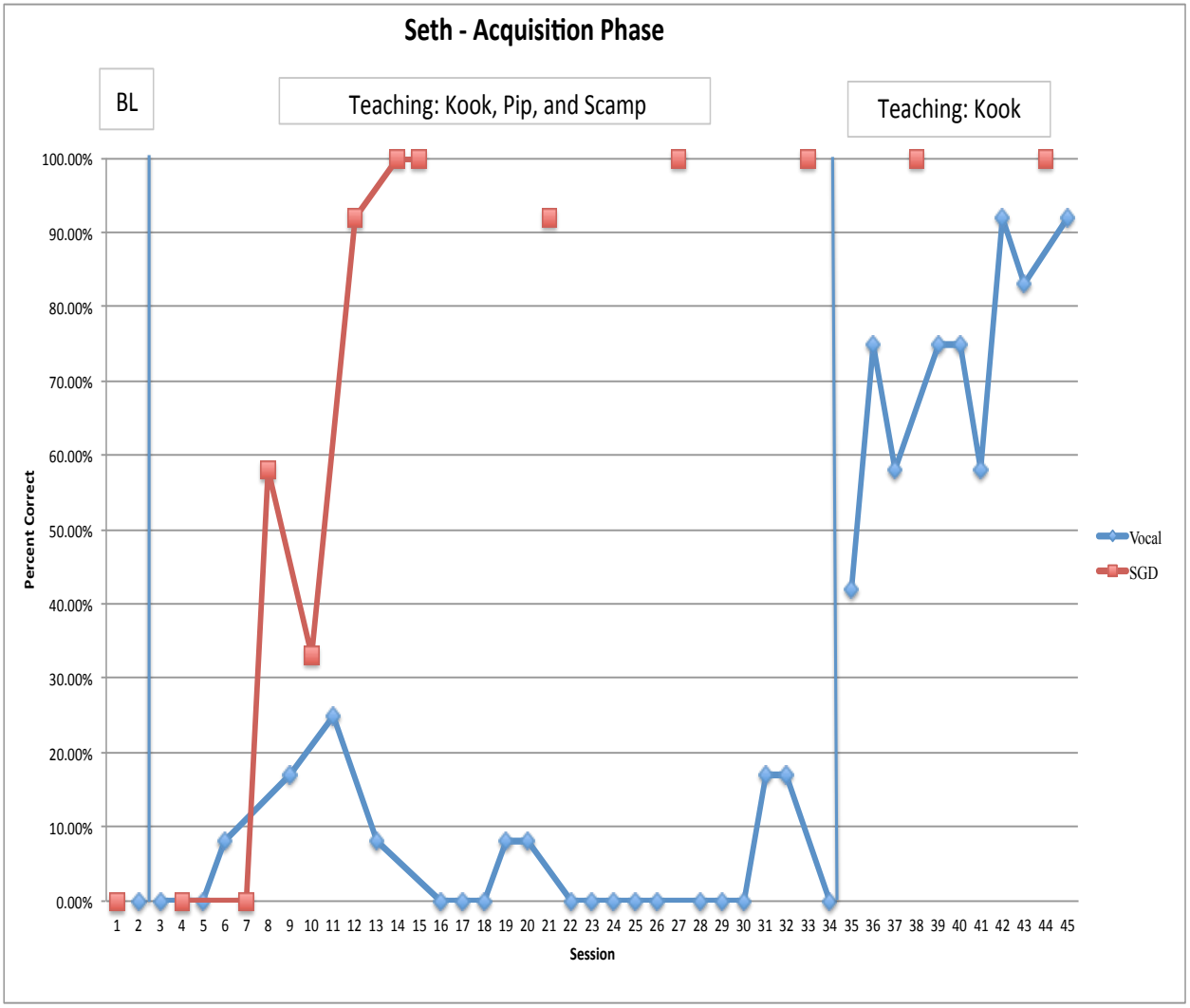

Figure 1. Results for the Acquisition phase for Seth. The graph displays the percent of correct responding across each modality (red data path represents SGD sessions; blue data path represents vocal sessions).

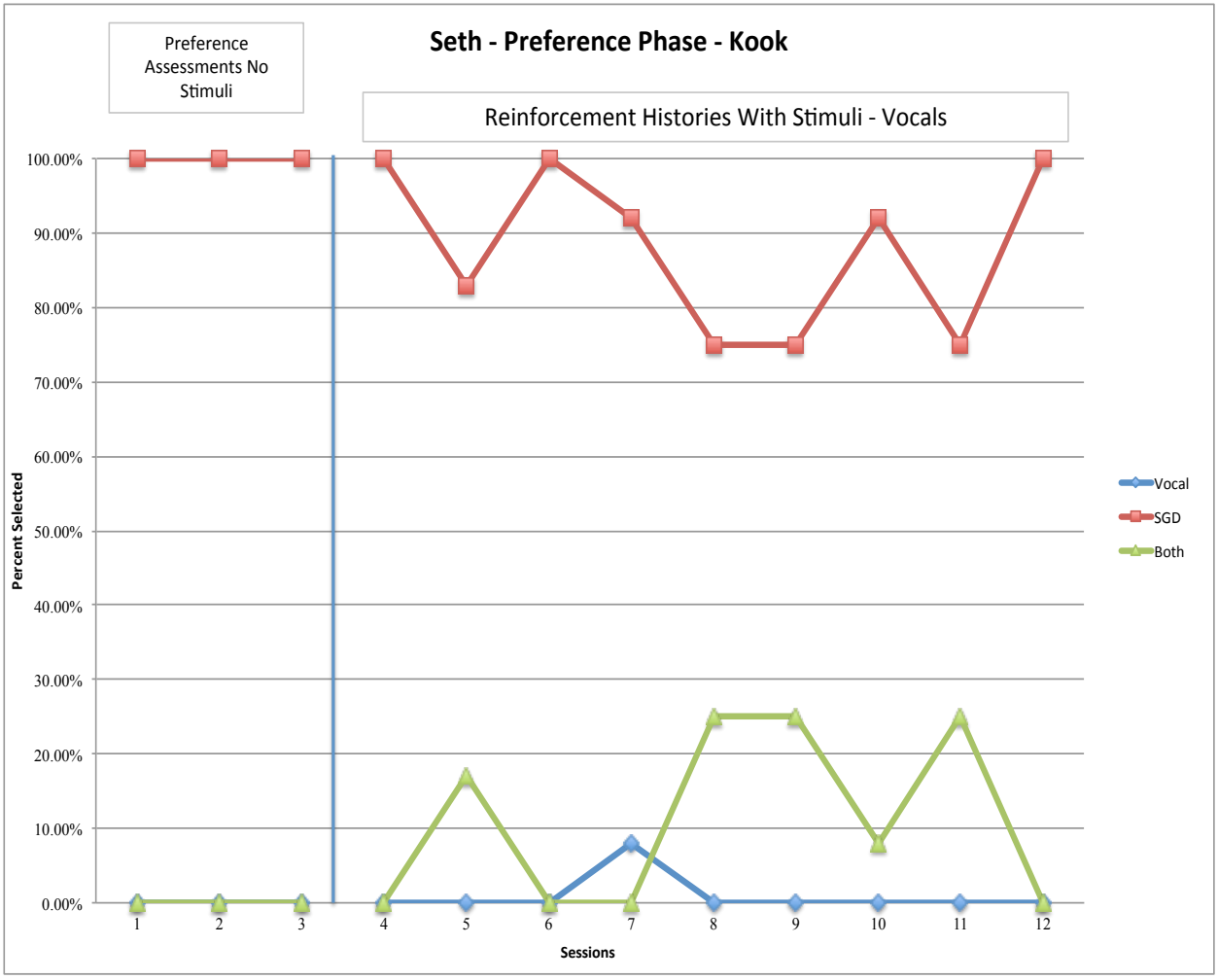

Figure 2. Results for the Preference phase for Seth. The graph displays the percent each modality was selected across conditions (red data path represents SGD selections; blue data path represents vocal selections; green data path represents both selections).

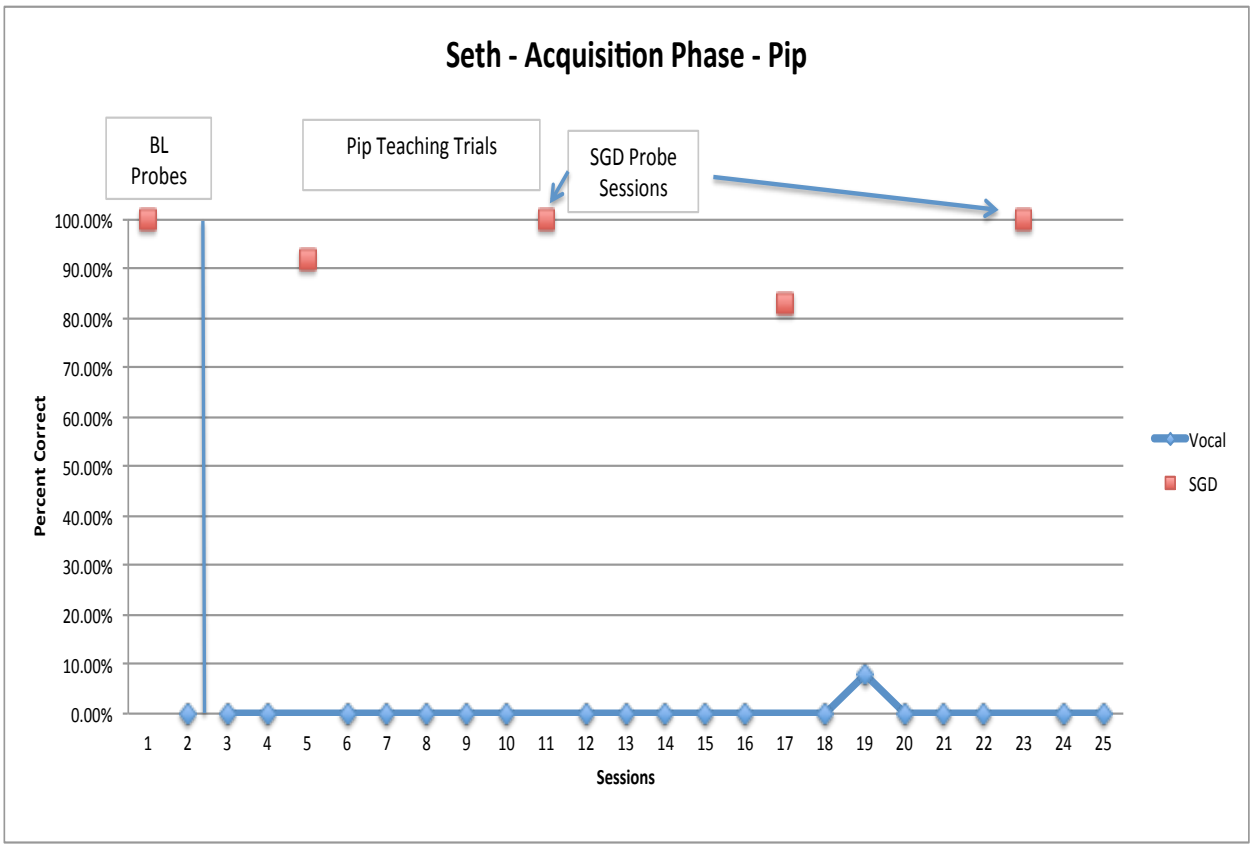

Figure 3. Results for the Acquisition phase for Seth. The graph displays the percent of correct responding across each modality (red data path represents SGD sessions; blue data path represents vocal sessions).

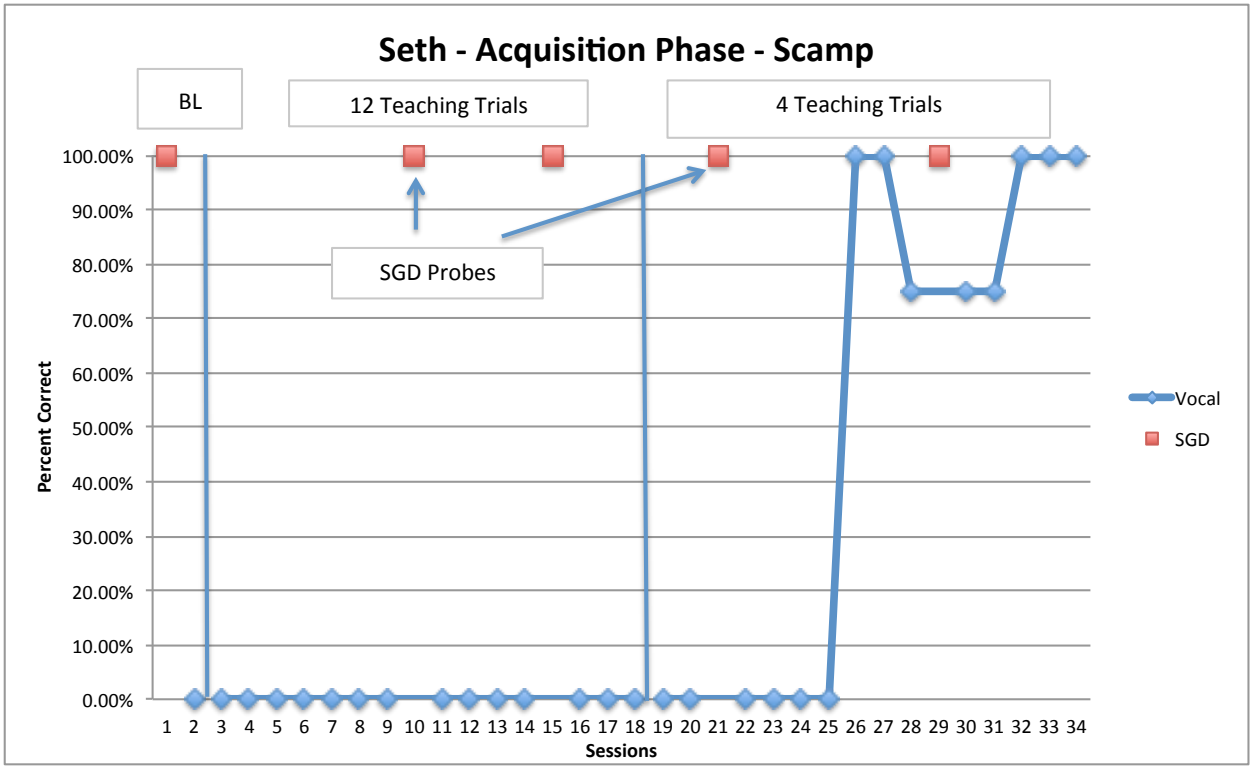

Figure 4. Results for the Acquisition phase for Seth. The graph displays the percent of correct responding across each modality (red data path represents SGD sessions; blue data path represents vocal sessions).

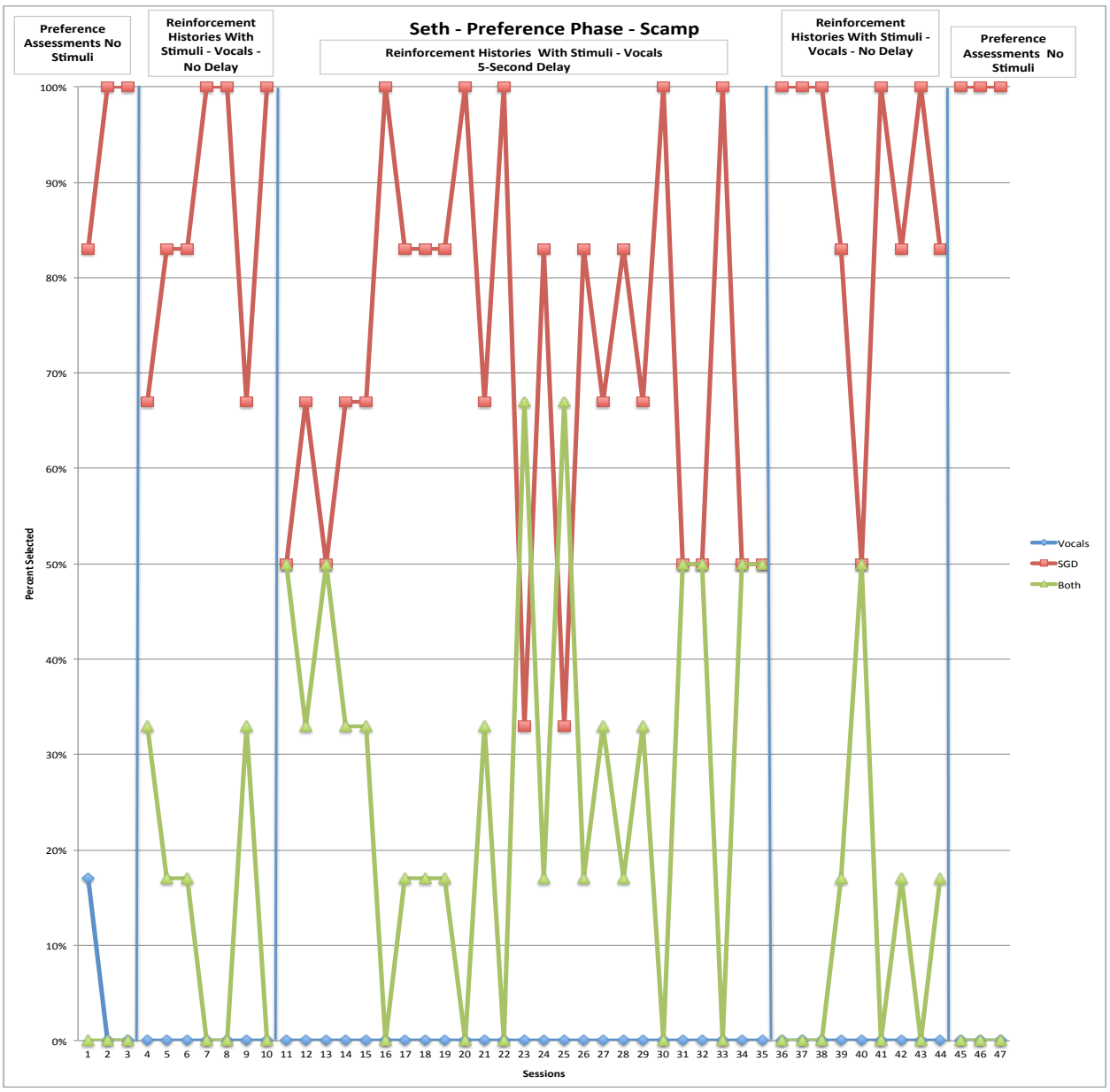

Figure 5. Results for the Preference phase for Seth. The graph displays the percent each modality was selected across conditions (red data path represents SGD selections; blue data path represents vocal selections; green data path represents both selections).

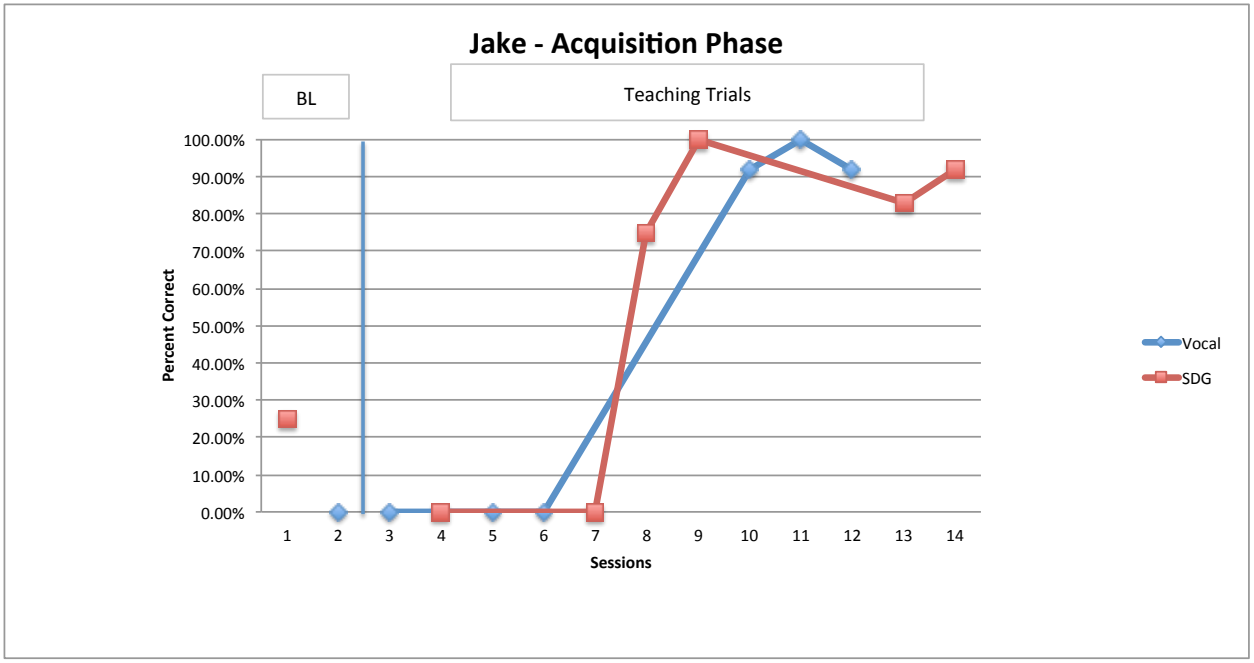

Figure 6. Results for the Acquisition phase for Seth (stimulus Kook). The graph displays the percent of correct responding across each modality (red data path represents SGD sessions; blue data path represents vocal sessions).

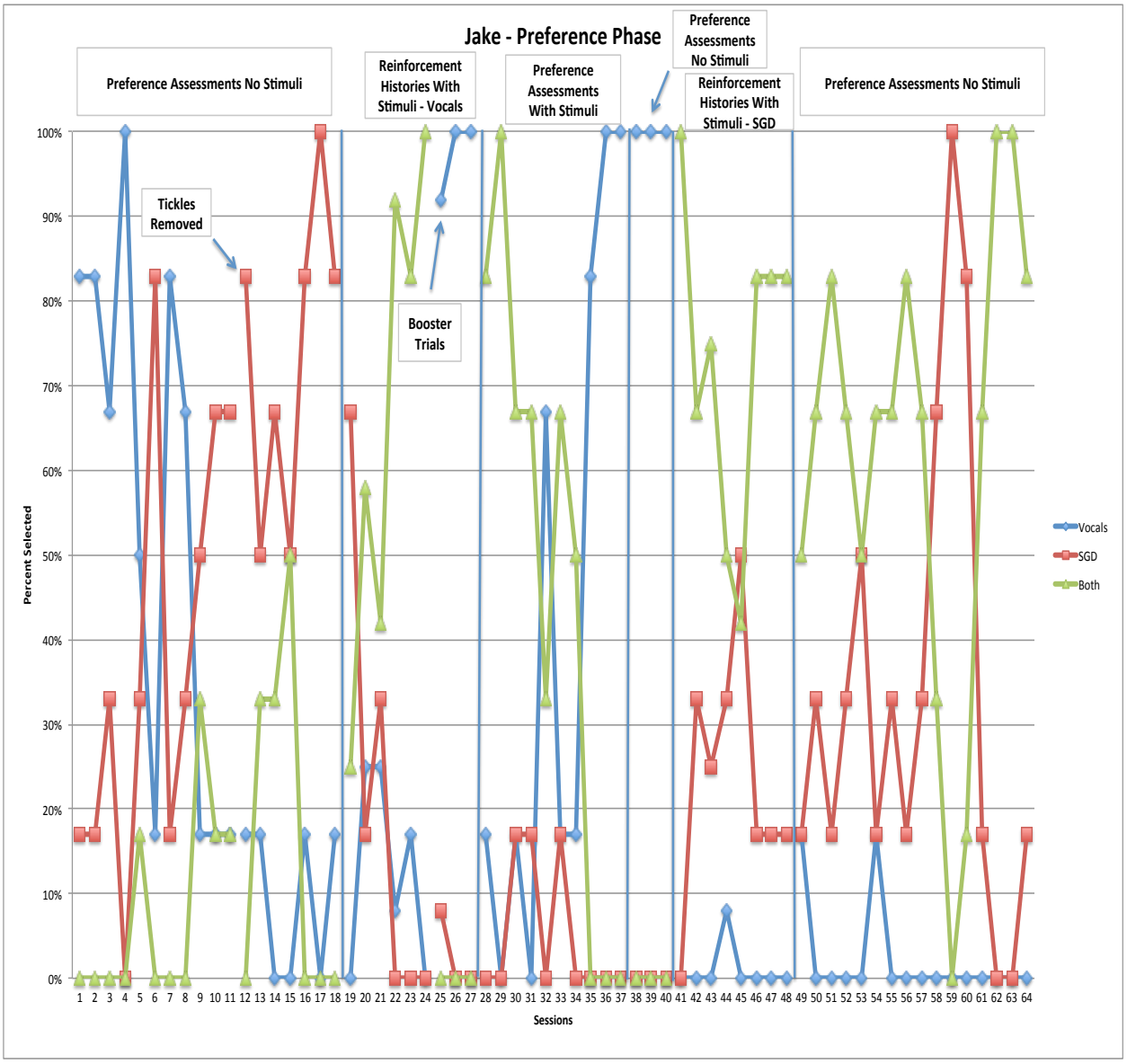

Figure 7. Results for the Preference phase for Jake (stimulus Kook). The graph displays the percent each modality was selected across conditions (red data path represents SGD selections; blue data path represents vocal selections; green data path represents both selections).

Appendix A

Acquisition Phase Data Sheet Vocal Approximations

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Acquisition Phase Data Sheet SGD

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Date: Session Number: Prompt Level:

Correct Independent: Correct Prompted: Total Correct:

Appendix B

Preference Phase Data Sheet Preference Assessments (No Stimuli)

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Preference Phase Data Sheet Reinforcement Histories (With Stimuli)

Date: Session Number: Target Modality:

% Vocal Modality: % Both: % SGD:

Date: Session Number: Target Modality:

% Vocal Modality: % Both: % SGD:

Date: Session Number: Target Modality:

% Vocal Modality: % Both: % SGD:

Date: Session Number: Target Modality:

% Vocal Modality: % Both: % SGD:

Date: Session Number: Target Modality:

% Vocal Modality: % Both: % SGD:

Preference Phase Data Sheet Preference Assessments (With Stimuli)

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Date: Session Number:

% Vocal Modality: % Both: % SGD:

Appendix C

Acquisition Phase Treatment Integrity Vocal Approximations Conditional Discriminations

Description	Yes	No
Laminated photo indicating vocals options present on instructional table		
Blue tablecloth covering table; instructor wears blue T-shirt		
3 characters total, 4 trials each per session		
Instructor presents characters in counterbalanced order		
Instructor presents target stimulus and asks, "Who is it?"		
Correct prompt level used during session: Instructor begins with immediate full echoic throughout session, then fades to five second delay after 80% or higher correct responding across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); 5 second delay used throughout session until correct responding is 80% or higher across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); independent level throughout session until 80% correct responding or higher across three consecutive sessions (Formula: Correct Independent/Total Trials X 100), then mastered; if 50% or lower correct responding across two consecutive sessions at one prompt level, instructor returns to previous prompt level (Formula: (correct prompted + correct unprompted)/total trials X 100).		
Correct prompting procedure used: If full echoic prompt, instructor immediately provides full vocal model; if 5 second delay, instructor waits 5 seconds, then provides full vocal model; if independent level, instructor provides no prompt.		
Praise and preferred item delivered on FR1 schedule following all correct prompted and unprompted trials (10 seconds)		
Instructor records data on data sheet, including level of prompting (e.g., FE+, FE-, --, I, etc.)		
Instructor records initial of character next to each data point to track order of characters		
Instructor records session number and date of session		

Instructor correctly follows error correction procedure: If participant responds incorrectly during prompted or independent trials, instructor immediately states name of item (e.g., "It's (name of item)"), then immediately presents next trial; during prompted trials, if participant does not respond within 5 seconds of prompt, instructor immediately vocalizes name of item (e.g., "It's (name of item)"), then immediately presents next trial; during independent trials, if participant does not respond within 5 seconds of delivery of SD (i.e., "Who is it?"), instructor immediately vocalizes name of item (e.g., "It's (name of item)"), then immediately presents next trial; no reinforcement provided for incorrect or no responses.		

Acquisition Phase Treatment Integrity Vocal Approximations Stimulus Kook

Description	Yes	No
Laminated photo indicating vocals options present on instructional table		
Blue tablecloth covering table; instructor wears blue T-shirt		
12 trials Kook		
Instructor presents target stimulus and asks, "Who is it?"		
Correct prompt level used during session: Instructor begins with immediate full echoic throughout session, then fades to partial echoic after 80% or higher correct responding across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); partial echoic used throughout session until correct responding is 80% or higher across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); independent level throughout session until 80% correct responding or higher across three consecutive sessions (Formula: Correct Independent/Total Trials X 100), then mastered; if 50% or lower correct responding across two consecutive sessions at one prompt level, instructor returns to previous prompt level (Formula: (correct prompted + correct unprompted)/total trials X 100).		
Correct prompting procedure used: If full echoic prompt, instructor immediately provides full vocal model; if partial echoic prompt, instructor provides part of the vocal model (i.e., "Koo"); if independent level, instructor provides no prompt		
Praise and preferred item delivered on FR1 schedule following all correct prompted and unprompted trials		
Instructor records data on data sheet, including level of prompting (e.g., FE+, FE-, --, I, etc.)		
Instructor records session number and date of session		
Instructor correctly follows error correction procedure: If participant responds incorrectly during prompted or independent trials, instructor immediately states name of item (e.g., "It's (name of item)"), then immediately presents next trial; during prompted trials, if participant does not respond within 5 seconds of prompt, instructor immediately vocalizes name of item (e.g., "It's (name of item)"), then immediately presents next trial; during independent		

trials, if participant does not respond within 5 seconds of delivery of SD (i.e., “Who is it?”), instructor immediately vocalizes name of item (e.g., “It’s (name of item)”), then immediately presents next trial; no reinforcement provided for incorrect or no responses.		

Acquisition Phase Treatment Integrity Vocal Approximations Stimulus Pip

Description	Yes	No
Laminated photo indicating vocals options present on instructional table		
Blue tablecloth covering table; instructor wears blue T-shirt		
12 trials Pip		
Instructor presents target stimulus and asks, "Who is it?"		
Correct prompt level used during session: Instructor begins with immediate full echoic throughout session, then fades to partial echoic after 80% or higher correct responding across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); partial echoic used throughout session until correct responding is 80% or higher across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); independent level throughout session until 80% correct responding or higher across three consecutive sessions (Formula: Correct Independent/Total Trials X 100), then mastered; if 50% or lower correct responding across two consecutive sessions at one prompt level, instructor returns to previous prompt level (Formula: (correct prompted + correct unprompted)/total trials X 100).		
Correct prompting procedure used: If full echoic prompt, instructor immediately provides full echoic; if partial echoic prompt, instructor provides part of the vocal model (i.e., "Pi"); if independent level, instructor provides no prompt		
Praise and preferred item delivered on FR1 schedule following all correct prompted and unprompted trials		
Instructor records data on data sheet, including level of prompting (e.g., FE+, FE-, --, I, etc.)		
Instructor records session number and date of session		
Instructor correctly follows error correction procedure: If participant responds incorrectly during prompted or independent trials, instructor immediately states name of item (e.g., "It's (name of item)"), then immediately presents next trial; during prompted trials, if participant does not respond within 5 seconds of prompt, instructor immediately vocalizes name of item (e.g., "It's (name of item)"), then immediately presents next trial; during independent		

trials, if participant does not respond within 5 seconds of delivery of SD (i.e., “Who is it?”), instructor immediately vocalizes name of item (e.g., “It’s (name of item)”), then immediately presents next trial; no reinforcement provided for incorrect or no responses.		

Acquisition Phase Treatment Integrity Vocal Approximations Stimulus Scamp

Description	Yes	No
Laminated photo indicating vocals options present on instructional table		
Blue tablecloth covering table; instructor wears blue T-shirt		
12 trials Scamp		
Instructor presents target stimulus and asks, "Who is it?"		
Correct prompt level used during session: Instructor begins with immediate full echoic throughout session, then fades to partial echoic after 80% or higher correct responding across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); partial echoic used throughout session until correct responding is 80% or higher across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); independent level throughout session until 80% correct responding or higher across three consecutive sessions (Formula: Correct Independent/Total Trials X 100), then mastered; if 50% or lower correct responding across two consecutive sessions at one prompt level, instructor returns to previous prompt level (Formula: (correct prompted + correct unprompted)/total trials X 100).		
Correct prompting procedure used: If full echoic prompt, instructor immediately provides full vocal model; if partial echoic prompt, instructor provides part of the vocal model (i.e., "Sca"); if independent level, instructor provides no prompt		
Praise and preferred item delivered on FR1 schedule following all correct prompted and unprompted trials		
Instructor records data on data sheet, including level of prompting (e.g., FE+, FE-, --, I, etc.)		
Instructor records session number and date of session		
Instructor correctly follows error correction procedure: If participant responds incorrectly during prompted or independent trials, instructor immediately states name of item (e.g., "It's (name of item)"), then immediately presents next trial; during prompted trials, if participant does not respond within 5 seconds of prompt, instructor immediately vocalizes name of item (e.g., "It's (name of item)"), then immediately presents next trial; during independent		

trials, if participant does not respond within 5 seconds of delivery of SD (i.e., “Who is it?”), instructor immediately vocalizes name of item (e.g., “It’s (name of item)”), then immediately presents next trial; no reinforcement provided for incorrect or no responses.		

Acquisition Phase Treatment Integrity SGD Conditional Discriminations

Description	Yes	No
SGD present on instructional table within reach of participant		
Yellow tablecloth covering table; instructor wears yellow T shirt		
3 characters total, 4 trials each per session		
Instructor presents characters in counterbalanced order		
Instructor presents target stimulus and asks, "Who is it?"		
Correct prompt level used during session: Instructor begins with immediate gesture throughout session, then fades to five second delay after 80% or higher correct responding across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); 5 second delay used throughout session until correct responding is 80% or higher across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); independent level throughout session until 80% correct responding or higher across three consecutive sessions (Formula: Correct Independent/Total Trials X 100), then mastered; if 50% or lower correct responding across two consecutive sessions at one prompt level, instructor returns to previous prompt level (Formula: (correct prompted + correct unprompted)/total trials X 100).		
Correct prompting procedure used: If gesture prompt, instructor immediately provides gesture towards correct target on SGD; if 5 second delay, instructor waits 5 seconds, then gestures toward correct stimulus; if independent level, instructor provides no prompt		
Praise and preferred item delivered on FR1 schedule following all correct prompted and unprompted trials		
Instructor records data on data sheet, including level of prompting (e.g., G+, G-, --, I, etc.)		
Instructor records initial of character next to each data point to track order of characters		
Instructor records session number and date of session		
Instructor correctly follows error correction procedure: If participant responds incorrectly during prompted or independent trials, instructor immediately touches correct stimulus on screen and says,		

"That's the one," or "That's (name of item)," then immediately presents next trial; during prompted trials, if participant does not respond within 5 seconds of prompt, instructor immediately touches correct stimulus on screen and says, "That's the one," or "That's (name of item)," then immediately presents next trial; during independent trials, if participant does not respond within 5 seconds of delivery of SD (i.e., "Who is it?"), instructor immediately touches correct item on screen (e.g., "It's (name of item)"), then immediately presents next trial; no reinforcement provided for incorrect or no responses.		
Instructor intermittently rotates position of items on screen		

Acquisition Phase Treatment Integrity SGD Stimulus Kook

Description	Yes	No
SGD present on instructional table within reach of participant		
Yellow tablecloth covering table; instructor wears yellow T shirt		
12 trials Kook		
Instructor presents target stimulus and asks, "Who is it?"		
Correct prompt level used during session: Instructor begins with immediate gesture throughout session, then fades to five second delay after 80% or higher correct responding across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); 5 second delay used throughout session until correct responding is 80% or higher across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); independent level throughout session until 80% correct responding or higher across three consecutive sessions (Formula: Correct Independent/Total Trials X 100), then mastered; if 50% or lower correct responding across two consecutive sessions at one prompt level, instructor returns to previous prompt level (Formula: (correct prompted + correct unprompted)/total trials X 100).		
Correct prompting procedure used: If gesture prompt, instructor immediately provides gesture towards correct target on SGD; if 5 second delay, instructor waits 5 seconds, then gestures toward correct stimulus; if independent level, instructor provides no prompt		
Praise and preferred item delivered on FR1 schedule following all correct prompted and unprompted trials		
Instructor records data on data sheet, including level of prompting (e.g., G+, G-, --, I, etc.)		
Instructor records session number and date of session		
Instructor correctly follows error correction procedure: If participant responds incorrectly during prompted or independent trials, instructor immediately touches correct stimulus on screen and says, "That's the one," or "That's (name of item)," then immediately presents next trial; during prompted trials, if participant does not respond within 5 seconds of prompt, instructor immediately touches correct stimulus on screen and says, "That's the one," or "That's (name of item)," then immediately presents next trial; during independent trials, if participant does not respond within 5 seconds		

of delivery of SD (i.e., “Who is it?”), instructor immediately touches correct item on screen (e.g., “It’s (name of item)”), then immediately presents next trial; no reinforcement provided for incorrect or no responses.		
Instructor intermittently rotates position of items on screen		

Acquisition Phase Treatment Integrity SGD Stimulus Pip

Description	Yes	No
SGD present on instructional table within reach of participant		
Yellow tablecloth covering table; instructor wears yellow T shirt		
12 trials Pip		
Instructor presents target stimulus and asks, "Who is it?"		
Correct prompt level used during session: Instructor begins with immediate gesture throughout session, then fades to five second delay after 80% or higher correct responding across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); 5 second delay used throughout session until correct responding is 80% or higher across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); independent level throughout session until 80% correct responding or higher across three consecutive sessions (Formula: Correct Independent/Total Trials X 100), then mastered; if 50% or lower correct responding across two consecutive sessions at one prompt level, instructor returns to previous prompt level (Formula: (correct prompted + correct unprompted)/total trials X 100).		
Correct prompting procedure used: If gesture prompt, instructor immediately provides gesture towards correct target on SGD; if 5 second delay, instructor waits 5 seconds, then gestures toward correct stimulus; if independent level, instructor provides no prompt		
Praise and preferred item delivered on FR1 schedule following all correct prompted and unprompted trials		
Instructor records data on data sheet, including level of prompting (e.g., G+, G-, --, I, etc.)		
Instructor records session number and date of session		
Instructor correctly follows error correction procedure: If participant responds incorrectly during prompted or independent trials, instructor immediately touches correct stimulus on screen and says, "That's the one," or "That's (name of item)," then immediately presents next trial; during prompted trials, if participant does not respond within 5 seconds of prompt, instructor immediately touches correct stimulus on screen and says, "That's the one," or "That's (name of item)," then immediately presents next trial; during independent trials, if participant does not respond within 5 seconds		

of delivery of SD (i.e., “Who is it?”), instructor immediately touches correct item on screen (e.g., “It’s (name of item)”), then immediately presents next trial; no reinforcement provided for incorrect or no responses.		
Instructor intermittently rotates position of items on screen		

Acquisition Phase Treatment Integrity SGD Stimulus Scamp

Description	Yes	No
SGD present on instructional table within reach of participant		
Yellow tablecloth covering table; instructor wears yellow T shirt		
12 trials Scamp		
Instructor presents target stimulus and asks, "Who is it?"		
Correct prompt level used during session: Instructor begins with immediate gesture throughout session, then fades to five second delay after 80% or higher correct responding across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); 5 second delay used throughout session until correct responding is 80% or higher across two consecutive sessions (Formula: (correct prompted + correct unprompted)/total trials X 100); independent level throughout session until 80% correct responding or higher across three consecutive sessions (Formula: Correct Independent/Total Trials X 100), then mastered; if 50% or lower correct responding across two consecutive sessions at one prompt level, instructor returns to previous prompt level (Formula: (correct prompted + correct unprompted)/total trials X 100).		
Correct prompting procedure used: If gesture prompt, instructor immediately provides gesture towards correct target on SGD; if 5 second delay, instructor waits 5 seconds, then gestures toward correct stimulus; if independent level, instructor provides no prompt		
Praise and preferred item delivered on FR1 schedule following all correct prompted and unprompted trials		
Instructor records data on data sheet, including level of prompting (e.g., G+, G-, --, I, etc.)		
Instructor records session number and date of session		
Instructor correctly follows error correction procedure: If participant responds incorrectly during prompted or independent trials, instructor immediately touches correct stimulus on screen and says, "That's the one," or "That's (name of item)," then immediately presents next trial; during prompted trials, if participant does not respond within 5 seconds of prompt, instructor immediately touches correct stimulus on screen and says, "That's the one," or "That's (name of item)," then immediately presents next trial; during independent trials, if participant does not respond within 5 seconds		

of delivery of SD (i.e., “Who is it?”), instructor immediately touches correct item on screen (e.g., “It’s (name of item)”), then immediately presents next trial; no reinforcement provided for incorrect or no responses.		
Instructor intermittently rotates position of items on screen		

Appendix D

Preference Phase Treatment Integrity Preference Assessments (No Stimuli) Kook

Description	Yes	No
SGD and picture indicating vocals option BOTH present in random positions on instructional table		
Each session will consist of six trials of Kook		
Preference assessment conducted prior to each trial		
The instructor holds up the picture of Kook and presents the following instruction: “You can tell me or you can show me. Who is it?”		
Participant is given 10 seconds to choose a modality		
Reinforcement in the form of social praise and a tangible item are provided for correct responding using either modality. Item delivered for 10 seconds.		
Instructor records modality selected after every trial		

Preference Phase Treatment Integrity Reinforcement Histories (With Stimuli) Kook

Description	Yes	No
Salient stimuli corresponding to non-preferred modality present on instructional table. Specifically, if participant preferred the SGD during preference assessments (no stimuli), then the BLUE TABLECLOTH covers the instructional table, and the instructor wears a BLUE T-SHIRT (i.e., blue stimuli associated with vocal teaching trials). If participant preferred the vocal modality during preference assessments (no stimuli), then the YELLOW TABLECLOTH covers the instructional table, and the instructor wears a YELLOW T-SHIRT (i.e., yellow stimuli associated with SGD teaching trials).		
Both modalities present on instructional table, in random positions		
Instructor states rule: "When blue is present you have to tell me" (if vocals targeted) OR "When yellow is present you have to show me" (if SGD targeted)		
Instructor presents picture of Kook and asks, "Who is it?"		
Correct consequence implemented Reinforcement histories established for vocals: • If participant responds using SGD, instructor states, "Kook" or "It's Kook," provides no reinforcement, and continues to next trial • If participant responds using vocal approximations, the instructor provides reinforcement in the form of praise and a preferred item Reinforcement histories established for SGD: • If participant responds using vocals, the instructor touches Kook on the SGD, states, "That's the one," provides no reinforcement, and continues to next trial • If participant responds using the SGD, the instructor provides reinforcement in the form of praise and a preferred item		
Instructor records preferred modality on data sheet and runs 12 trials per session		
Phase terminated when participant responds correctly using the SGD during 80% or more trials per session (i.e., 10 out of 12 trials or greater), across three consecutive sessions		

Preference Phase Treatment Integrity Preference Assessments (With Stimuli) Kook

Description	Yes	No
SGD and picture indicating vocals option BOTH present in random positions on instructional table		
Stimuli associated with previous reinforcement histories condition present (i.e., blue or yellow).		
Each session consists of six trials of Kook		
Preference assessment conducted prior to each trial		
The instructor holds up the picture of Kook and presents the following instruction: “You can tell me or you can show me. Who is it?”		
Participant is given 10 seconds to choose a modality		
Reinforcement in the form of social praise and a tangible item are provided for correct responding using either modality. Item delivered for 10 seconds.		
Instructor records modality selected after every trial		