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The Effects of Adult Contingent Vocal Imitation on the Vocal Behavior of Young Children with Autism

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Abstract

Adult contingent vocal imitation (ACVI) is a procedure whereby an adult imitates the vocal behavior of a child. There is evidence showing that ACVI can increase the frequency of a child's vocal behavior, imitative vocal behavior, and vocal turn taking, however few studies have investigated the effects of ACVI with young children diagnosed with autism. The present study examined the effects of ACVI with children diagnosed with autism who seldom made vocal responses or imitated the vocal responses of other people. Experiment 1 compared the effects of an adult either imitating the child's vocal responses or providing non-imitative praise contingent on the child's vocalizations. Increases in child vocalizations were only observed in the ACVI condition. Experiment 2 described a clinical intervention using the ACVI procedure in an applied setting. Improvements in the children's vocal responding and vocal imitative responding were observed, and vocal mand training was successfully implemented with both children. Results from Experiment 1 and 2 support previous research on the reinforcing effects of ACVI and contributes to the limited research literature on the effects of ACVI with children diagnosed with autism.

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Introduction

It is well documented that a parent will imitate their child's motor and vocal behavior often throughout infancy and well into early childhood (e.g., Gros-Louis, West, Goldstein, & King, 2006; Masur & Olson, 2008; Papoušek & Papoušek, 1989; Pawlby, 1977). This type of stimulation, according to longitudinal research (Masur & Olson, 2008), is vitally important for early communication and language development throughout the pre-school and early elementary school years.

Learning theorists and researchers agree that an adult imitating the behavior of a young child can serve a reinforcing function for additional responses, and further, that the similarity or correspondence between the adult and the child's respective behaviors contributes the most to the process (Bijou & Baer, 1965; Fouts, Waldner, & Waldner, 1976; Lewis, 1959; Olmsted, 1971; Thelen, Dollinger, & Roberts, 1976).

The behavior of an adult imitating the behavior of a child is termed "adult contingent imitation" or ACI for short (Gazdag & Warren, 2000). Judging by the research literature, ACI is receiving increased attention as a reinforcement-based means to strengthen the motor and vocal behavior of young children with developmental disabilities in particular. The evidence thus far indicates that ACI functions as a positive reinforcer for (1) vocal and motor responses (Calise, Cautilli, & Galino, 2009; Cautilli & Dziewolska, 2005; Field, Field, Sanders, & Nadel, 2001; Field, Guy, & Umbel, 1985), (2) imitation (Field et al., 2010; Heimann, Laberg, & Nordøen, 2006; Sanefuji & Ohgami, 2013), (3) smiling (Field et al., 2001; Field et al., 1985), (4) proximity to an adult (Field et al., 2001), (5) touching an adult (Escalona, Field, Nadel, & Lundy, 2002; Field et al., 2001; Heimann et al., 2006; Nadel et al., 2000), (6) looking at an adult (Field et al., 2001;

Heimann et al., 2006; Nadel et al., 2000; Sanefuji & Ohgami, 2011, 2013), and (7) reciprocal play (Field et al., 2001). These studies, as a group, document the beneficial effects of ACI and show, too, that the reinforcement relation in ACI is functionally related to the similarity between a child's response and an adult's imitation of it.

The literature on ACI is categorized according to whether motor or verbal-vocal responses are targeted for change. The term for latter, and the topic of the present study, is "adult contingent vocal imitation" or ACVI. We turn to a review and critique of that literature next.

Adult Contingent Vocal Imitation

With ACVI, an adult vocally imitates the vocal behavior of the child (Gazdag & Warren, 2000). The adult matches all features of the child's vocalization (e.g., pitch, duration, loudness, etc.) in order to maximize the reinforcement effects of the similarity between the child's response and the adult's response. There is ample evidence showing that under these conditions, ACVI can increase the frequency of a child's vocal behavior (Bendixen & Pelaez, 2010; Bonow & Ghezzi, 2013; Hamilton, 1977; Haugen & McIntire, 1972; Hirsh, Stockwell, & Walker, 2014; Ishizuka & Yamamoto, 2016; Parnes, 2000; Neimy, Pelaez, Carrow, Monlux, & Tarbox, 2017; Neimy, Pelaez, Monlux, Carrow, Tarbox, & Weiss, 2020; Pelaez, Borroto, & Carrow, 2018; Pelaez, Virués-Ortega, & Gewirtz, 2011a, 2011b). There is evidence to suggest, too, that ACVI can strengthen a child's own imitative vocal behavior (Bonow & Ghezzi, 2013; Gazdag & Warren, 2000; Hirsh et al., 2014; Ishizuka & Yamamoto, 2016; Neimy et al., 2020; Pelaez et al., 2018), and further, that ACVI may enhance vocal turn taking as a by-product of the process (Ishizuka & Yamamoto, 2016).

Given the contingency inherent in ACVI, it is common to use a noncontingent control (NC) condition for comparative purposes. The temporal distribution and density of stimuli remain constant between the ACVI and NC conditions, and any increase in responding in the ACVI condition that does not occur in the NC condition is evidence of a reinforcement effect.

An experiment by Pelaez and colleagues (2011b) illustrates the procedure. Eleven mothers and their 3-to-8 month old infant children identified as at-risk for a developmental disability participated in the study, which utilized a reversal design to differentiate the effects of ACVI from NC. Mothers in the ACVI condition imitated their infant's babbling immediately. Mothers in the NC condition, in contrast, listened to a recording of their own vocalizations from a previous ACVI condition and imitated those same responses. The evidence indicated that ACVI reinforced vocalizations with 10 out of the 11 infants.

Hirsh and colleagues (2014) investigated the effects of ACVI with multiple caregivers. They also gathered data on vocalizations made by the infant in response to the adult imitation. Three infants, ranging from 7-to-12 months, participated in the ACVI condition and a NC condition with the child's mother and a related caregiver (father, grandmother). Different rates of infant vocalizations occurred across caregivers and conditions. Vocalizations in response to the mothers in the ACVI condition were highest among the caregivers, and imitative return vocalizations during the ACVI condition were higher than the NC condition for mothers and caregivers.

Pelaez et al. (2018) studied the effects of ACVI on infant vocalizations in three typically developing infants, ranging from 3-to-14 months. An alternating treatment

design was utilized with an adult experimenter under ACVI and NC conditions. The results confirmed the reinforcing effects of ACVI reported by Peleaz et al. (2011b) with mothers and their infants, and showed further that contrary to Hirsh et al. (2014), an unfamiliar adult can achieve positive effects with ACVI.

While these studies confirm the reinforcing effects of ACVI, they do not isolate imitation as the critical stimulus per se. Any other vocal stimulus, delivered contingent on a vocal response, could produce the same effects. To that point, the role of imitation in ACVI is investigated by comparing ACVI to other types of non-imitative adult contingent vocal stimulation.

Parnes (2000) explored the similarity between a child's vocalizations and the mother's imitative responses in a study involving typically developing infants, ranging from 3-to-9 months. Two conditions were compared: matching and non-matching imitations. The matching condition mirrored ACVI, i.e., the mother duplicated the sounds made by her infant. In the non-matching condition, the mother produced an entirely different sound each time her child made a sound. Vocalizations were highest during the ACVI condition, which led Parnes to conclude that the close match between infant and mother vocalizations in the ACVI condition was responsible for the increase in vocalizations.

Dunst, Gorman, and Hamby (2010) reviewed 22 studies, conducted between 1959 and 2008, and compared the effects of three different types of adult contingent vocal responses on child vocalizations. These were ACVI, verbal commenting (e.g., "Good boy"), and vocal sounds (e.g., "tsk, tsk, tsk"). The authors concluded that while increases

in the frequency of child vocalizations occur with all forms of adult contingent vocal responses, ACVI produces the largest increase.

A variation on this line of research incorporates "motherese" (e.g., Brand, Baldwin, & Ashburn, 2002) as a comparison. Motherese refers to the high-pitched tone, exaggerated intonation, and simple, repetitive speech that a mother displays naturally while interacting with her child (Falk, 2004; Snow, 1972). Investigators (Bendixen & Pelaez, 2010; Neimy et al., 2017; Neimy et al., 2020; Pelaez et al., 2011a) report that while contingent maternal stimulation in general results in an increase in infant vocalizations, there is no evidence at this time to suggest that ACVI or motherese are more or less effective in increasing the frequency of a young child's vocalizations. Comparatively higher rates of matching and non-matching reciprocal vocalizations reportedly occur with ACVI (Neimy et al., 2020), which could tip the balance in favor of ACVI should the effect be confirmed by future research.

The conclusion for now is that ACVI can reinforce a young child's vocalizations. Imitation is the critical feature, and the correspondence or match between the child's vocalization and the adult's vocalization is the dimension along which reinforcing effects of ACVI vary. In the light of these evidence-based conclusions, a reasonable next step is to determine whether individuals with delays in communicative and language behavior might benefit from ACVI.

Three studies to date have examined the effects of ACVI with children with developmental disabilities. Gazdag and Warren (2000) implemented ACVI as an intervention with young children with intellectual disabilities, and positive effects on the children's vocal imitative behavior were observed. All three children responded to the

adult's vocal imitation with imitative return vocalizations during training. Increases in the children's spontaneous imitation occurred during training and generalization sessions. It should be noted, however, that the experimenter did not always imitate the child exactly, but sometimes made partial (e.g., child says "ba bo" and adult responds with "ba") and modified imitative responses (e.g., child says "da" and adult responds with "da do"). The contribution of the variability in adult's responses is unclear.

In a study reminiscent of the experiment by Gazdag and Warren (2000), Ishizuka and Yamamoto (2016) compared the effects of ACVI to adult contingent praise on the vocal-verbal behavior of six, 3-to-5-year-old children with autism. Higher frequencies of vocalizations, vocal imitative responses, and vocal turn taking occurred in the ACVI condition for all participants. Several aspects of the study are worth noting. The ACVI condition included modified imitative responses, which makes it difficult to discern the effects of exact versus modified adult contingent vocal imitation. The study took place in a structured manner with the experimenter presenting objects for the child to name in order to evoke vocal responses that, in turn, would be imitated by the experimenter. This practice differs from ACVI interventions that are predominately child-led. Additionally, the children emitted words and engaged in vocal imitation prior to the start of the study. Nonetheless, ACVI was effective at improving the vocal-verbal behavior of children with autism over a brief period.

In a case study by Bonow and Ghezzi (2013), the ACVI procedure was implemented with a young child with autism enrolled in a university-based Early Intensive Behavioral Intervention Program (EIBI). At baseline, the child made only a few sounds and seldom imitated the sounds of others. The child's vocalizations increased

with ACVI, plus an increase in the child imitating the adult, as opposed to the adult imitating the child, also occurred. These two effects dissipated over sessions, however, and of the two, imitating the adult model fell apart the quickest for the child.

This collection of three studies, in our view, constitutes a weak basis for recommending ACVI to practitioners. More research is needed, especially with children that stand to benefit the most from ACVI, namely, young, pre-school-aged children with autism that present with low rates of vocalizations. The present study is designed with these children and ACVI in mind.

Purpose

The purpose of the present study was to investigate the effects of ACVI on the vocal behavior of young children diagnosed with ASD who display low baseline rates of vocalizations and do not engage in vocal imitation. Experiment 1 examined the extent to which the reinforcing effects of ACVI depend on the correspondence between the child's vocalization and the adult's vocalization. An alternating treatments design was utilized to compare the effects of an adult experimenter either imitating the child's vocal responses (ACVI condition) or providing non-imitative praise contingent on the child's vocalizations (ACP condition). Experiment 2 described a clinical intervention using the ACVI procedure in an applied setting.

Experiment 1: Methods

Participant

A 4.7-year-old boy diagnosed with autism, Jack, participated in the study. Prior to the start of the study, his Autism Index Score (AIS) was 106 on the Gilliam Autism Rating Scale (GARS-3; Gilliam, 2014), indicating a "very likely" probability of autism.

The DSM-5 Severity Scale indicated a level three (3). Jack was recruited from the University of Nevada, Reno Early Childhood Autism Program (ECAP) waitlist. While he was not enrolled in EIBI services prior to the study, services began during the course of the study (1-1.5 hours per week). Jack emitted few vocal responses (approximately 5 sounds per minute) and no recognizable words, and did not engage in vocal imitation at the onset of the study. He exhibited normal hearing and vision, as reported by his parents.

Setting and Materials

All sessions took place in the child's bedroom (11'9" X 10'3") in his home. Toys and furniture present in the child's room remained in the room and were accessible to the child throughout the study. Two video cameras were set up in the corners of the room to record the sessions. A timer was used to signal the start and end of the session. Data sheets, a clipboard, and pencils were used to record dependent measures.

Experimental Preparations and Session Termination Procedures

Baseline and experimental sessions began when the child was well rested, fed and healthy, per parent report. The child's parent also reported that the child was wearing a clean diaper and was toileted just prior to the session.

In the event that the child eliminated during the session, the session stopped and then started again after the parent changed and cleaned the child. A tantrum prior to start of a session delayed the start of a session until the child was calm. A tantrum during a session that lasted for 30 sec or more resulted in terminating and rescheduling the session the next day.

Experimental Design

This study utilized an alternating treatments design (Barlow & Hayes, 1979) with an initial baseline phase followed by the introduction and subsequent alternation in the ACVI and ACP conditions.

Procedure

A series of "rapport building" sessions took place prior to the start of the study. This consisted of five, 20-minute sessions in which the experimenter played with the child in the room where the study took place.

A series of five, 5-min baseline sessions followed. The child was not required to sit or stay still during these sessions and had unrestricted access to the materials (toys, books, etc.) in the room. The experimenter did not interact with the child or toys, but instead remained silent and within 3 feet of the child at all times.

The two experimental conditions, ACVI and ACP, followed the baseline sessions. These sessions entailed two, 5-minute conditions, one ACVI and the other ACP, with a 1-minute break between them. The order of the conditions was random. The experimenter wore a yellow shirt in the ACVI condition and a purple shirt in the ACP condition (determined randomly via coin flip). Sessions occurred once a day, five days a week.

Any time the child emitted a vocalization, the experimenter either a) provided no programmed consequence (Baseline Condition), b) imitated the child's vocalization (ACVI Condition), or c) responded to the child's vocalizations with a praise statement (ACP Condition). There were no programmed consequences for any other behavior besides vocalizations.

Baseline. There were no programmed consequences for vocalizations during baseline. Instead, the experimenter maintained 3-ft proximity to the child but otherwise remained silent throughout the session.

ACVI**.** During this condition, the experimenter imitated verbatim all vocalizations made by the child the moment after they occurred. The experimenter duplicated the volume, pitch, intonation and timbre of each vocal stimulus the child produced in a session.

ACP. During the ACP condition, the experimenter provided one of several praise statements immediately following each vocalization made by the child (e.g. "Great job!" "Amazing work!"). The statements, all formally dissimilar to the child's vocalizations, occurred with genuine enthusiasm and natural variation.

Response Measurement

The dependent variable in the study was the frequency of child vocalizations. Vocalizations were defined as one or more discernable, discrete syllable sounds separated by at least one second. Coughing, whining, screaming, crying, belching, hiccupping, sneezing, whistling, laughing, loud breathing and any other audible sounds made by the child were excluded.

Interobserver Agreement (IOA)

Two trained observers independently collected and recorded data on the number of vocalizations for 33% or more of the baseline, ACVI, and ACP sessions. IOA was calculated using a total-count IOA method. Average IOA was 91.8% (range 87.5%-96.2%), 92.4% (range 79.5%-100%), and 96.1% (range 90.9%-100%), for baseline, ACVI, and ACP sessions, respectively.

Treatment Integrity

Treatment integrity was assessed for 33% or more of the sessions during all phases. The protocol was broken down into components and errors of omission (i.e., not implementing components of a protocol) and commission (i.e., implementing components when they should not be implemented or implementing procedures not prescribed by the protocol) were assessed. The measure of treatment integrity was the percentage of components the experimenter implemented correctly. Treatment integrity averaged 100%, 99.3% (range 98.8%-100%), and 99.3% (range 98.9%-100%), for baseline, ACVI, and ACP sessions, respectively.

Experiment 1: Results and Discussion

Shown in Figure 1 are the frequencies of child vocalizations. Jack emitted an average of 21.6 vocalizations per session during baseline sessions. Average frequencies of child vocalizations in the ACVI and ACP conditions were 24.7 and 20.2, respectively. In the ACVI condition, a sharp increasing trend is apparent from session 7 to session 16, followed by variability in the data path for the remaining sessions. Considerable variability occurred in the ACP condition, particularly in the later sessions.

The results show that ACVI increased vocal responding above baseline levels, while ACP did not. Large increases in the frequency of child vocalizations occurred within the first few ACVI sessions, supporting the findings from previous research (Neimy et al., 2017; Pelaez et. al., 2018; Pelaez et al., 2011a, 2011b). Considerable variability was apparent over repeated sessions, however, which adds caution to this conclusion.

Several aspects of the study may account for the variability. Changes in Jack's EIBI treatment may have influenced his responding in the study. Parallels between his responding during experimental and EIBI sessions occurred following changes made in EIBI sessions. For example, Jack's treatment hours increased by 50% and he began discrete trials teaching on following instructions (e.g., Sit, stand, come here) between experimental sessions 23 and 24. Additionally, the number of demands placed on Jack increased during this time. There was a substantial decrease in the frequency of vocalizations between session 23 and 24, and responding remained lower and more variable than it was prior to these changes. The number of requests (mands) made by Jack during EIBI sessions decreased at this time as well. Similar increases in interfering behavior (e.g., crying, property destruction) occurred in both EIBI and experimental sessions following the increase in the number of demands during EIBI sessions.

Another possible source of variability is the naturalistic environment in which the study took place. Competing sources of reinforcement may have interfered with Jack's vocal responding during some sessions, as he had access to toys and items present in his room. In sessions 24, 29, 36, and 37, for example, Jack was playing with toys for the majority of the session, while in session 18 Jack was engaging in object mouthing. These sessions represent many of the low data points, suggesting that other sources of reinforcement could have lowered the value of ACVI and ACP.

The impetus for this study was to investigate the effects of ACVI with a child diagnosed with autism under relatively controlled circumstances. If imitation is the critical feature of ACVI, as hypothesized, then comparing the effects of an adult either imitating the child's vocalizations or providing non-imitative praise statements

contingent on the child's vocalizations constitutes a test of the hypothesis. The present results support the hypothesis that the correspondence between the child's vocalizations and adult's vocalization, inherent in the ACVI procedure, is most likely responsible for the observed increases in child vocalizations.

One limitation of the current study was the lack of a noncontingent control condition. Adding the NC condition would permit a clearer analysis of the reinforcing effects of ACVI. Future research might compare the effects of an adult providing either contingent imitation, contingent praise, or noncontingent vocal stimuli on the vocal behavior of children diagnosed with autism. Additionally, this study only assessed the effects of ACVI and ACP on the frequency of child vocalizations. Since no analysis is available on the child's subsequent response to the adult's vocalization, it is impossible to know if one or the other procedure was more or less effective at increasing the probability that the child will match the sounds made by others. Future research may benefit from including this response measurement in the analysis.

Because only one child participated in this study, any conclusions about the effects of ACVI are even more tentative than we have thus far pointed out. It would be premature, in our view, to promote ACVI to practitioners as a means of increasing the frequency of vocal responses on the strength of the current data or, for that matter, on the strength of the extant research on ACVI. We forged ahead nonetheless with a second study on the effects of ACVI with practitioners in mind, and within the context of a young child's EIBI program. The purpose was to approximate the conditions under which a practitioner might employ ACVI as a means of improving a child's vocal behavior and vocal imitative behavior.

Experiment 2: Methods

Participants

Two boys diagnosed with autism participated in the ACVI intervention. Both children were receiving EIBI services from the University of Nevada, Reno Early Childhood Autism Program (ECAP). The current intervention was included in their EIBI treatment in response to the observation that each child made few "spontaneous" vocal responses, seldom imitated the vocal responses of other people, and failed to benefit from standard methods of vocal imitation instruction.

Jack, the participant from Experiment 1, also participated in Experiment 2. Jack was 4.9 years old at the start of the study, and was receiving roughly 20 hours per week of in-home EIBI services.

Mark was a 5.8-year-old boy receiving roughly 26 hours per week of in-home EIBI services. At the start of his treatment his Autism Index Score (AIS) was 104 on the Gilliam Autism Rating Scale (GARS-3; Gilliam, 2014), indicating a "very likely" probability of autism. The DSM-5 Severity Scale indicated a level three (3).

Setting and Materials

ACVI sessions occurred at the child's home during EIBI sessions. Jack's ACVI sessions took place in a various rooms (bedroom, living room) and in Jack's backyard. Toys and items present inside and outside the house were accessible to Jack during the ACVI sessions.

Mark's ACVI sessions occurred in his bedroom. He sat in a child-sized chair in front of a small table facing his tutor. No toys were accessible to him during the ACVI sessions.

A phone or iPad was used to video record ACVI sessions for both children. A timer signaled the start and end of the session. Data sheets, a clipboard, and pencils and/or a tally counter were used to record a child's vocalizations.

Procedure

The child's tutor(s) imitated all vocalizations made by the child throughout all EIBI sessions. The one and only exception to this was when the child engaged in undesirable behavior such as a tantrum. In addition to imitating the child's vocalizations, the tutor presented a preferred item or activity (e.g., physical touch, access to toys, swings) to the child contingent on imitation according to a fixed-ratio 1 (FR1) schedule.

The magnitude and/or duration of the contingent items and activities differed depending on the vocal behaviors of the child and tutor. For example, if the child made one vocalization (e.g., child: "be"), the tutor would imitate the vocalization and might then tickle the child for 1 second. If the child responded with an approximation to the tutor's imitation (e.g., child: "be"→ tutor: "be"→ child: "ba"), the tutor would imitate the child's vocalization and might then tickle the child for 2 seconds. If the child responded to the tutor's imitation with an identical sound (e.g., child: "be"→ tutor: "be"→ child: "be"), the tutor would imitate the child's vocalization and might provide tickles for 3 seconds. In the event that the child did not respond to the tutor's vocalization (e.g., child: "be"→ tutor: "be"→ child: No vocalization), the tutor waited silently until the child vocalized or the session ended.

It became clear that a single tutor who was responsible for implementing other learning programs and procedures (e.g., discrete trials teaching, behavior reduction protocols) could not collect ACVI data at the same time. Tutors still imitated the child's

vocalizations during all EIBI sessions, and 5 minutes of each 2-hour session was devoted entirely to ACVI. ACVI data were collected at this time.

Jack

ACVI sessions began with Jack engaged in a preferred activity. The tutor followed his lead, maintaining 3 feet proximity throughout the 5 min session. Jack was not required to sit or remain in one place during a session, and access to the toys and items in his house was unrestricted. The tutor delivered a variety of preferred items and/or activities (e.g., toys, swings, tickles, etc.) to Jack during the course of imitating his vocalizations, and manipulations occurred now and then to induce Jack to vocalize during the session (e.g., holding the swing and waiting for Jack to vocalize to release and push the swing). In addition to imitating Jack's vocalizations, a tutor occasionally imitated his motor behavior.

Two "phase changes" took place for Jack. Moving his ACVI sessions to the backyard swing was the first change. The second change was more substantial. Jack's parents learned to implement the ACVI procedure using a "behavioral skills training" (BST) approach (Parsons, Rollyson, & Reid, 2013). Specifically, the parents were given the rationale for imitating their child's vocal behavior and were instructed how to implement the procedure throughout the day and evening. In-vivo modeling was first used to show them how to do this, and then the parents practiced the procedure with Jack while the trainer provided contingent supportive and corrective feedback to the parents until they were accurately and reliably implementing the procedure. At this point, his tutors and his parents were imitating Jack's vocalizations during all his waking hours.

Mark

During all of Mark's ACVI sessions, he sat in a chair approximately 1-3 feet away from the tutor. No toys or additional items were accessible to him during these sessions. There were no antecedent manipulations or attempts to induce vocalizations. Instead, the tutor sustained eye contact with Mark and remained silent until he vocalized. Tutors additionally provided physical touch contingent on sound making. There were no programmed consequences for any behaviors besides vocalizations.

An adult imitated Mark's vocalizations during all of his waking hours from the start of the ACVI procedure. Tutors imitated his vocalizations during his EIBI sessions, and his parents imitated his vocalizations outside of these sessions. As with Jack, Mark's parents participated in behavioral skills training in which they learned how to accurately and reliably implement the ACVI procedure.

Phase Change 1. Mark's tutors wore an orange shirt during ACVI sessions.

Phase Change 2. Mark's tutors went from taking ACVI samples every session to one sample per week.

Response Measurement

The primary dependent variable from the ACVI sessions was the frequency of child vocalizations. Vocalizations were defined as one or more discernable, discrete syllable sounds separated by at least one second, excluding coughing, whining, screaming, crying, belching, hiccupping, sneezing, whistling, and loud breathing. Child vocalizations were divided into two categories: matching and non-matching vocalizations. Matching vocalizations were defined as a vocal response identical to the tutor's vocalization that occurred within 5 seconds of the tutor's response. Non-matching

vocalizations included all other vocalizations that did not meet the criteria for matching vocalizations.

Data were also taken on three additional measures outside of the ACVI sessions. First, percentage correct on the Vocal Imitation portion of the Early Learning Measure (ELM; Lovaas, 1987) was determined prior to, during, and after the ACVI intervention. This was calculated by dividing the number of trials the child correctly imitated the vocal model by the total number of trials presented and multiplying by 100%. Data was also taken on the cumulative frequency of vocal responses introduced in traditional vocal imitation training prior to, during, and after the ACVI intervention. This measure referred to vocalizations that were under the discriminative stimulus control of the vocal model during traditional VI training.

Additional data were collected on the cumulative frequency of vocal mands post ACVI intervention during mand training. Vocal mands were defined as articulate vocal requests by the child for an item or access to an activity. Vocal mands were divided into four categories: (1) independent, (2) independent/contrived, (3) partial verbal/gestural prompt, and (4) full model prompt. A mand was scored as independent when the child engaged in the response without prompting or environmental arrangement by the tutor (e.g., child says “toy”). A mand was scored as independent/contrived when the tutor arranged or contrived a situation for teaching a skill or ability (e.g., tutor holds a preferred toy in front of the child and the child says “toy”). A mand was scored as a partial verbal/gestural prompt when the tutor, after a 5-7 sec delay, supplied an appropriate vocal and/or facial response (e.g., a tutor holds a preferred toy in front of the child and, with a quizzical look, says to the child, “What do you want?” and the child

says “toy”). A mand was scored as a full model prompt when the tutor supplied the child with a complete, contextually appropriate response that the child imitates (e.g., a tutor holds a preferred toy in front of the child, says “Say *toy*” and gives the toy to the child contingent on an audible, articulate imitation of the tutor’s model).

Interobserver Agreement (IOA)

A trained observer independently collected and recorded data on the number of matching, non-matching, and total vocalizations for 25% of Jack and Mark’s ACVI sessions. IOA was calculated using a total-count IOA method to compare observer data to the data the tutor collected within the session. Average IOA for Jack was 85.0% (range 55.6%-100%) for matching vocalizations, 88.9% (range 46.4%-100%) for non-matching vocalizations, and 91.4% (range 70.7%-100%) for total vocalizations. Average IOA for Mark was 91.0% (range 66.7%-100%) for matching vocalizations, 90.8% (range 70.6%-100%) for non-matching vocalizations, and 92.1% (range 72.4%-100%) for total vocalizations.

Treatment Integrity

Treatment integrity was assessed for 25% of Jack and Mark’s ACVI sessions. A child-specific checklist was used, which consisted of all of the components necessary to conduct each child’s particular protocol. Changes in the children’s protocol (“phase changes”) were included in the child-specific checklists, and both errors of omission and commission were assessed. Treatment integrity reflects the percentage of components the tutor implemented correctly. Treatment integrity averaged 92.9% (range 74.0%- 100%) and 91.8% (range 77.5%- 100%) for Jack and Mark, respectively.

Experiment 2: Results and Discussion

Figure 2 displays the frequency of child vocalizations for Jack and Mark. Figure 2 also shows the proportion of matched to non-matched child vocalizations.

The frequency of vocalizations increased throughout the ACVI procedure for both Jack and Mark. Jack's vocalizations remained relatively stable from session 1 to session 63, followed by an increasing trend after BST with the parents was conducted (session 64-session 79). Similarly, Mark's vocalizations remained relatively stable from session 1 to session 63, however, there was a sharp increasing trend for the remainder of the sessions (session 64- session 120). There was also an increase in the proportion of matched vocalizations throughout the ACVI procedure for both children. Similar patterns were also observed; relatively stable frequencies of matched vocalizations were apparent from session 1 to session 63, followed by an increase in matched vocalizations for the remainder of the sessions. Larger increases in matched vocalizations occurred with Mark.

Figure 3 shows the percentage correct on the vocal imitation portion of the ELM assessment before, during, and after the study. Jack scored a 0% on the VI portion of all ELM assessments. Mark, in contrast, scored a 9% on the VI portion of the ELM during the intervention, and a 31% and 45% at the first and second post- intervention assessments, respectively.

Figure 4 displays the cumulative frequency of vocal responses introduced in traditional vocal imitation training before, during, and after the study. No vocal responses occurred with Jack. For Mark, vocal responses did not occur prior to ACVI, however, 8 vocal responses occurred during ACVI and 44 more vocal responses occurred after the

study ended. Of the 52 total vocal responses, 34 consisted of sounds (phonemes) in the English language and 18 were words in the English language.

Figure 5 displays the cumulative frequency of vocal mands during mand training after the study ended. Vocal mand training was successful with both children. Jack learned one vocal response, “hem”, to request all items and activities. This response was accompanied with pointing to the item or activity while engaging in eye contact with the tutor. The cumulative frequency of independent, independent/contrived, partial verbal/gestural prompt, and full model prompt mands for Jack were 472, 1,118, 158, and 100, respectively.

Mark learned nine vocal responses to request specific items and activities, as follows: “e” to eat, “f” to play with the phone, “v” for high fives, “t” for toys, “eat” to replace “e” to eat, “be” to lay in bed, “bed” to replace “be” to lay in the bed, “come” to request the tutor to follow him, and “go” for piggy back rides and to go outside. Mark requested all other items and activities by pointing with eye contact and making a specific mouth movement (i.e., opening and closing his mouth). The cumulative frequency of independent, independent/contrived, partial verbal/gestural prompt, and full model prompt mands for Mark were 25,121, 11,030, 970, and 1,585, respectively.

Results revealed vocalizations increased throughout the intervention for both children. Additionally, the proportion of matched vocalizations increased throughout ACVI for both children. These results support previous research and suggest that an adult imitating the child’s vocalizations may serve both a reinforcing function for additional vocalizations and a discriminative function for subsequent matching vocal responses (Neimy et al., 2020; Pelaez et al., 2018).

Results from the ELM assessments revealed increases in Mark's vocal imitation performance throughout and post intervention, while no increases occurred for Jack's vocal imitation performance on the ELM. Likewise, traditional vocal imitation training was successful with Mark but not with Jack. Mark was emitting many vocalizations and reliability matching or partially matching most vocalizations emitted by others by the end of the intervention, thus tutors were successful shaping and prompting vocalizations and bringing them under the discriminative stimulus control of the vocal model. This suggests that ACVI may be useful with children diagnosed with autism enrolled in EIBI services who may not emit the necessary requisite skills to benefit initially from VI training alone. Once the child is benefitting from ACVI and reliability producing many sounds and attempting to match the sounds made by others, ACVI in combination with traditional vocal imitation training may be an effective way to increase the frequency of a child's vocal imitative behavior.

Following the ACVI procedure, vocal mand training was successful with both children, albeit to varying degrees. Both children requested all preferred items and activities by pointing and making eye contact prior to implementing ACVI. This non-vocal response often limited the child's access to obtaining specific items and activities from others, as many instances were inaudible and thus "missed" by the listener, which often resulted in undesirable behavior. Both children were able to vocally mand for preferred items and activities following ACVI. This not only increased the probability of the child obtaining access to specific items and activities, it also reduced undesirable behavior that interfered with the children's learning.

Overall, improvements in both children's vocal behavior were observed following the ACVI intervention; however, greater gains occurred with Mark. Several differences between ACVI and participant characteristics may account for the differences observed between children. First, there were differences in the amount or quantity of ACVI. An adult imitated Mark's vocalizations during all waking hours from the start of ACVI, while tutors were imitating Jack's vocalizations during EIBI sessions only at the start of the intervention. Once Jack's parents learned how to imitate his vocalizations, there was a substantial increase in the frequency of vocalizations and matched vocalizations. (Mark experienced 120 ACVI sessions and Jack experienced 79 ACVI sessions.)

Another potential reason for the differences observed during ACVI sessions was the availability of other sources of reinforcement during sessions. Mark did not have access to other toys and activities during ACVI sessions and there were no programmed consequences for any behaviors besides vocalizations, while Jack had access to preferred toys and activities and other behaviors were reinforced during some ACVI sessions. Removing distracting stimuli from the environment and not providing reinforcement for other behaviors may limit competing sources of reinforcement that may interfere with the effectiveness of ACVI. Clinically, however, this environmental arrangement can be counter-productive. For Jack, removing or denying access to preferred items and activities occasioned undesirable behavior that interfered with sound making. Preferred items and activities were incorporated within his sessions as antecedent and consequential manipulations to increase vocalizations, as social interactions were inconsistently reinforcing. In Mark's case, toys were not necessary to induce or

consequate vocalizations during ACVI sessions, as physical touch and social interactions were consistently highly preferred by Mark.

The impetus for this intervention was to improve the vocal behavior and vocal imitative behavior of clients in EIBI treatment as efficiently as possible. Additionally, this study was conducted in response to the fact that very few studies are available in the research literature that inform practitioners on the effects of implementing ACVI with children who seldom make vocal responses or imitate the vocal responses of other people. While improvements in the vocal behavior of both children occurred following the introduction of ACVI, thereby supporting previous research, there are limitations to note and future direction for research to mention.

This study took place in an applied setting as a clinical intervention with many extraneous, uncontrolled sources of variation. Procedural modifications did not occur on a predetermined protocol but rather in the light of the totality of a child's EIBI treatment. Additionally, no formal baseline measures were taken. The lack of experimental control evident in this study does not allow for any conclusions to be made regarding the independent effects of an adult imitating the child's vocalizations. It is not possible to determine if the changes in the children's responding following the introduction of ACVI were due to the intervention alone. Furthermore, additional sources of reinforcement were contingent on child vocalizations (e.g., toys, swings, physical touch) during the intervention making it even more difficult to interpret the independent effects of ACVI. While incorporating additional contingencies and procedural modifications as the intervention progresses is the hallmark of EIBI and it is the most likely circumstance in which ACVI would occur in applied settings, technically sound studies are needed prior

to promoting ACVI to practitioners as a means of improving the vocal behavior and vocal imitative behavior of children with autism. Additional research on the settings and circumstances under which ACVI constitutes best practice is warranted.

It may be important to note that improvements in the children's vocal behavior were not observed immediately following the introduction of the ACVI intervention. If the intervention was indeed responsible for these improvements, these results suggest it may take repeated exposure to ACVI over an extended period to observe beneficial effects. Another limitation of the current study was that no direct comparisons to other procedures and practices were made. It is therefore difficult to evaluate the efficacy of the ACVI procedure relative to other procedures designed to increase vocal and vocal imitative responding.

General Discussion

Taken collectively, the results of Experiment 1 and 2 support previous research on the reinforcing effects of ACVI (Bendixen & Pelaez, 2010; Bonow & Ghezzi, 2013; Gazdag & Warren, 2000; Hamilton, 1977; Haugen & McIntire, 1972; Hirsh et al., 2014; Ishizuka & Yamamoto, 2016; Parnes, 2000; Neimy et al., 2017; Neimy et al., 2020; Pelaez et. al., 2018; Pelaez et al., 2011a, 2011b). Experiment 1 revealed an adult imitating the child's vocal responses increased vocalizations above baseline levels, while an adult providing non-imitative praise contingent on the child's vocalizations did not. This finding further supports the assertion that the reinforcing effects of ACVI depend on the similarity or correspondence between the child's vocalization and the adult's vocalization. Experiment 2 described a clinical intervention using the ACVI procedure in an applied setting. Results revealed the frequency of vocalizations and matched

vocalizations increased once the ACVI intervention was implemented. This outcome, in turn, appeared to contribute to the subsequent success of vocal mand training with the two participants. Increasing vocal responding and vocal imitative responding is vital to the development of verbal behavior and behavior development in general (Novak & Pelaez, 2004), and these results suggest that ACVI may be an effective procedure to implement with children diagnosed with autism who seldom make vocal responses or imitate the vocal responses of other people.

This study contributes to the limited research literature on ACVI with children diagnosed with ASD. What is especially unique to Experiment 2 was that the ACVI intervention was conducted within the context of the children's EIBI treatment. The results from experimental studies on ACVI led researchers (Neimy et al., 2017; Neimy et al., 2020; Pelaez et. al., 2018; Pelaez et al., 2011a, 2011b) to suggest that ACVI interventions can be designed by practitioners in applied settings to improve the vocal behavior of children with developmental disabilities and language delays, however few studies are available. This preliminary study shows how ACVI interventions can be incorporated in EIBI treatment with children with autism.

Further investigation of the effects of ACVI on the vocal and vocal imitative behavior of children diagnosed with autism who, by definition, show a deficit in learning these types of behaviors, is clearly and urgently needed.

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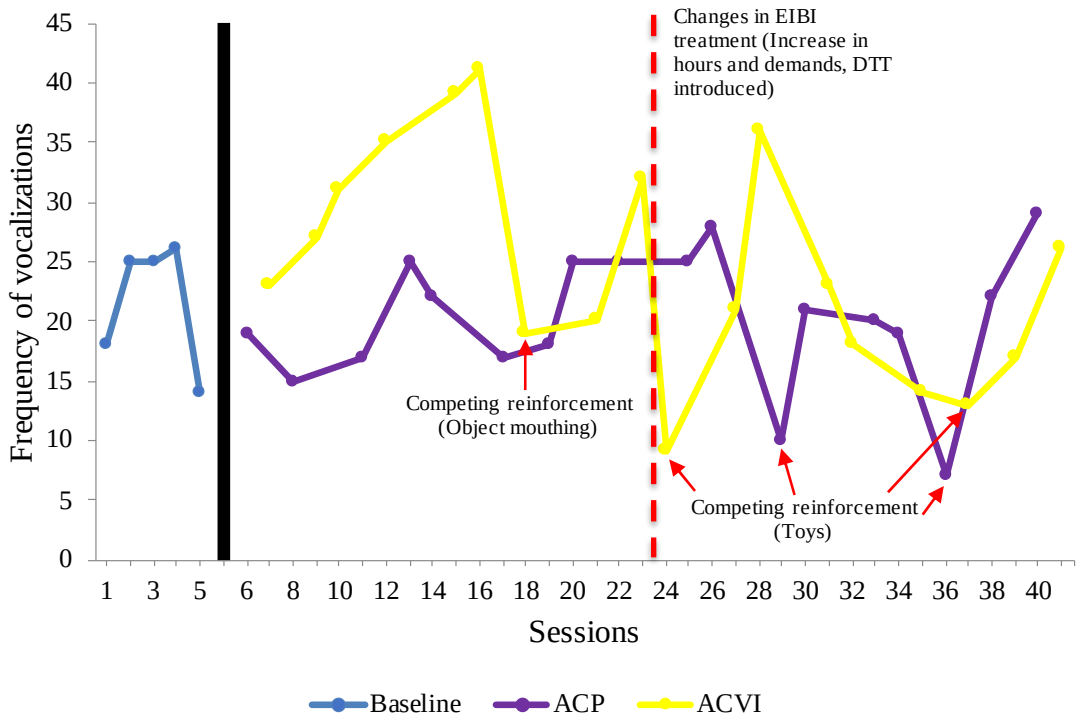

Figure 1. Frequency of child vocalizations during baseline (blue), adult contingent vocal imitation condition (yellow), and adult contingent praise condition (purple). Changes in Jack's EIBI treatment occurred between experimental sessions 23 and 24 (increases in EIBI hours, increases in number of demands during EIBI sessions, and discrete trials teaching was introduced during EIBI sessions), which is denoted by the red dashed line. Arrows represent ACVI sessions with competing sources of reinforcement; in session 18 Jack was engaging in object mouthing, and in sessions 24, 29, 36 and 37 Jack was playing with toys for the majority of the session.

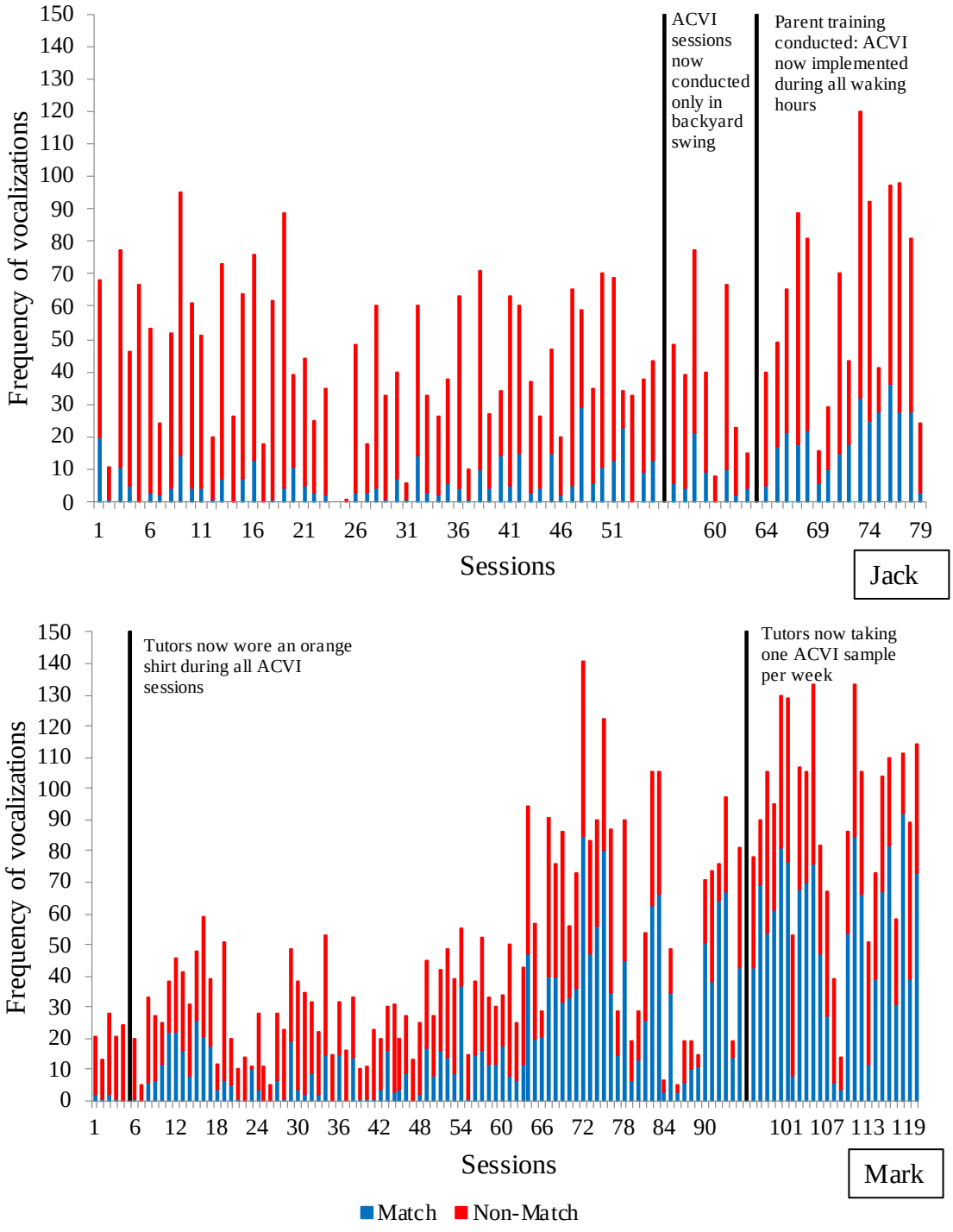

Figure 2. Frequency of child vocalizations during the ACVI intervention. Proportion of matched (blue) to non-matched (red) child vocalizations. Changes in the children's protocols ("phase changes") are denoted by the black vertical lines.

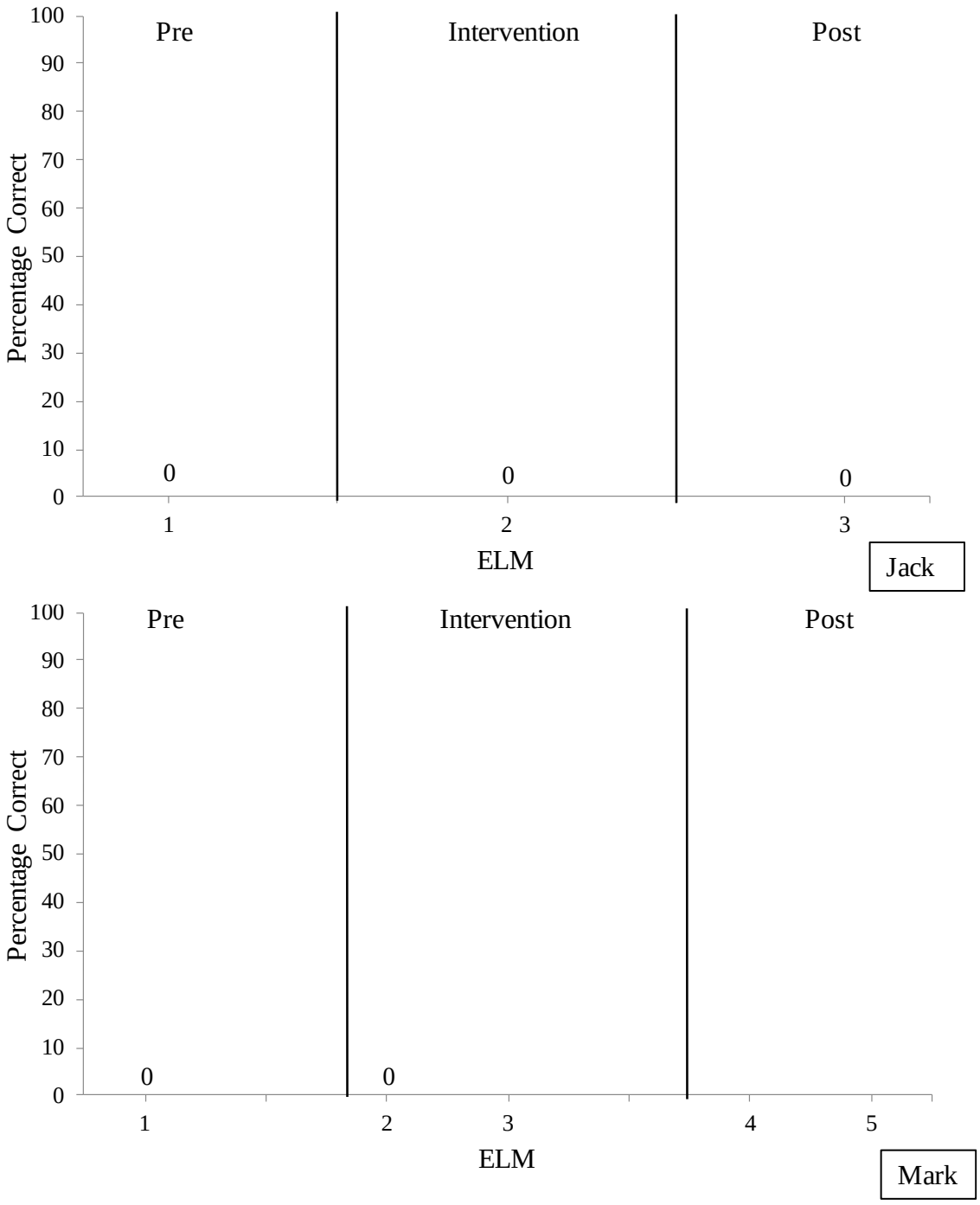

Figure 3. Percentage correct on the VI portion of the ELM assessment prior to, throughout, and post intervention. Jack's post intervention assessment occurred 6 weeks after the study ended. Mark's post intervention assessments occurred 12 weeks and 31 weeks after the study ended.

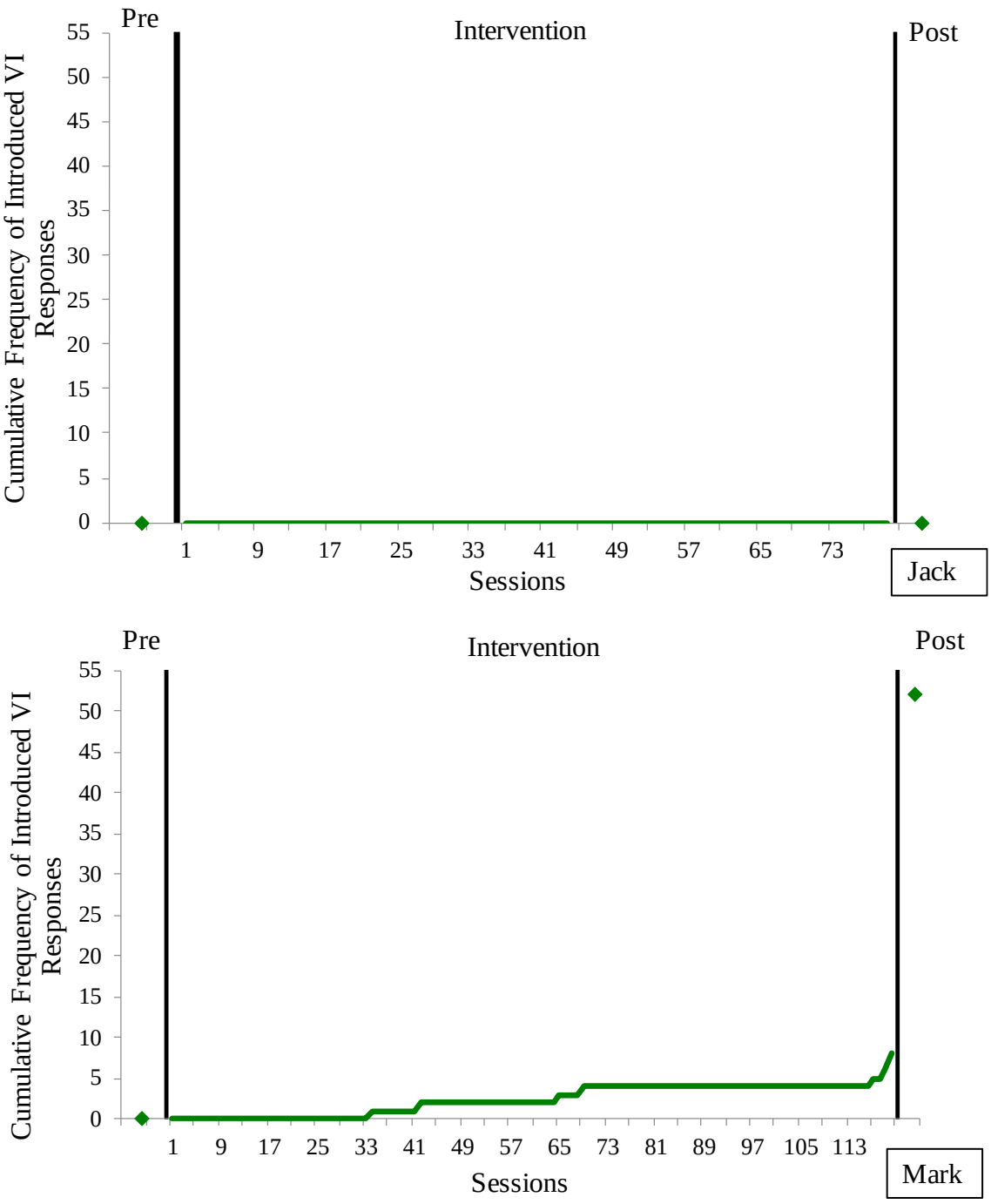

Figure 4. Cumulative frequency of vocal responses introduced in traditional VI training prior to, throughout, and post intervention. Jack's post intervention follow-up occurred 7 months after the study ended. Mark's post intervention follow-up occurred 16 months after the study ended.

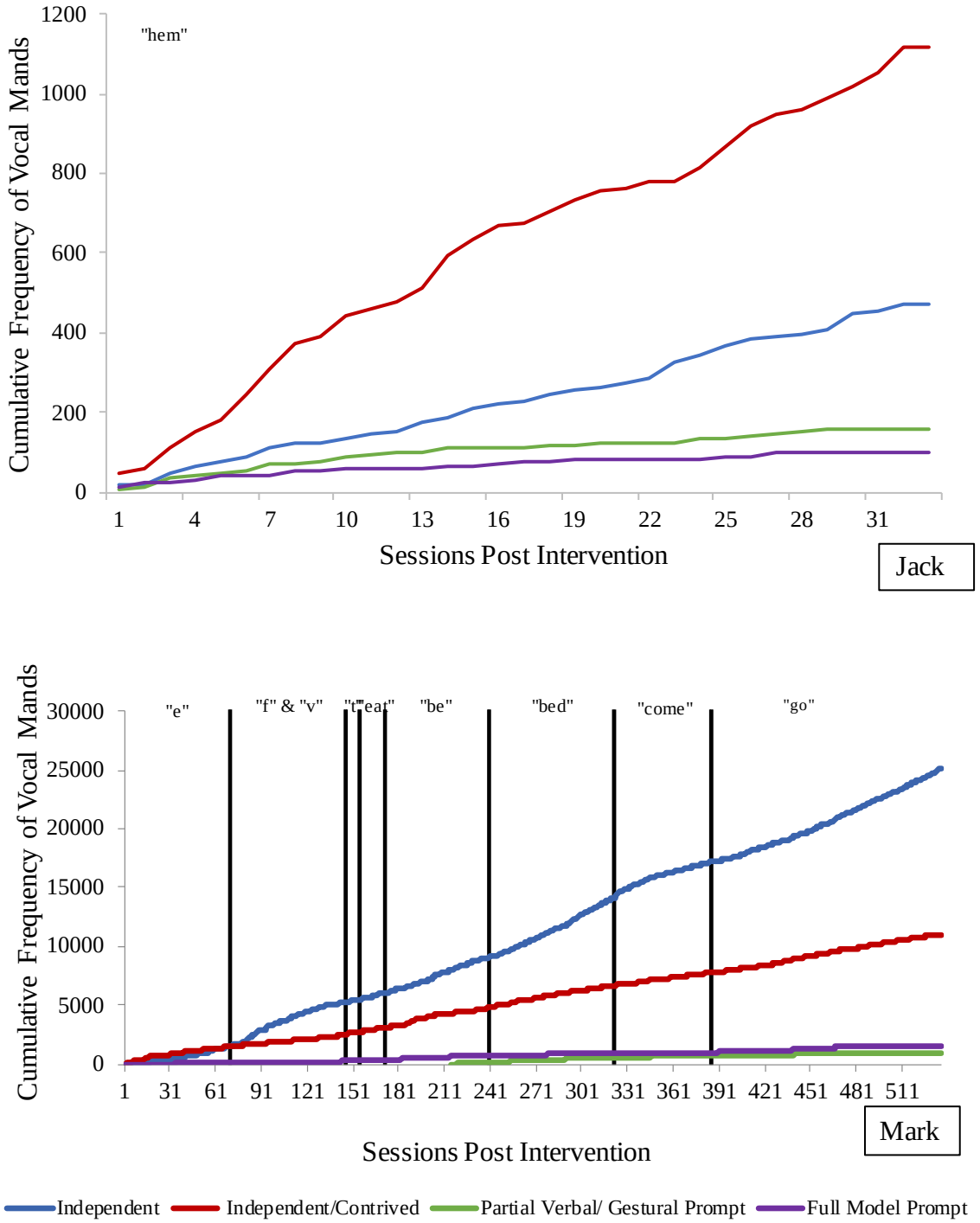

Figure 5. Cumulative frequency of vocal independent (blue), independent/contrived (red), partial verbal/gestural prompt (green), and full model prompt (purple) mands post intervention during mand training. Phase changes (black vertical lines) denote new mand target.