THE EFFECTS OF SIGN LANGUAGE ON THE VOCAL RESPONSES OF A CHILD WITH AUTISM

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Sign language is an effective form of alternative communication for persons with autism and other developmental disabilities. Only a few studies have systematically measured the effects of sign language on the vocal responses of its users. This study employed a multiple baseline design to evaluate the effects of sign language on the vocal responses of a four-year-old boy with autism. Results indicate that a reinforcement contingency placed only on sign responses is inadequate for maintaining vocal responses. When a reinforcement contingency is placed on sign responses as well as vocal responses that the user is capable of emitting in verbal imitation, both sign and vocal responses are maintained. Results are discussed in terms of the need for a reinforcement contingency placed on vocal and sign responses, the effects of teaching procedures on response variability, and the need for future research to examine procedures utilized to teach sign language to persons within the developmental disabilities population.

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INTRODUCTION

According to the Diagnostic and Statistical Manual of Mental Disorders, autism is a neurobehavioral syndrome that affects three general categories of "behavioral impairment" including: qualitative impairment in social interaction, qualitative impairments in communication, and restricted repetitive and stereotyped patterns of behavior, interests, and activities (American Psychiatric Association, 1994).

Perhaps the most detrimental category of impairment affecting people with autism is that of communication. Research suggests that the majority of children with autism lack any functional vocal language at the onset of their diagnosis, and approximately 50% of children with autism remain "functionally mute" for the rest of their lives (New York Department of Health, 1996). Communication deficits of one form or another are universally present in individuals with autism. This has led some researchers to hypothesize that behaviors characteristic of autism such as aggression, self-stimulatory behavior, and self-injury are a secondary result of communication deficits (Koegel & Koegel, 1995). Existing data also suggest that teaching appropriate ways of communicating to people who are nonverbal is effective in reducing such problem behaviors (Day, Horner, & O'Neill, 1994; Frea, Koegel, & Koegel, 1993).

Technological gains have made the communication prognosis for children with autism more promising than it once was. Early research demonstrating effective treatment for children with autism focused heavily on teaching verbal imitation through operant conditioning in highly structured environments. While many children made substantial gains with this type of intervention, language gains seen in the training

environment did not generalize outside of that environment and roughly 50% of the children remained functionally nonverbal. However, more recent data suggest that approximately 50% to 70% of children with autism who were completely nonverbal learned some vocally generated expressive language that generalized to the natural environment (Prizant & Weatherby, 1989).

Even with these technological gains in teaching procedures there remains a percentage of the population with autism who do not acquire functional vocal language. It is in these cases that nonspeeech or augmentative communication systems must be considered. Among the most common forms of augmentative communication are sign language or gestural communication, picture-based communication, and computer generated communication. All of these systems have been successful with individual users, however when it comes to deciding which system should be implemented the decision is frequently based on personal preference and assumed knowledge of the speech and language consultant, rather than being based on empirical literature (Shafer, 1993).

While there is no empirical data that definitively answers the question, "what behavioral repertoires are necessary for an individual augmentative system to be effective," data showing the effectiveness of each individual augmentative system does exist. However, in spite of success with augmentative communication systems, speech remains the strived for goal of functional communication (Sundburg & Partington, 1998). One of the most frequently asked questions when deciding whether to implement an augmentative communication program is, "what effects will the

augmentative system have on the user's vocalizations?" One possible effect of augmentative communication is that any vocal behavior the user emitted prior to the introduction of the system may decrease or diminish following acquisition of the system. On the other hand, the reverse is also a possibility and the augmentative system may facilitate vocal responses in some manner. A third possibility is that the augmentative system will have no impact on the user's vocalizations. For these questions, there is virtually no empirical data.

A literature review of sign language in the developmental disabilities community was conducted by examining available databases pertaining to the fields of behavior analysis, special education, and communication disorders. Only articles pertaining to sign language in the developmental disabilities community were included. Articles were searched through the year 2003. Thirty-four articles were reviewed, with the range of publication from the years 1973-2002. Of those articles 5 were review articles, 4 dealt with some theoretical issue related to sign language, 2 reported case studies, while the remaining 23 were experimental in nature.

Four main areas of research have developed in sign language outside of the deaf community over the past 30 years: studies examining the ability of people with developmental disabilities to learn expressive or receptive labels via sign language,

(Carr et al. 1978; Carr, 1982; Carr & Kologinsky, 1983) studies and reports comparing sign language acquisition to some form of speech therapy or verbal input alone, (Abrahamsen et al., 1985; Kelsch-Daniloff & Shafer 1981; Hobson & Duncan 1979; Kahn 1981; and Kouri, 1989) studies comparing total communication (sign +

speech) and sign alone (Clarke et al., 1988; Remington & Clarke, 1983; Romski & Ruder, 1984; and Sisson & Barrett, 1984) and studies comparing stimulus selection-based verbal behavior (picture exchange or pointing) and topography-based verbal behavior (sign language) (Shafer, 1993; Sundberg & Sunberg, 1990; & Wraikat et al., 1991).

Researchers began investigating whether people with developmental disabilities could learn expressive and receptive vocabulary through the use of sign language in the 1970s (Miller & Miller, 1973). Of the 10 studies examining this question, all found that sign language was an effective methodology for teaching expressive and receptive language to people with developmental disabilities including autism (Benaroya & Wesley, 1977; Bonvillian & Nelson, 1976; Carr et al., 1978; Carr et al., 1983; Clarke et al., 1986; Hobson & Duncan, 1979; Miller & Miller, 1973; Kelsch-Daniloff & Shafer, 1981; Miller & Miller, 1976; Salvin et al., 1977). Of these articles, seven made anecdotal mention of any effects of sign language seen on the subjects' vocalizations. Three of the studies reported no improvement in the subjects' vocalizations (Bonvillian & Nelson, 1976; Clarke et al., 1986; & Salvin et al., 1977) while four articles reported an improvement in the subjects' vocalizations (Benaroya & Wesley, 1977; Fulwiller & Fouts, 1976; Hobson & Duncan, 1979; Kelsch-Daniloff & Shafer, 1981).

Because it was demonstrated that people with developmental disabilities could benefit from the use of sign language, researchers began comparing either different sign language teaching formats or the benefit of various types of speech therapy or verbal input with the benefit of sign language. Of the three articles comparing the

benefit of sign language to the benefit of responses dependent on verbal input or production, all three found that subjects acquired sign language responses more quickly than they did responses dependent on verbal input or production (Abrahamsem & Cavallo, 1985; Carr & Pridal, 1984; Kahn 1981). However, Kahn (1981) was the only investigator who reported any effects seen on the participants' vocalizations. This study reported that sign language was judged to have desired effects on two of the four participants' vocalizations.

Research that compared teaching sign language through total communication, in which the manual sign is presented along with a verbal stimulus, with sign alone, or verbal input alone, found that most subjects benefited more from total communication or sign language alone than they did from speech alone (Barrera et al., 1980; Barrera & Sulzer-Azaroff, 1983, Clarke et al., 1988; Layton, 1988; Remington & Clark, 1983; Romski & Ruder, 1984; Sisson & Barrett, 1984). Four of the seven articles that compared either total communication, sign alone, and speech alone anecdotally reported that sign language seemed to facilitated speech in some way (Barrera et al., 1980, Barrera & Sulzer-Azaroff, 1983; Clarke et al., 1988; Romski & Ruder, 1984).

The most recent research topic compares sign language with picture based communication. Three of the five articles reviewed that examined this comparison found that most subjects acquired targets taught via sign language more quickly than they did targets taught via picture based communication (Hodges & Schwethelm, 1984; Sundberg & Sundberg, 1990; Wraikat, et al., 1991). Bristow and Fristoe (1984) found no overall difference between signs and pictures, while Anderson (2001) in a more

thorough investigation, found that most subjects acquired picture based communication more quickly and had better generalization than they did with sign language. Although none of the other articles mentioned any effects seen on vocalizations, Anderson (2001) measured subjects' vocalizations with each communication system and found a higher percentage of vocalizations with sign language than with PECS.

Only two articles were found in which the effects of sign language on vocal responses was the primary dependent variable. Kouri (1989) presents a case study that analyzed the relationship between sign and spoken word productions in a young girl with Down syndrome. The analysis revealed that most of the words that the subject initially signed later evolved into spontaneous spoken productions.

While comparing instruction in sign alone, total communication, and speech alone, Yoder and Layton (1988) utilized a group correlation study to examine speech following sign language training. Yoder and Layton found that speech alone, total communication, and alternating presentation of speech and sign facilitated more child-initiated speech during treatment than did sign alone.

It is clear from the reviewed literature that people with autism and other disabilities can acquire sign language as an effective mode of communication. However, available research does not make it possible to determine whether or not sign language acquisition facilitates speech. Carr (1982) concludes that the majority of sign language research involves complex treatment packages, in that sign training was often accompanied by specific instruction in play skills, special programs for controlling undesirable behaviors, extra sessions devoted to vocal speech training, and a wealth of

other interventions. Research conducted in such a manner makes it impossible to determine which component of the treatment package contributed to behavior change. Carr (1979) further points out that it is impossible to replicate most of the studies reported in the literature because of the general emphasis on outcome rather than process.

Although virtually no measurable objective data exists to support the claim that sign language facilitates vocal language, some researchers provide theoretical rationales as to why they believe this occurs as well as suggest behavioral repertoires important for speech facilitation. Bonvillian, Nelson and Rhyne (1981) offer several theoretical rationales for why they believe sign language facilitates vocal responding. They speculate that when total communication is utilized to teach sign language, the two input modes may function "in a redundant manner, with remembered signs being used to cue forgotten words and vice versa" (p. 131). They further speculate that the signs may help the signer distinguish where a word starts and stops, and that when words are difficult to say or sound similar, the signer may be able to better distinguish among the words because of the salient difference between signs. As one of their final arguments Bonvillian et al. suggest that the motor, kinesthetic, and visual systems of children with autism appear to be more intact than do their auditory-vocal system, and since sign language is a visual-motor communication system, it may, "bypass many of the difficulties that autistic children have with auditory-vocal processing."

Sundberg and Partington (1998) state that acquiring a sign language repertoire allows nonvocal individuals to come into contact with reinforcers for successful verbal

behavior for the first time by facilitating successful interactions with others. They also state that if the trainers speak as they sign while requiring and reinforcing vocal approximations made by the subject, specific words can become associated with specific motor patterns and reinforcement. These sounds may then become conditioned or even automatic reinforcers, and can strengthen vocal behavior.

Researchers also theorize about why there is no improvement in some students' speech following sign language training. Carr (1979) and Kiernan (1983) both attribute stimulus overselectivity to the lack of improvement in speech. Carr (1979) concludes that mute children are the most obvious candidates for sign language training, and that such children typically have low mental ages, which correlates with overselective attention. Therefore, when signs are combined with spoken words, as in the total communication method, mute children will attend to the signs but not the words. Kiernan (1983) parallels this theory but talks about it in terms of the children's ability to process auditory and visual stimuli.

In order for theoretical constructs to be useful, the behavioral repertoires exhibited by the subjects whose speech improved following acquisition of sign language must be examined. Reviewing sign language literature reveals that sign training may facilitate the acquisition of vocal behavior only when some degree of verbal imitation is emitted by the learner, or when specific interventions and reinforcement contingencies are placed on vocal behavior. Of the studies reviewed for this research 12 reported an increase in vocalizations. Of those 12 studies, only six report the subjects' verbal imitation abilities or baseline expressive vocabulary (Anderson, 2001; Barrera et al.,

1980; Barrera & Sulzer-Azaroff, 1983; Clarke et al., 1988; Kouri 1989; Yoder& Layton, 1988). All of the subjects who were reported to have increased vocalizations had some degree of verbal imitation or expressive vocabulary prior to sign language training. Three of the studies that reported increased vocalizations included either verbal imitation training in addition to sign training, or a reinforcement contingency for vocalizations (Hobson & Duncan 1979; Kelsch-Daniloff & Shafer, 1981; Schaeffer 1980). The two remaining studies that reported an increase in the subjects' vocalizations did not report the subjects' verbal imitation abilities, or if vocalizations were reinforced if they occurred (Benaroya & Wesley, 1977; Fulwiller & Fouts, 1976; Kahn 1981).

The purpose of this study is to objectively measure the effects of sign language on the vocal responses of a child with autism who has minimal imitation skills, and to examine the effects of a reinforcement contingency placed on vocalizations following sign language acquisition. Because the majority of sign language studies were conducted in the 1970s and 1980s and behavioral language intervention programming has advanced since then, this experiment will utilize naturalistic teaching procedures to teach sign language to a four-year-old boy with autism, while measuring the effects of total communication training on the frequency and topography of vocal responses. This experiment will begin with a baseline measure of the participant's vocalizations and will also demonstrate the effects of sign language on vocal responses through the acquisition phase, whereas the majority of previous research has only anecdotally reported effects on vocal responses post sign language training.

METHOD

Participant

A four-year-old boy diagnosed with autism was the participant in the study. At the beginning of the study the participant had received behaviorally based in-home intervention for approximately a year and a half. At the onset of the study the participant received 6-10 hours per week of in-home intervention; however two months into the study the participant received no in home treatment due to financial constraints of the family.

In addition to the language, academic, and self-help goals, the participant's intervention program targeted the following skills: remain engaged with a preferred item while a therapists sits beside him, continue engagement with a preferred item when a therapist touches the preferred item, remain seated when a therapist removes and immediately returns a preferred item, remain seated when a therapist removes a preferred item and delivers a different item, comply with a therapist delivered instruction prior to receiving a preferred item, and reinforcing the absence of tantruming when the participant's mother left the room.

Prior to this study, the participant's language intervention consisted of Mand training through shaping verbal approximations in a format consistent with the Natural Language Paradigm (Koegel et al., 1987; Koegel et al., 1988). The participant's beginning language intervention program consisted of reinforcing any verbal sound emitted, then reinforcing successive approximations to specific vocal responses. A

concurrent phase of his language intervention included verbal imitation of simple sounds and oral motor imitation. However, the participant never emitted mands in the form of independent discriminated vocal responses.

In order to request an item the participant would most frequently take an adult's hand and lead them in the direction of the desired item. If required, the participant would emit a simple vocal response within his imitative repertoire to receive an item, or if given a verbal model of the item's name the participant would make an approximation to the item's name. However, when not given a verbal model of the desired item's name, the participant's independent vocal utterances were frequently not related to the name of the desired item. To receive a desired item the participant would typically emit either of the sounds, "mm," "duh," or, "buh." Failure to deliver a desired item following these responses would result in the participant crying, running around in circles, lying on the floor, banging his head on the floor, throwing objects, pulling an adult's hair, or biting the adult.

The participant's other behavioral repertoires consisted of gross motor imitation of 13 specific targets, verbal imitation of 11 simple consonant and consonant-vowel combinations, motor imitation with vocalizations of 2 targets, imitation of 5 actions performed with 5 objects, and matching identical objects and pictures. He had no receptive labels in his repertoire but could follow 4 one-step verbal instructions to perform motor activities (see Table 1).

Settings and Materials

The study took place in the offices of a behavioral consulting firm in Dallas, TX. Sessions were conducted in a 13 x 16 room. The room was separated into the experimental section and consultant's section. The experimental section was the only area of the room that the participant was permitted to be in during the experiment. This area contained a child-sized table, and two chairs, a television on top of a 2ft high stand with drawers, and 3 shelves with the lowest shelf 5ft. from the ground. The experimental section was separated from the consultant's area by an adult size office desk and a row of chairs placed arm-to-arm so that the participant could not enter into the consultant area without an adult moving the chairs. Table 2 contains a complete list of materials utilized throughout this experiment.

Measures

Data was collected on four categories of verbal responses: vocal, sign, sign plus vocal, and other sign. The data collection system is provided in Appendix A.

Vocal responses were defined as any non-perseverative vocal sound with audible volume in which the participant was facing either the experimenter or a target stimulus item. An example of a vocal response would include the participant orienting his eyes or body in the direction of a preferred item being offered by the experimenter and making a vocal utterance such as "duh." Another example would include the participant orienting his eyes or body towards the experimenter and making a vocal utterance such

as, "ah." A non-example of a vocal response would include the participant orienting his eyes or body away from the experimenter or a preferred item while making a vocal utterance such as, "duh," or "ah."

Sign responses were defined as movement of a hand or hands in the formation of a predetermined configuration that corresponds to a specific item while the participant oriented towards the experimenter or a preferred item and no vocal utterances were emitted within 2 seconds of the hand formation. An example of a sign response entails the participant orienting towards the experimenter or preferred item and makes no vocal utterance within 2sec of placing his hands in the formation of the American Sign Language sign for "book."

Sign plus vocal responses were recorded when both a vocal response and a sign response were emitted within 2sec of each other while the participant oriented towards the experimenter or a preferred item.

Other sign was defined as a sign response in which the participant oriented towards an item, emitted the sign for a different item than the one he was orienting towards quickly followed by the emission of the sign for the item he was orienting towards. For example, if the participant oriented towards the materials for "draw" but emitted the sign for "tape" quickly followed by the sign for "draw" data would be scored as *other sign*. Opportunities were also scored as *other sign* if the participant oriented towards the experimenter, emitted a sign response, but rejected or did not engage the item corresponding to the sign response upon its delivery. For example, if the

participant oriented towards the experimenter and emitted the sign for "draw" and pushed the materials for "draw" away when the experimenter delivered them, the opportunity would be scored as *other sign*.

For the purposes of this study, approximations to the predetermined hand configuration were scored as correct sign responses. For example, the sign for book entails placing the palms of both hands together with the fingers pointing away from the body, and then opening the hands so the palms face upward. However, a trial would be scored as a sign response if while orienting towards the experimenter or preferred item the participant omitted the first step in the action sequence and only placed his hands together with his palms facing upward.

Two measures were taken to judge the topography of vocal responses, *related* and *non-related*.

Related vocal responses were defined as a vocal sound or sounds emitted that contained any part of the name of the item being requested. For example, if a book was offered by the experimenter and while orienting towards the experimenter or the preferred item the participant emitted either of the following sounds or any combination of the following sounds, data was scored as related vocal response: "b," "oo," or "k."

Non-Related vocal responses were defined as a vocal sound or sound emitted that did not contain any part of the name of the item being requested. For example, if a book was presented and the participant oriented towards either the book or the experimenter and any sound other than "b," "oo," or "k," the trial would be scored as a non-related vocal response.

An additional measure (tantrum) was added for the third target item, mama. Tantruming was defined as loud elongated vocal sounds, which may have been accompanied by tears, throwing items, falling on the floor, grabbing the experimenter, biting the experimenter, or repeatedly jumping up and down. A trial was scored as "tantrum" if the participant's first response upon his mother exiting the room was to engage in one of the described behaviors.

Sessions and Trainers

Sessions were scheduled four times per week, with up to 3 -10min. sessions per day. The participant had a history of exhibiting extreme tantruming behavior whenever his mother left the room he was in. The mother expressed concern that the participant's behavior in her absence made it extremely difficult for her to leave the house or for her to engage in her own personal hygiene regiments. This same behavior was exhibited at the experimental location. The participant would almost always play with the experimenter in the presence of his mother. However, if his mother would leave the participant would engage in extreme tantruming behavior and would not play with the experimenter. For these reasons the experimenter and the participant's mother agreed that the mother should participate in experimental sessions and that the participant would be taught sign language to request his mother.

The participant's mother was active in every session. The mother's primary role was to play with the child and preferred items and to withhold and deliver the preferred items when instructed by the experimenter. During baseline sessions if the participant played with his mother more than the experimenter, the mother was instructed to

withhold the preferred items until the participant made a vocal response. The mother's cue for delivering the preferred item was the experimenter saying the name of the item. When a target item was introduced the mother's role was to withhold preferred items so that the experimenter could physically prompt the participant to make the correct hand formations, and to deliver the preferred item as the experimenter said the name of the item. All other procedures were implemented by the experimenter.

PROCEDURES

Preference Assessment / Baseline

Baseline and preference assessments were combined into one 10min session that was conducted every day until all 3 target items entered the intervention phase. Conducting the preference assessment in this manner allowed for the collection of baseline data while measuring shifting preferences over time with stimuli that had a contingency placed on their delivery.

For each baseline/preference assessment, 10 to15 items that the experimenter and participant's mother thought the participant would engage with were placed around the room. When the participant oriented towards an item either the experimenter or the participant's mother withheld the item and required the participant to make a vocal utterance before gaining access to the item. Engagement was allowed for approximately 30sec. Following the 30sec consumption period the item was removed from the participant. If the participant continued to orient towards the item it was delivered contingent upon the participant emitting a vocal utterance, thus gaining access to the item for another 30sec. If the participant oriented towards a different

item that item too was withheld until the participant emitted a vocal utterance. Items that were engaged in most frequently were chosen as targets for sign language.

Baseline for "mama" was measured by having the participant's mother exit the experimental room (often saying, "bye" and waving). The experimenter opened the door to allow the participant's mother to reenter the room when the participant oriented towards either the door or the experimenter and made any vocal utterance in the absence of tantruming. The mother stayed in the room and played with the participant for approximately 2min.

Independent Variable

The independent variable was sign language training. Once a target item was selected from baseline / preference assessment it was introduced into sign language. At which time it was the only item available. The 10min session began when the participant oriented towards the target item. In some cases the participant was allowed to engage the item for a few seconds before the experimenter would remove the item and then use most-to-least physical prompting to form the participant's hands into the manual sign corresponding to the target item. Immediately following the physical prompt the experimenter said the name of the item and his mother returned the item to the participant. When a prompt was required for the participant to emit the sign response he was allowed access to the preferred item for approximately 15sec. At the conclusion of the 15sec consumption period the experimenter again removed the preferred item and repeated the same procedure. The experimenter systematically faded physical prompts to gestural prompts until no prompts were needed. When

independent signs were emitted by the participant he was allowed access to the preferred item for approximately 30sec in hopes that the use of differential reinforcement would facilitate the subject's acquisition of sign language. When a sign was independently performed at 80% accuracy for one session the target item was moved into the "multiple items" phase.

Multiple Items

In this phase of the experiment, newly acquired sign targets were made available with 2 other signing targets (book and drink) that the participant acquired in a pilot of this study. The available items were placed around the room within the participant's reach. The 10min session began when the participant oriented towards or interacted with one of the targeted items. The experimenter or the participant's mother would withhold the item that the participant was interested in until the participant emitted a sign response. If the participant emitted the sign corresponding to the item in which he was orienting the experimenter said the name of the item and the item was delivered to the participant for another 30sec. If the participant emitted a sign that did not correspond to the item in which he was orienting, the experimenter delivered the item corresponding to the sign emitted. For example, if the participant was orienting towards the books, but emitted the sign corresponding to drink, the experimenter delivered a drink. If the participant accepted and consumed the drink, data was scored as a sign response. However, if the participant pushed the drink away or did not consume the drink the opportunity was scored as "other sign." The participant was

permitted to emit "other signs" up to three times before the sign for the item to which he was orienting was prompted.

This is a procedure similar to one recommended in the PECS training manual that is not typically recommended in the sign language literature (Frost & Bondy, 1996). The ramifications of using this procedure will be discussed later.

Design

A multiple probe design across 3 target stimuli (draw, tape, and mama) was utilized. There were four phases in the experiment: baseline, intro sign, multiple items, and prompted vocal. Inter Observer Agreement was calculated by comparing the experimenter's data with that of a second observer or from video tape. Total agreement from the second observer was recorded for 25% of sessions. IOA averaged 92.5% with a range of 85% -100%. Total agreement was scored from video taped sessions for 10% of sessions. IOA averaged 90.5% with a range of 82% - 100%.

RESULTS

Figure 1 displays the percentage of types of responses the participant emitted. The top graph represents the first sign taught, "tape." The middle graph represents the second target taught, "draw," and the last graph represents the third target taught, "mama." The ordinate displays the percent of responses emitted during each 10min session. The abscissa displays the order in which the sessions were conducted. The closed circles represent vocal responses. Open circles represent sign responses. Open triangles represent other signs; closed squares represent vocal plus sign responses, and the addition signs represent tantrum responses. Only independent responses are displayed, with no prompted responses shown.

Baseline measures of "tape" and "draw" indicate that the participant made a vocal response to obtain these items 100% of the time. There were a total of 36 opportunities for "tape" during baseline, and 209 opportunities for "draw" in baseline. Baseline measures for "mama" were variable. There were 100 opportunities to request "mama" during baseline, with a total of 61 vocal responses (61%), 14 other sign (14%), and 23 tantrum responses (23%).

Upon introduction of the first sign (tape) vocal responses drop to zero with only 1 sign plus vocal response in the first session (#21). There were 6 *other signs* for the first session, but no more until the next sign was introduced. A similar pattern was observed when the sign for "draw" was introduced. While the sign is in acquisition vocal responses dropped significantly (20% or less). Once the sign is acquired (80% independent responding) vocal responses drop to zero.

The pattern was somewhat similar when the sign for "mama" was introduced. Vocal responses drastically decreased while there was an elevation of tantrum responses. However, once the sign was acquired vocal plus sign responses reached nearly 40%.

When "tape" entered the multiple items phase, responses were 100% sign only, but once the sign for "draw" was acquired *other signs* (i.e. draw) began appearing in the "tape" sessions. Likewise, after the introduction of "tape" and "draw" *other signs* appeared in the baseline for "mama," and they continued to appear when the sign for "mama" was introduced.

When "tape" and "draw" were available together in the multiple items phase *other sign* and *vocal plus sign* responses increased. However, once the two targets became more discriminated and the number of *other sign* responses decrease, *vocal plus sign* responses also decreased.

When the sign for "mama" was introduced vocal responses did not decrease as quickly as they had when the other two signs were introduced. Additionally, *other signs* that were present in the baseline for "mama" were not present when the sign for mama was introduced. However, there was a resurgence of *tantruming* when the sign for "mama" was introduced, but the tantruming responses went to zero once the sign for "mama" was acquired. At this time, *vocal plus sign* responses ranged between 13% and 36%. *Vocal plus sign* responses continued to appear when the sign for "mama" entered the multiple items phase even when there were no *other signs* emitted.

The topography of vocal responses is displayed in Figure 2. During baseline for "tape" the majority of vocal responses emitted are non-related. Related vocal responses were emitted only 8% to 10% of opportunities in two baseline sessions. When vocal plus sign responses reemerge between sessions 59 and 98 the topography continues to be mostly non-related vocal responses, with related responses appearing in 4 sessions and non-related appearing in 6 sessions.

Because one of the response forms the participant emitted most frequently to obtain any item was a "duh" sound, the topography of vocal responses during baseline of "draw" shows a high percentage of *related vocal responses (*range 100% - 30%*)*. However, the range of *non-related vocal responses* in baseline of "draw" is quite significant (100% - 6%).

The topography of vocal responses for "mama" is quite different. Almost all of the vocal responses emitted through baseline, and introduction of the sign for "mama' were non-related vocal responses (related vocal responses appeared in only 2 of 25 sessions). "Mama" was the only target item for which the participant had a discriminated response. The participant would consistently emit the vocal response, "buh, buh" when his mother left the room. This is in contrast to the vocal responses he emitted for "tape" and "draw," which were an array of vocal responses including mostly "duh," "buh," and "ah" sounds.

The discriminated vocal response for "mama" is most likely the reason that vocal responses did not extinguish as quickly as did the vocal responses for "tape" and "draw." Likewise it is possible that *vocal plus sign* responses continued to appear

throughout the project because "mama" was the only targeted item for which the participant had any type of discriminated response.

Prompt Vocal

Because there was such a drastic decrease in vocal responses from baseline and there did not appear to be a significant reemergence of vocal responses, an intervention phase designed to increase vocal plus sign responses with related vocal topographies was added.

Setting and Materials

At the onset of this experimental phase the location of the experiment changed due to the participating agency relocating. Sessions now took place in a 8 x 10 room with only a child-sized table and two chairs, 3 shelves that were 5 ft off the ground and the materials used in the experiment available. The experimental materials were placed around the room within the participants reach just as they were in the first intervention.

Procedures

The 10min session began when the participant oriented towards one of the available items. Upon the subject's orientation the experimenter withheld the preferred item and immediately prompted the sign response for the item and the first sound of the word. When the participant imitated both responses the preferred items were delivered while the experimenter modeled the name of the item. For example, when the participant oriented towards the materials for "draw" the experimenter withheld the materials, modeled the "draw" sign and said "duh." When the participant emitted the

sign response and said "duh," the experimenter gave him the drawing items and said, "draw." The decision to only provide the first sound of the word was made based on probes of verbal imitation done outside of the experimental sessions. These probes revealed that the participant could not make close approximations to the whole words of the targeted items, but he could imitate the first sounds when modeled in isolation.

The materials were delivered contingent on the subject imitating both the sign and vocal response. However, if the subject imitated only one of the responses, after 3 attempts the items were delivered on a VI 15sec schedule in order to avoid extinguishing responses all together. When the subject imitated both responses the items were delivered for approximately VI 30sec.

Opportunities to sign for "mama" were created when the subject's mother left the room and said, "bye." The experimenter immediately prompted the sign for "mama" and said, "mm." When the participant imitated both responses his mother came back into the room very excitedly, often gave him a hug, or swung him around. When the subject imitated only one of the responses, after 3 attempts his mother reentered the room in a neutral fashion and just said "Hi."

Once the participant imitated the *vocal plus sign* responses 80% of opportunities, the experimenter began implementing a systematic time delay that increased the time of her model by 2 sec.

A minimum of 3 opportunities to sign for "mama" were set up each session. However, by this point in the experiment the participant would frequently engage other items when his mother left the room. When this occurred, the experimenter waited for

the participant to orient towards the door or towards the experimenter before delivering the sign plus vocal model. Therefore, some sessions only show 1 or 2 opportunities because the subject would not emit the "mama" sign.

Results

The last portion of Figure 1 labeled "Prompt Vocal" represents this phase of the experiment. Only spontaneous independent responses are shown. The data for "tape" show that *vocal plus sign responses* systematically increased with one session reaching 100%. Examining Figure 2 shows that although vocal plus sign responses increased, the topography was mostly non-related. Verbal imitation probes conducted outside of experimental sessions revealed that the participant was no longer imitating the "t" sound. Instead, he would most frequently emit a "duh" sound or emit the sign for tape with a "duh" sound. During the experiment when the participant emitted a "duh" sound with the tape sign the experimenter repeated the model of the sign plus "t" sound up to 3 times before turning on the video tape.

The data for "draw" shows an increase in vocal plus sign responses in only 2 sessions. Session 139 shows 4 vocal plus sing responses out of 14 opportunities (29%) and session 142 shows 3 vocal plus sign responses out of 10 opportunities (30%). By examining Figure 3 it is seen that the total number of opportunities to sign "draw" drastically decreased from previous sessions. This indicates that the materials for "draw" were not as highly preferred as they once were. Therefore, decreased motivation to receive these items resulted in fewer opportunities to implement the *prompt vocal* procedure.

The data for "mama" is more similar to that of "tape." Prompt plus vocal responses systematically increased with 2 sessions reaching 100%.

DISCUSSION

The results support previous literature by demonstrating that undesired behavior (tantruming) decreased when an effective alternative response was acquired (Horner & Budd, 1985, Koegel et al., 1992). The results also suggest that when reinforcement contingencies are placed only on sign language, verbal responses extinguish. However, when reinforcement contingencies are placed on sign as well as vocal responses both response forms are maintained. It is outside the scope of this research to ascertain to what degree the participant's personal history and behavioral repertoire impacted the results of the study. It is possible that the procedures utilized in this research would yield different results with participants having learning histories different from those of the participant in this study. However, since this participant functioned at the lower end of the autism spectrum, it is likely that these procedures would be more beneficial to learners at the higher end of the spectrum.

A few vocal plus sign responses appeared each time a target item entered the "multiple items" phase of the experiment. At that point the sign response was not clearly discriminated and the participant emitted more variability in responding. Once the sign responses were discriminated, response variability decreased and vocal responses were no longer emitted (e.g. *other signs* and *vocal responses*). The response variability seen in the "multiple items" phase may be attributed to the procedures utilized in this phase. Because this participant was known to have a history of prompt dependency, procedures were designed to minimize prompting and maximize

contact with contingencies. Delivering the item that corresponded to the sign emitted by the participant even if it was not the item he was orienting towards, functioned as an extinction procedure for "other signs." While this procedure is not recommended in the sign language literature, Sundberg and Partington (1998) recommend increasing prompting when "other signs" occur, it is recommended in the PECS literature (Frost & Bondy, 1996). Future research should examine the benefits and costs of utilizing this procedure. It may be beneficial to use this procedure because it produced response variability including vocalizations. It is conceivable that a reinforcement contingency could be placed on vocal responses at this point in training, thus eliminating the need for the additional training phase employed in this experiment. However, literature focusing on discrimination training should also be considered as it is likely that other procedures may facilitate discriminated responding more quickly with fewer errors.

This study emphasizes the use of response specific reinforcers, whereas the majority of previous research utilized generalized reinforcers. Because individuals with autism frequently have few stimuli which function as reinforcers, it can be difficult to conduct research that emphasizes Mand Training. In this study, examination of the number of initiations to each target stimuli shows that the number of initiations to two of the targeted stimuli, "draw" and "Mama," decreased as the study progressed. This suggests that these two stimuli lost some of their reinforcing value over the course of the study, which may have affected the results of the study. This implicates the importance for future research to examine the effects of using response specific reinforcers as well as generalized reinforcers.

There is a need for future research to examine the procedures utilized to teach sign language to persons with developmental disabilities. Carr (1979) called for the creation of a teaching technology that would allow for teacher's manuals in sign training. Thus far, Sundberg and Partington (1998) have made the closest approximation to such a manual. However, research to support the procedures suggested in the manual, or alternative procedures, does not exist. Until such research exists, practitioners must rely on accessible recommended teaching procedures while tailoring them to meet the specific needs of their learners.

The results of this study support previous research demonstrating that persons with developmental disabilities including autism can acquire sign language as an alternative form of communication, but the findings contradict anecdotal reports that sign language facilitates vocal responding. This is not to say that vocal responses may be facilitated by sign in some cases.

If sign language were to facilitate vocal responses, there are most likely certain behavioral repertoires necessary for it to occur. Yoder & Layton (1988) found that pretreatment verbal imitation abilities positively predicted the size of child-initiated spoken vocabulary following sign language training. Examining the remaining sign language literature reveals that in all cases where increases in vocal responding were anecdotally reported, if the authors reported the subjects' imitation abilities, the effect on vocal responding was seen only in subjects who had pretreatment verbal imitation abilities.

Of the 15 studies reviewed that reported any effect seen on vocalizations, 12 reported that sign language facilitated vocal responding, while three studies reported no effect. Six of the 12 studies that reported an increase in vocal responding also included some description of the participants' behavioral repertoire. All of the participants who were reported to have an increase in vocalizations also had some verbal imitation abilities or expressive labels prior to learning sign language (Anderson, 2001; Barrera et al., 1980; Barrera & Sulzer-Azaroff, 1983, Clarke et al., 1988; Kouri, 1989; Yoder & Layton, 1988). Of the three studies that reported no effect, two reported that their subjects had little to no verbal imitation while the third did not report the subject's imitation repertoire (Bonvillian & Nelson, 1976; Clarke et al., 1986; Salvin et al., 1977).

The participant in this study had limited verbal imitation abilities but sign language training without an explicit reinforcement contingency placed on vocalizations totally extinguished vocal responding. However, when a shaping procedure was utilized that placed a reinforcement contingency on vocalizations, the participant's "sign plus vocal" responses increased. The demonstration that a reinforcement contingency must be placed on vocalizations in addition to sign responses is also demonstrated in the literature in that, three of the 12 studies that reported an increase in vocal responding included verbal imitation training or reinforcement of vocalizations as part of the treatment package (Hobson & Duncan 1979; Kelsch-Daniloff & Shafer, 1981; Schaeffer, 1980).

There appears to be nothing inherent to sign language that facilitates vocal responding. If such facilitation is to occur, sign learners must possess pretreatment

verbal imitation abilities. However, the threshold for what degree of verbal imitation must exist in a learner's repertoire needs to be examined. Additionally, it is unlikely that a verbal imitation repertoire alone would facilitate vocal responding without a specific reinforcement contingency for vocal responses in place. If it is the case that sign users must have a strong verbal imitation repertoire in order for sign language to facilitate vocal responding. Also, it is likely that learners with such an imitation repertoire would also be successful when naturalistic teaching procedures were utilized to increase vocalizations without the use of sign language. (Koegel 1987; Koegel et al., 1988; Koegel, 2000).

APPENDIX A

TABLES

Table 1.

Participant's Behavioral Repertoire

Verbal Imitation	Oral Motor Imitation	Gross Motor Imitation
Ah M Ee Oo Ss H Ck T Dee May Du	Open mouth Blow raspberry Put lips together Pucker Open & close mouth	Pat head Stomp feet Shake leg Point to nose Sit in chair Tap knees Wave bye Cover face with 2 hands Turn around Wipers ("Wheels on Bus") Wheels ("Wheels on Bus") Choo-choo (Pulling cord)
Fine Motor Imitation	Receptive Instructions	
Wiggle fingers Make "ok" sign" Point with index finger	Wave bye-bye Turn around Do "choo-choo" Do "wheels"	

Table 2

Materials Used in Experiment

Tangible Items	Physical Play	Food / Drink
Baby doll Balloons Basket ball Ball play set with slide Books Bubbles Chalk Crayons Helicopter Lincoln logs Markers Musical boat Musical TV toy Spinning light toys Stickers Video tapes	Running and being caught by an adult Being spun around by an adult Tickles	Carbonated beverages Potato chips

APPENDIX B

OBSERVATION CODE

AND DATA SHEETS

OBSERVATION CODE

Vocal response: any non-perseverative vocal sound with audible volume in which the participant was facing either the experimenter or a target stimulus item.

Examples:

- The participant orients his eyes or body in the direction of a preferred item and says, "duh," or, "ah."
- The participant orients his eyes or body towards the experimenter and says, "mm," or, "buh."

Non-Examples:

- The participant orients his eyes or body *away* from the experimenter or a preferred item and says, "duh," or "ah."
- The participant orients his eyes or body towards the experimenter or preferred item and emits perseverative vocal utterances, such as, "ah duh, ah duh, ah duh."

Sign response: movement of a hand or hands in the formation of a predetermined configuration that corresponds to a specific item while the participant oriented towards the experimenter or a preferred item and no vocal utterances were emitted within 2 seconds of the hand formation.

Example:

- The participant orients towards the experimenter or preferred item and makes no vocal utterance within 2sec of placing his hands in the formation of the American Sign Language sign for "book."

Non-Example

- The participant orients towards the experimenter or preferred item and places his hands in the formation of the American Sign Language sign for "book," and says, "duh" within 2 seconds of emitting the sign.

Sign plus vocal responses: Both a vocal response and a sign response were emitted within 2sec of each other while the participant oriented towards the experimenter or a preferred item.

Example:

- The participant orients towards the experimenter or preferred item and places his hands in the formation of the American Sign Language sign for "book," and says, "duh" within 2 seconds of emitting the sign.

Non-Example:

- The participant orients his eyes or body in the direction of the experimenter or a preferred item and says, "duh," or, "ah."
- The participant orients towards the experimenter or preferred item and makes no vocal utterance within 2sec of placing his hands in the formation of the American Sign Language sign for "book."

Other sign: A sign response in which the participant oriented towards an item, emitted the sign for a different item than the one he was orienting towards quickly followed by the emission of the sign for the item he was orienting towards. Or, if the participant oriented towards the experimenter, emitted a sign response,

but rejected or did not engage the item corresponding to the sign response upon its delivery.

Examples:

- The participant oriented towards the materials for "draw" but emitted the sign for "tape" quickly followed by the sign for "draw."
- The participant oriented towards the experimenter and emitted the sign for "draw" and pushed the materials for "draw" away when the experimenter delivered them.

Non-Example:

- The participant orients in the direction of the experimenter or a preferred item and emits the sign for "draw" and accepts the drawing materials when handed to him.

Related vocal responses: A vocal sound or sounds emitted that contained any part of the name of the item being requested.

Example:

- A book was offered by the experimenter and while orienting towards the experimenter or the preferred item the participant said either, "b," "oo," or "k."

Non-Example

- A book was offered by the experimenter and while orienting towards the experimenter or the preferred item the participant said either, "m," "du," or "p."

Non-Related vocal responses: A vocal sound or sound emitted that did not contain any part of the name of the item being requested.

Example:

- A book was presented and the participant oriented towards either the book or the experimenter and any sound other than "b," "oo," or "k."

Tantrum: Loud elongated vocal sounds, which may have been accompanied by tears, throwing items, falling on the floor, grabbing the experimenter, biting the experimenter, or repeatedly jumping up and down.

Examples:

- Upon the participant's mother exiting the room, the participant emitted an elongated, "ah" sound and repeatedly jumped up and down.
- Upon presentation of a preferred item the participant bit the experimenter.

Non-Examples:

- Upon the participant's mother exiting the room, the participant continued to play with toys.
- Upon the participant's mother exiting the room, the participant approached the experimenter, took here hand and led her to the door.

Subject:			Date			Time			Condition/Session #			Available Items:	
Item:		Item:		Item:		Item:		Item:		Item:		Item:	
Sign only		Sign only		Sign only		Sign only		Sign only		Sign only		Sign only	
Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.	
Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR	
Other Sign		Other Sign		Other Sign		Other Sign		Other Sign		Other Sign		Other Sign	
NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal	
R Vocal		R Vocal		R Vocal		R Vocal		R Vocal		R Vocal		R Vocal	
Item:		Item:		Item:		Item:		Item:		Item:		Item:	
Sign only		Sign only		Sign only		Sign only		Sign only		Sign only		Sign only	
Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.	
Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR	
Other Sign		Other Sign		Other Sign		Other Sign		Other Sign		Other Sign		Other Sign	
NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal	
R Vocal		R Vocal		R Vocal		R Vocal		R Vocal		R Vocal		R Vocal	
Item:		Item:		Item:		Item:		Item:		Item:		Item:	
Sign only		Sign only		Sign only		Sign only		Sign only		Sign only		Sign only	
Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.	
Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR	
Other Sign		Other Sign		Other Sign		Other Sign		Other Sign		Other Sign		Other Sign	
NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal	
R Vocal		R Vocal		R Vocal		R Vocal		R Vocal		R Vocal		R Vocal	
Item:		Item:		Item:		Item:		Item:		Item:		Item:	
Sign only		Sign only		Sign only		Sign only		Sign only		Sign only		Sign only	
Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.		Sign & Rel.	
Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR		Sign & NR	
Other Sign		Other Sign		Other Sign		Other Sign		Other Sign		Other Sign		Other Sign	
NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal		NR Vocal	
R Vocal		R Vocal		R Vocal		R Vocal		R Vocal		R Vocal		R Vocal	
		Code: P = Prompted		I = Response Occurred			Please phonetically spell any vocal responses.						

Data Summary Sheet

Session # | IOA

Condition | Topography

Tot. #	Item	# vocal	% vocal	# sign	% Sign	# Other	% Other	# Voc & Sign	%Voc & Sign	# % NR voc	# % R Voc

Session # | IOA

Condition | Topography

Tot. #	Item	# vocal	% vocal	# sign	% Sign	# Other	% Other	# Voc & Sign	%Voc & Sign	# % NR voc	# % R Voc

Session # | IOA

Condition | Topography

Tot. #	Item	# vocal	% vocal	# sign	% Sign	# Other	% Other	# Voc & Sign	%Voc & Sign	# % NR voc	# % R Voc

Session # | IOA

Condition | Topography

Tot. #	Item	# vocal	% vocal	# sign	% Sign	# Other	% Other	# Voc & Sign	%Voc & Sign	# % NR voc	# % R Voc

Session # | IOA

Condition | Topography

Tot. #	Item	# vocal	% vocal	# sign	% Sign	# Wrong	% wrong	# Voc & Sign	%Voc & Sign	# % NR voc	# % R Voc

APPENDIX C

FIGURES

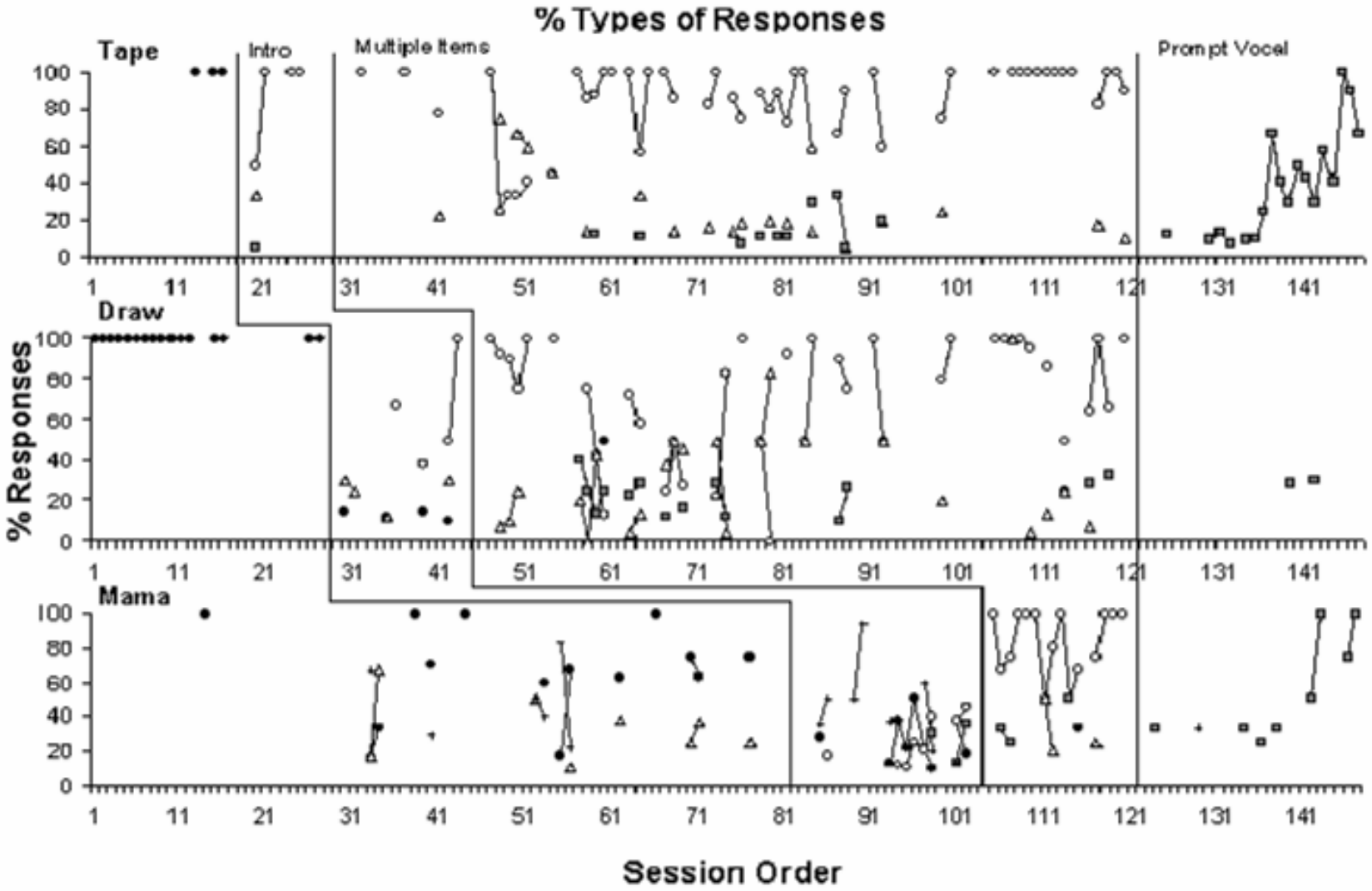

Figure 1: Peroent types of responses across three stimuli. Only unprompted responses are displayed.

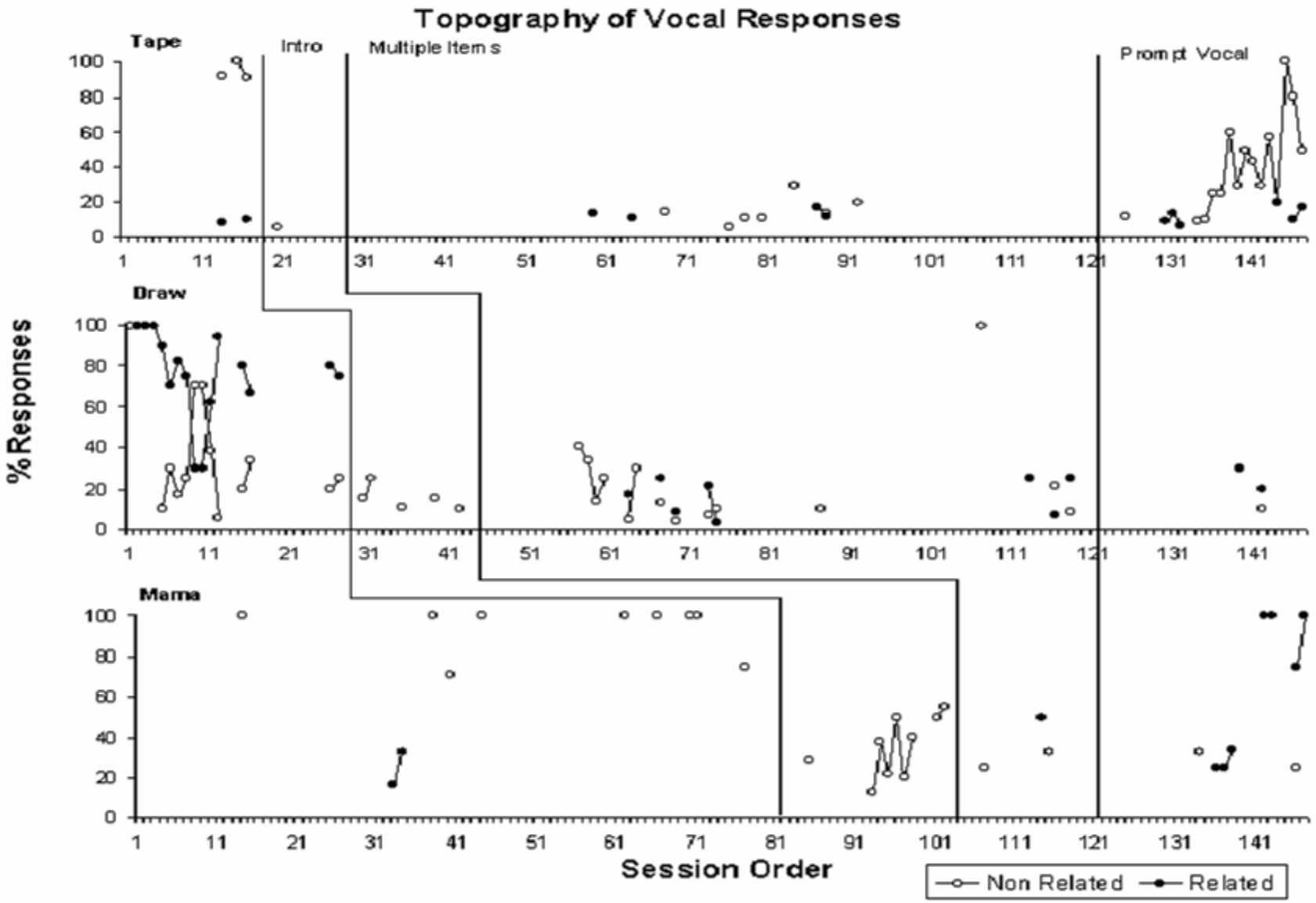

Figure 2: Topography of vocal responses across three stimuli. Only unprompted responses are displayed.

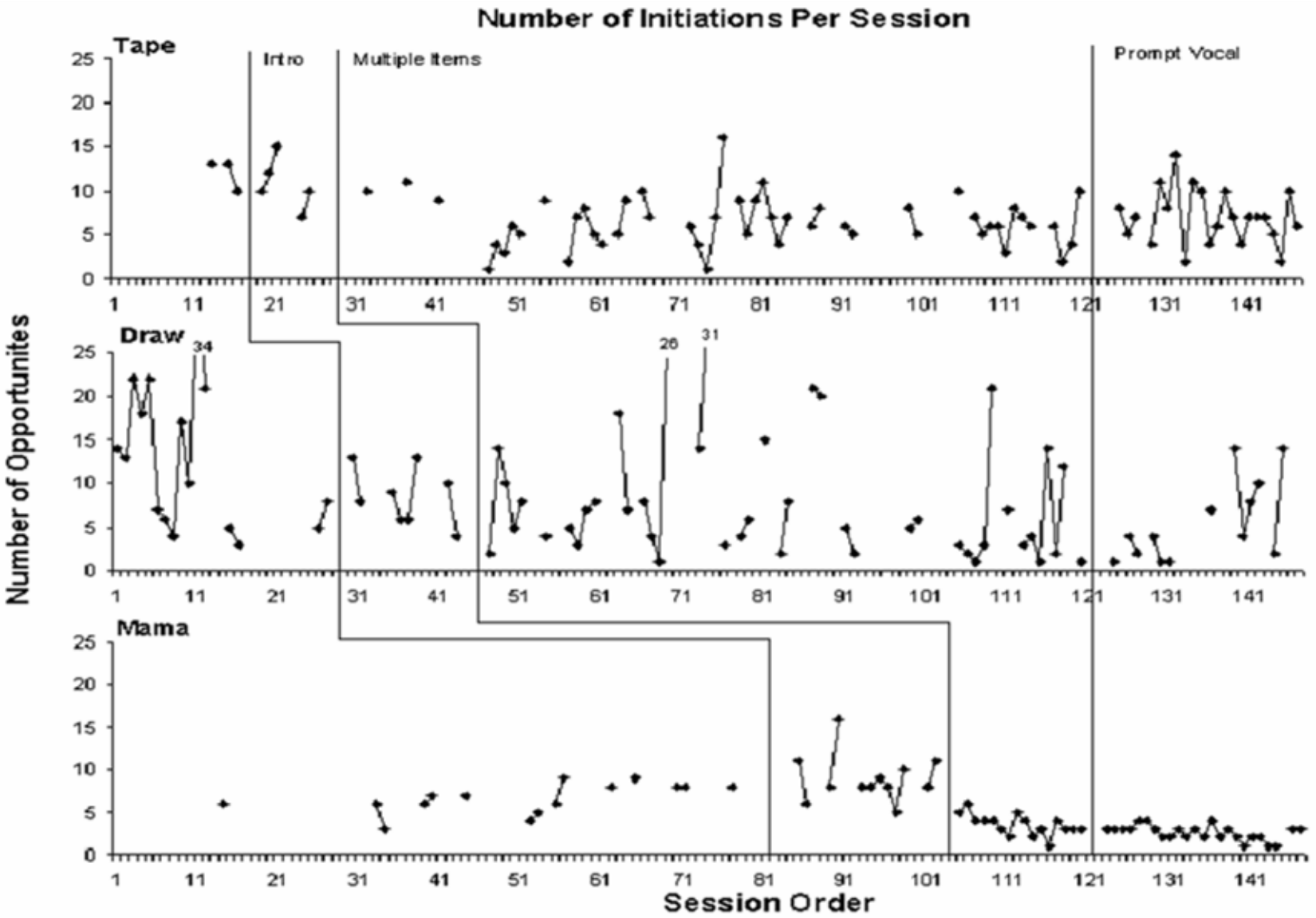

Figure 3: Number of initiations per session.

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