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Comparing mand-training efficiency with selection-based and topography-based communication systems

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COMPARING MAND-TRAINING EFFICIENCY WITH SELECTION-BASED AND TOPOGRAPHY-BASED COMMUNICATION SYSTEMS

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ABSTRACT

Alternative communication systems such as picture exchange systems and sign language are commonly used instructional techniques when teaching verbal operants to individuals with deficient vocal verbal repertoires, but which response topography is most efficient is highly debated. Selection-based manding responses and topography-based manding responses were alternately taught to three boys with severe language deficits in order to determine the relative efficiency of acquisition of each system. The results indicated that selection-based communication systems were more readily acquired across all participants.

INTRODUCTION

Therapists frequently use direct instruction techniques to teach verbal behavior to individuals with developmental disabilities or speech delays. Often, this instruction involves arranging appropriate antecedents and reinforcing consequences to develop mands, tacts, intraverbals, and echoics (Skinner, 1957). Ideally, this instruction involves teaching these verbal operants as vocal responses; however, it is common to teach alternative communication systems such as sign language or picture exchange systems to individuals with deficient vocal verbal repertoires.

Michael (1985) suggested that it may prove useful to classify these communication systems as either topography-based or selection-based communication systems. According to this taxonomy, selection-based communication systems are those in which a speaker is presented with multiple stimuli, and they engage in verbal behavior by selecting a particular stimulus. In other words, each response is topographically identical (e.g., a point) and each response is differentiated by the selected stimulus (e.g., pointing to a card that says candy versus play). Topography-based communication systems are those in which each response is differentiated by its topography (form) and thus will be distinct in terms of sound, duration, force, and direction. Topography-based verbal behavior most commonly involves either vocal language or sign language.

Selection-based systems (e.g., picture-exchange systems and button-press systems) are more commonly used with children with developmental delays and language deficits. Sundberg and Sundberg (1990) offered several possible explanations for their popularity. First, less time and effort is required to teach caregivers to respond to selection-based systems relative to topography-based systems such as sign language. Second, developing sign language repertoires can involve shaping the speaker’s motor skills that may not be fully developed. Despite the apparent relative ease of selection-based systems, Michael (1985) suggested that individuals with developmental disabilities may more readily acquire topography-based systems. Specifically, he noted that selection-based systems require a developed scanning and selection repertoire as well as the ability to make conditional discriminations, which are frequently absent among developmentally disabled populations. These prerequisites are not required for effective use of topography based systems in which there is a point-to-point correspondence between each response and its reinforcer.

In addition to these challenges, Sundberg and Sundberg (1990) offered a few practical limitations of selection-based communication systems. First, selection-based systems require the use of equipment (e.g. a microswitch) which is not physically available at all times; however, topography-based communication is readily accessible and easily transported. Second, some words (e.g. verbs) are difficult to depict through symbols or pictures, but American Sign Language (ASL) encompasses all words. Third, in order to see and respond to selection-based systems the listener must remain close to the speaker, while signing and vocalizing can be performed and understood from a distance.

While the proposed limitations of teaching verbal behavior through selection-based training were speculations from Michael's (1985) paper, some empirical evaluations have provided support for his assertions. For example, Sundberg and Sundberg (1990) compared the acquisition rate of tacts, responses occasioned by a nonverbal discriminative stimulus that results in social reinforcement (Skinner, 1957), and intraverbals, responses occasioned by a verbal discriminative stimulus which do not share a point-to-point correspondence with the occasioning stimulus and results in social reinforcement (Skinner, 1957), for nonsense objects and symbols using topography-based and selection-based training. Results showed that topography-based training required fewer trials and resulted in more correct responses than selection-based training. They also found that topography-based training led to the emergence of more untrained receptive language. Wraikat, Sundberg, and Michael (1991) replicated the above study while adjusting for task difficulty on an individual basis depending on functioning level. Their results were similar to Sundberg and Sundberg (1990) in that they found topography-based training to require fewer trials and lead to more spontaneous, untrained verbal behavior.

Comparisons of mand training efficacy have been curiously absent from these previous evaluations. A mand is a verbal operant in which the response is evoked under a relevant establishing operation and reinforced by a characteristic consequence (Michael, 1988; Skinner, 1957). Michael argued that mand training is particularly important for people with developmental disabilities. First, although normal functioning adults and children can be taught tacts and will then also engage in these responses as mands, these response classes will frequently maintain their functional independence among individuals with developmental disabilities (Lamarre & Holland, 1985) therefore requiring the direct training of mands. Second, since mands are directly reinforced by their consequences, learners may be more likely to participate in other educational or socially beneficial activities that may involve manding (i.e., early mand training may facilitate later participation and compliance). Manding is also beneficial as it can reduce problem behavior by replacing inappropriate “requesting” topographies (e.g. aggression) with more appropriate ones, such as signing.

Carr and Durand (1985) demonstrated the effectiveness of mand training to replace problem behavior (termed functional communication training or FCT) with children with developmental delays. After demonstrating that problem behavior was evoked either by the presentation of challenging tasks or by periods of low attention, the experimenters taught participants appropriate vocal requests for either praise or assistance while on task. Problem behavior decreased below baseline levels following FCT, indicating that FCT resulted in an increase in appropriate requests and a decrease in problem behaviors.

Previous researchers have demonstrated the expedited efficiency in the acquisition of topography-based communication systems in the acquisition of tacts, intraverbals, and receptive behavior; however, researchers have not directly compared topography and selection based systems in the acquisition of manding. Due to the frequency of mand training in early intervention for individuals with disabilities, we attempted to do so. The purpose of the present study was to alternately teach a selection-based manding response and a topography-based manding response to children with language impairments in order to determine the relative efficiency of acquisition of each system.

METHOD

Participants and Setting

Three children referred for severe language deficits participated in this study. Joey was a two-year-old boy diagnosed with autism who was receiving home-based Early Intensive Behavior Intervention (EIBI) targeting the development of imitation, manding, and matching colors. He presented no intelligible vocal verbal behavior and had limited exposure to sign language and Picture Exchange Communication Systems (PECS). His predominant mand form consisted of leading an adult to a desired item and grunting. We conducted Joey's sessions within the context of his EIBI services, which were conducted three hours per day Monday through Friday. Wyatt was a six-year-old boy diagnosed with autism referred by his teachers for lacking the ability to communicate his needs. He produced no intelligible vocal verbal behavior, had little exposure to sign language or PECS, and demonstrated little motor imitation abilities. Wyatt rarely requested items, but when he did, his predominant mand form consisted of leading a person to his desired object. We conducted sessions in an empty room at Wyatt's school. Sam was a five-year-old boy diagnosed with autism referred by his parents for lacking the ability to request preferred items. He had no comprehensible vocal verbal behavior, had little exposure to sign language or PECS, and did demonstrate a motor imitative repertoire. Sam did use the ASL sign for "bathroom" inconsistently, but his main mand form was pulling a person's hand toward his desired item. We conducted sessions in Sam's home one hour per day, four days per week.

Materials

During selection-based training trials, we presented one target picture card in an array with two other comparisons, and we placed the array in front of participants. In topography-based training trials, no picture cards were present. To indicate which communication system was available, color cards served as discriminative stimuli in all baseline and training sessions (orange for topography-based and green for selection-based).

Measurement and Interobserver Agreement

In selection-based training sessions, we defined a correct response as picking up the correct picture card for the target item and handing it to the therapist. In topography-based training, we identified a correct response as the performance of the appropriate sign for the target item, with each sign having its own operational definition. The signs for Joey's target items were an arbitrarily designed sign for "iPod®" (presenting the index and middle fingers in a "v" formation with the other fingers in a fist) and modified versions of the ASL signs for "milk" (the formation of one closed fist with knuckles facing toward the torso), and "chip" (the presentation of one hand, palm facing up and the other hand in a "c" formation with at least 1 in between the thumb and other four fingers; the hand in the "c" formation had to move across the palm of the bottom hand at least one time). Wyatt's target item was Skittle®, so we used a modified ASL sign for "candy" (contact of the index finger to the cheek with the remaining fingers in a fist formation; the index finger was required to make at least one downward motion on the cheek). Sam's target items were a Barney™ movie and Mike and Ike® candy. We used the ASL sign for "movie" (presentation of one outward-facing hand above the other hand with the bottom hand palm side down; both hands had to be above the plain of the waist with no more than 6 in between each hand) and the ASL sign for "sweet" (the index and middle fingers placed together with the remaining fingers in a fist formation; the index and middle fingers had to make at least one downward motion across the chin). Trained data collectors recorded responses using paper and pen data and specified responses as occurring independently or following a vocal, model, or physical prompt. We defined a vocal prompt in both training conditions as the therapist instructing the participant, “If you want something, ask for it.” In selection-based training conditions we defined a model prompt as the therapist picking up the corresponding picture card for the target item and a physical prompt as the therapist delivering hand-over-hand guidance for the participant to pick up the correct card. In topography-based training we defined a model prompt as the therapist performing the target sign and a physical prompt as the therapist forming the participant’s hand/fingers into the correct signing position.

To obtain interobserver agreement for all phases, two observers collected data simultaneously but independently for a total of 42% of sessions for Joey, 57% of sessions for Wyatt, and 42% of sessions for Sam. We calculated agreement by adding all agreements and dividing the sum by the number of agreements plus disagreements for each session and multiplying by 100. Prior to this study, we trained observers, and we did not include their data until they reached at least 85% agreement with another trained data collector.

The mean agreement for independent responses was 98.6% (range 30% to 100%) across all conditions for Joey, 97.9% (range 80% to 100%) across all conditions for Wyatt, and 100% across all conditions for Sam. The one score of 30% for Joey was the result of a data collector missing the first trial; the two data collectors were then out-of-sync for the remainder of the session.

Procedures

The general procedures of this study included a preference assessment to identify putative reinforcers for mand training, a baseline condition to ensure participants did not exhibit the target topography-based or selection-based mand responses under study conditions, and a mand-training comparison phase. Mand-training comparison phases included training a selection-based and a topography-based mand for the same reinforcer in alternating sessions conforming to a multielement design. For some participants, we initiated this mand training comparison sequentially across multiple items conforming to a multiple probe design. For each response, we set a mastery criterion of three consecutive sessions with at least eight independent responses during each 10-trial session.

Preference Assessment. We conducted the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996) with participants' parents to identify and nominate potential highly preferred food and leisure items which we then included in a paired-item preference assessment using the procedures described by Fisher, Piazza, Bowman, Hagopian, Owens, and Slevin (1992). We conducted a separate preference assessment for edible and leisure items and selected the most preferred items to be used during mand-training. For Joey, we identified chips, milk, and access to an iPod® as preferred (the iPod® was loaded with a variety of children's shows and applications which he was able to operate independently). For Wyatt, we identified Skittles® as preferred. For Sam, we identified a Barney™ movie and Mike and Ike® candy as preferred.

Baseline and Probes. Prior to the mand-training comparison, we conducted a minimum of three sessions of a selection-based responding (SB) baseline and three sessions of a topography-based responding (TB) baseline. During SB baseline sessions, we presented the target picture card in an array with two other comparison cards on a table top in front of the participant. We constructed all pictures by printing digital photographs of the target item on 4 in x 6 in cards. The comparison cards consisted of images of items that would not be targeted for mand-training during the course of the study. Leisure items were always placed in an array with other leisure items and edible items were always placed in an array with other edible items. To initiate a trial, we held the putative reinforcer in front of the participant's visual field from a distance of approximately 1 m to signal its availability. We then waited 5 s for an independent response. If the participant did not respond within that 5 s, we removed the target item for 2 s and then represented the item to initiate the next trial. If the participant did engage in a correct response, we did not provide access to the reinforcer. Sessions during the TB baseline were similar except that we removed the picture card array and instead targeted a signed response. We paired each of these teaching conditions with a unique discriminative stimulus (i.e., a colored 8 in x 10 in sheet of paper placed upon the table at which the participant sat) to facilitate discriminated responding.

Selection-Based Mand-Training. The physical arrangement of selection-based training was identical to its baseline condition. Before each 10-trial session, the therapist briefly placed the target item in front of the participant to signal its availability. Each trial began with a 5-s delay during which the participant could emit an independent mand which would have resulted in 30-s access to the reinforcing stimulus in the case of a leisure item or one piece of food in the case of an edible reinforcer. If the participant did not respond during the 5-s delay, or immediately following an incorrect response, then the therapist initiated a graduated prompting hierarchy to teach the target mand. For Sam, we used a three-step prompting hierarchy in which we sequentially provided a vocal, model, and then physical prompt. For Joey and Wyatt we implemented a two-step hierarchy in which we provided a vocal and then a physical prompt. We omitted the model prompt for Joey and Wyatt as they did not demonstrate a motor imitation repertoire at the time of this study. We initially also provided reinforcement for prompted responding for Joey, but then restricted the reinforcement contingency to only support independent responding at the points noted in the results section.

Topography-Based Mand-Training. TB training sessions were the same as SB training sessions except that (a) the picture cards were not present during sessions, (b) the target response was a motoric gesture, and (c) the physical prompting provided was to complete the motoric gesture.

Maintenance. We conducted periodic follow-up (maintenance) sessions with Joey and Wyatt once one response was mastered. We only conducted maintenance sessions in the mand-training condition that was mastered, and procedures were the same as those used during SB and/or TB mand-training. We continued to simultaneously train subsequent items while conducting these periodic maintenance sessions.

RESULTS

Joey

We conducted baseline probes to assess Joey's pretraining level of responding for an iPod®, chips, and milk during which he engaged in near zero levels of SB or TB responses (Figure 1). Therefore, we initiated the mand-training comparison with the iPod® as a reinforcer (first and second panel of Figure 1). For Joey's first three sessions of both types of training we reinforced prompted responding but then restricted reinforcement for independent responses only for the remainder of the sessions and items. Joey met mastery of the SB mand after 21 sessions but did not acquire the TB mand after 27 sessions. We then conducted an additional baseline probe of SB and TB responding for chips (third and fourth panels of Figure 1); Joey engaged in independent SB responses during 6.7% of trials and did not engage in the TB mand. Joey reached mastery criterion for the SB mand after 16 sessions but never engaged in an independent TB mand after 23 sessions. We then conducted additional probes of Joey's responding for milk (fifth and sixth panels of Figure 1) during which Joey engaged in SB mands during 5.6% of trials and did not engage in any TB mands. Joey reached mastery criterion for SB mands after seven sessions but never engaged in an independent TB mand after 13 sessions. Joey continued to engage in independent SB responding in the follow-up sessions.

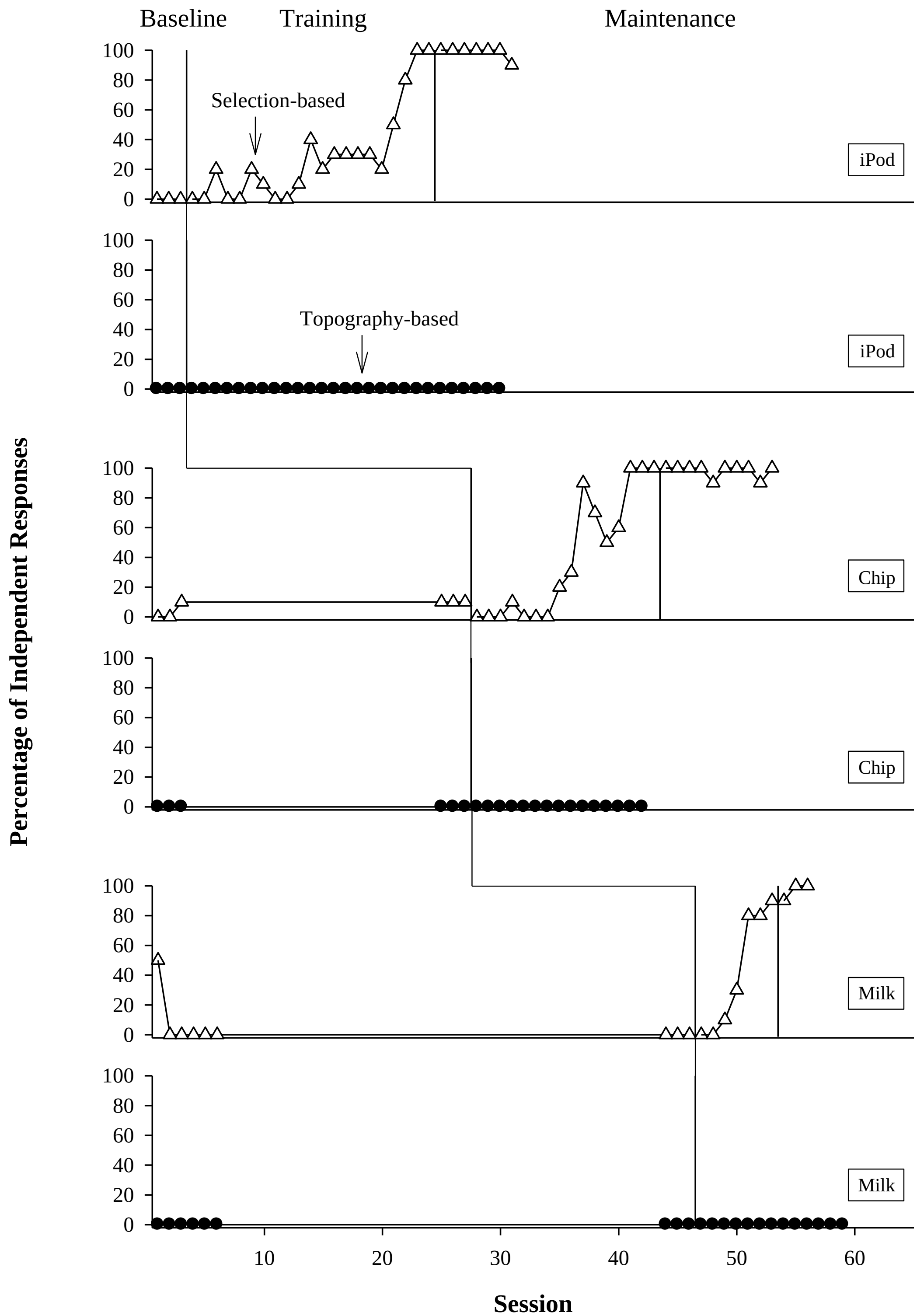

Figure 1. Results of Joey's mand-training. Percentage of independent responses in baseline, training, and maintenance conditions for iPod®, chip, and milk.

Wyatt

We conducted baseline probes to assess Wyatt's pretraining level of responding for Skittles® during which he engaged in zero levels of SB or TB responses (Figure 2). We then began the mand-training comparison with Skittles® serving as the reinforcer (first and second panel of Figure 2). Wyatt met mastery criteria for the SB mand after 11 sessions. He did engage in independent TB responses for 1.6% of sessions but never met mastery criteria for the TB mand after 17 sessions. Wyatt continued to engage in independent SB responding in the follow-up sessions. We were not able to train subsequent items for Wyatt due to his unexpected departure from school.

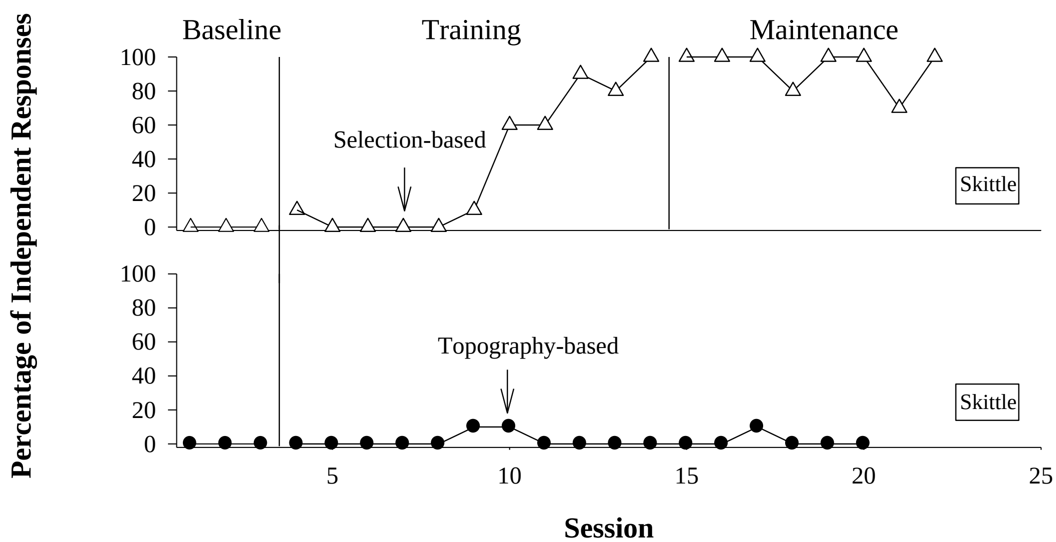

Figure 2. Results of Wyatt's mand-training. Percentage of independent responses in baseline, training, and maintenance conditions for Skittles®.

Sam

We conducted baseline probes to assess Sam's pretraining level of responding for the Barney™ movie and Mike and Ike® candy during which he engaged in zero levels of responding for SB or TB responses (Figure 3). Therefore, we initiated the mand-training component with the Barney™ movie serving as the reinforcer (first and second panel of Figure 3). Sam reached mastery criteria for the SB response after three sessions but never engaged in independent TB responses after nine sessions. We then conducted an additional baseline probe for SB and TB responding for Mike and Ike® candy (third and fourth panels of Figure 3); Sam engaged in independent SB responses during 5% of sessions and never engaged in independent TB responses. Sam met mastery criteria for the SB mand after nine sessions but never engaged in independent TB mands after 13 sessions.

Overall, each of three participants, with a total of six mand-training comparisons, reached the mastery criterion for their target item(s) in the SB mand-training. However, none of the participants reached mastery criterion for their target items in the TB mand-training. Across all participants, the average number of trials to reach mastery criterion per item in the SB mand-training was 15 training sessions (150 trials).

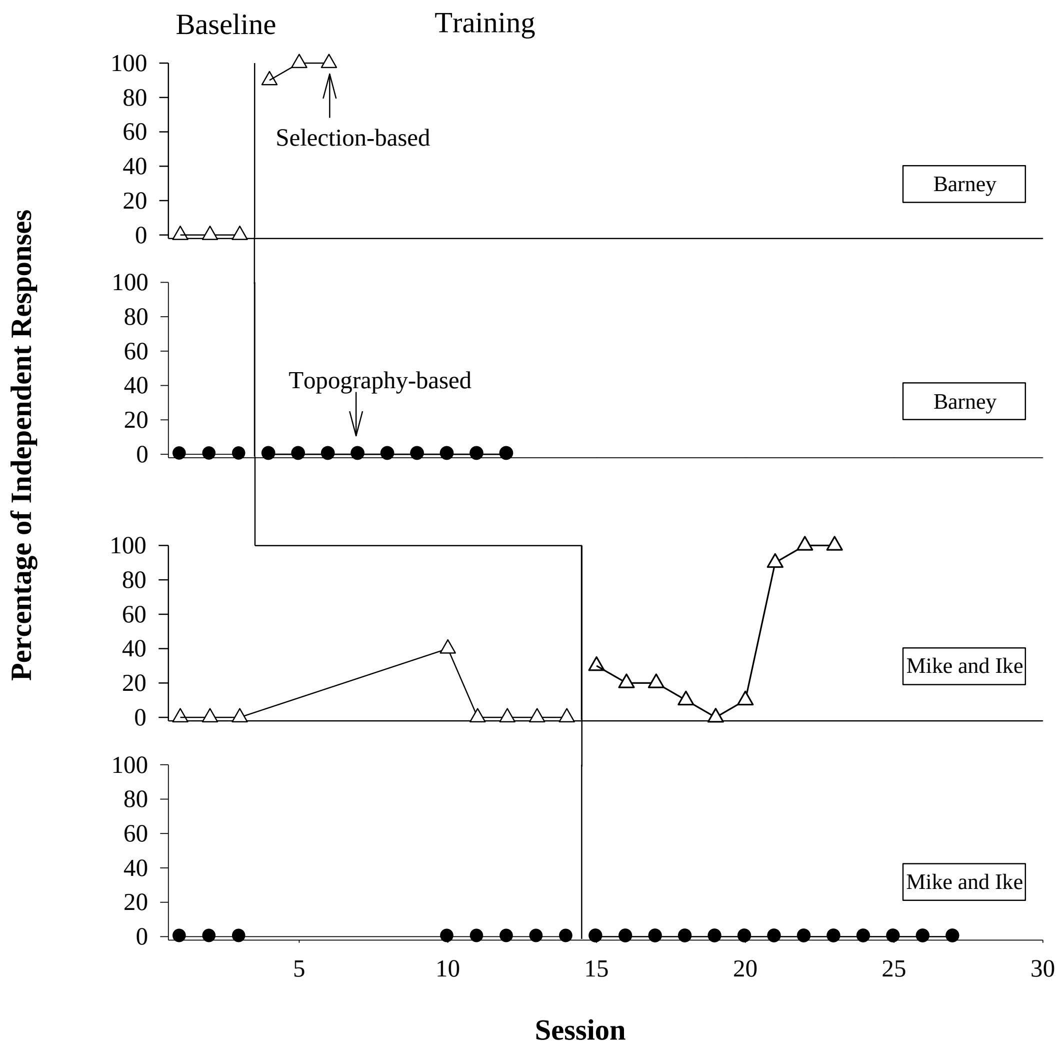

Figure 3. Results of Sam's mand-training. Percentage of independent responses in baseline and training conditions for Barney™ movie and Mike and Ike® candy.

DISCUSSION

In the current study we compared the relative efficiency of acquisition of SB and TB communication systems during the training of mands with three young boys diagnosed with autism who exhibited severe language deficits. We alternated training both systems within a multielement and multiple probe design, and we evaluated the treatments across several preferred items per participant. We found that all participants acquired the SB communication system but never acquired the TB communication system for all of their target items.

The present study differed from existing research comparing SB and TB communication systems in that we examined their efficiency during the acquisition of mands. Sundberg and Sundberg (1990) and Wraikat, Sundberg, and Michael (1991) presented data indicating that TB communication systems are more efficient than SB communication systems in the training of tacts and intraverbals. In both studies, therapists taught tacts and intraverbals for nonsense images and items to participants with developmental disabilities using both TB and SB training and found that TB training required fewer trials to meet mastery criterion and occasioned more correct responses than SB training. Their results support Michael's (1985) assertion that TB systems, in general, are acquired more readily than SB systems by individuals with developmental disabilities. Our results, however, are inconsistent with such prior research given that all of our participants acquired the SB system for mands more readily for all of their target items. In fact, none of our participants ever acquired the TB communication system for any of their items. There are a number of potential explanations for this discrepancy.

First, it may be that we targeted mands in lieu of other verbal operants such as tacts and intraverbals for which the superiority of TB responding has been demonstrated. It is not abundantly clear at this point why one class of verbal operants would be acquired differentially via SB responding relative to other classes. Future research will be needed in which comparisons are made between mand, tact, and intraverbal acquisition given SB and TB training are conducted within the same individual to rule out individual differences in reinforcement and learning histories.

Second, inconsistencies between the current study's findings and results of existing research could be related to the weak imitative repertoire in our participants. During TB training Joey, Wyatt, and Sam all showed some approximations during a few of the training sessions, but they were never able to master the target sign. Lacking the ability to imitate motor responses could make TB communication systems more difficult to acquire than SB systems given the complexity of forming a sign with one's hands and fingers. Tincani (2004) offered some preliminary evidence for the importance of imitative repertoires in acquiring sign relative to PECS. Specifically, he compared the acquisition of sign language and the Picture Exchange Communication System (PECS) when training mands to two young children with autism who presented with described "moderate" and "weak" imitative repertoires. The participant who presented moderate imitative skills exhibited more independent mands through the use of sign language; the participant who presented with a weak imitative repertoire exhibited more independent mands through the use of PECS.

Although, identification of the behavioral prerequisites for developing any augmentative communication system would be an extremely valuable contribution to the literature, it should be noted that sign language has been taught to extremely young children who presumably did not have robust imitative repertoires. Thompson, McKerchar, and Dancho (2004) taught typically developing infants ranging from the ages of six to 13 months signs in order to gain access to preferred items using a delayed physical prompting and reinforcement procedure. Thompson, Cotnoir-Bichelman, McKerchar, Tate, and Dancho (2007) used similar procedures in addition to adding a model prompt and also presented results indicating infants could acquire multiple signs through a delayed prompting and reinforcement procedure, which included a model prompt, in addition to showing generalization of successful sign training across items, therapists, and settings. Thus, imitation may facilitate the development of sign, but does not appear to be a needed prerequisite; our participants would likely have developed some in time given continued exposure.

The discrepancies among such findings implicate the need for further research and analyses in the area. Given that our participants never acquired TB communication systems, it is important for researchers and practitioners who heavily support TB systems over SB systems to reconsider the lack of efficiency associated with SB systems. It may be possible that SB systems are more practical when training specific verbal operants or for individuals exhibiting particular deficits (e.g. weak imitative repertoire).

It is likely the case that different individuals will be more or less likely to acquire SB responding relative to TB responding. Rather than continuing to accumulate individual instances of each pattern, researchers would be best served to begin identifying the individual differences in terms of learning histories or behavioral prerequisites that predict these sensitivities. In particular, we believe that investigating the role of imitative repertoires, fine motor coordination, scanning repertoires, selection repertoires, ability to make conditional discriminations, the complexity of the selected sign, and the presence or absence of stereotypy may be beneficial. The strength of each of these individual repertoires could influence the response effort associated with each response topography.

Future researchers may also consider assessing participants' preferences for each communication system training. Richman, Wacker, and Winborn (2001) assessed one child's preference for PECS relative to sign within the context of treatment for aggression maintained by social positive reinforcement. Therapists in this study taught the participant both a signed response and PECS response to gain access to a preferred item. During one phase after both responses were acquired, the participant could have gained access to tangible items via either the card exchange, a sign, or aggression; the participant engaged nearly exclusively in signs. Honoring individual children's preferences may both improve the efficacy of interventions but also allow individuals with developmental disabilities a greater degree of autonomy and self-determination in the treatment decision process (Hanley, 2010).

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VITA

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