

Parentese Speech and Vocal Imitations on the Vocalizations of Typically Developing Infants and an Infant At-risk for Autism Spectrum Disorderh



Martha Pelaez^{1*}, Rebeca Pelaez¹, Elisa Lagé¹ and Hayley Neimy²

¹Florida International University Rebeca Pelaez, USA

²Capilano University, Canada

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***Corresponding author:** Martha Pelaez, Department of Counseling, Recreation & School Psychology, Florida International University, USA

Abstract

Caregivers interact with their young infants using parentese and vocal imitations. Parentese otherwise known as motherese resembles “baby” talk which uses words and sentences in high-pitched tones, a songlike rhythm and inflections on verbs and nouns. This contingent vocal stimulation, when provided contingently, often makes a significant difference in young infant’s vocalization rates as demonstrated in previous research. Our aim is to compare the findings of two studies that used contingent reinforcements in the form of: (a) parentese speech and, (b) vocal imitation on the frequency of vocalizations among infants who are typically developing, and one infant identified at-risk for autism spectrum disorder (ASD). Study 1 (a single-subject design) explored the use of contingent and non-contingent bilingual parentese provided to a 6- month-old infant using a withdrawal design (i.e., A-B-C-D-E). The second study explored the effects of parentese and vocal imitations on the frequency of infant vocalizations of a typically developing 8-month-old infant and a 12-month-old infant at-risk for ASD. Reinforcement conditions for each infant were provided by their two caregivers (mother and father) using an alternating treatment design (i.e., A-B-C-B-C). Results from both studies replicated previous findings that contingent parentese can increase the frequency of infant vocalizations. In addition, results from study 1 suggested that the use of contingent parentese speech provided in the home language of the infant (Spanish) produced slightly more vocalizations on average. Furthermore, Study 2 found that both contingent vocal imitations and parentese increased vocalizations well above the baseline for both infants regardless of developmental trajectory and caregivers providing the reinforcement conditions, with vocal imitations producing slightly higher mean vocalizations.

Keywords: Vocal Imitation; Vocalization; Infants; Parentese Speech; Language Acquisition; Bilingual; Contingent; Non-Contingent; Reinforcement; Autism

Introduction

Early forms of stimulus-response relations are generally learned by infants in a sequential manner and begin with eye gazing, joint attention, and social referencing [1]. Such stimulus-response relations learned by infants can be considered crucial foundational building blocks for communication and social development. This is supported by literature regarding early operant conditioning which identifies social and nonsocial stimuli that reinforce infant vocalization through tactile stimulation, eye contact, smiling and auditory vocal stimulation Pelaez et al. [2]. Infant vocalizations which are considered to be sounds such as phonemes that do not generate any recognizable words or phrases, are considered to be an acquired skill which depends

largely on stimuli/reinforcers provided through interactions in their environment. A substantial amount of literature has supported the notion that early development of preverbal skills in young infants can highly influence successful language acquisition later in development [2-4]. In fact, research concerning infant vocalizations have found that maternal responsiveness is a reliable indicator of the onset of infant’s future language milestones Hirsh et al. [5]. Moreover, Pelaez et al. [1]. in conjunction with a breadth of other research Risley & Hart [6] posit that infants who grow up with higher rates of verbal interactions at home are more likely to have improved literacy skills and extended vocabulary in the future.

Findings from Pelaez et al. [7] suggest that infants' vocalizations can be influenced to a great extent by the use of maternal speech as a contingent reinforcer. Interactions between caregiver and infant have profound effects beyond the immediate increase in vocalizations. According to Pelaez et al. [7] "specific forms of maternal vocal stimulation could be programmed to maximize the acquisition of preverbal skills among typically developing and language-delayed children" (p. 35). An important aspect of language development also appears to be the relationship between the infant and caregiver. A study by Hsu et al. [8] found that infants produced more speech-like sounds (syllables) when they were smiling, their mothers were smiling, or when looking at their mother's face. Generally, caregivers initiate and respond to infant's vocalizations in the natural environment with either imitative sounds (vocal imitation) or infant-directed speech also known as parentese Neimy et al. [9]. Several observations conducted in research about infants' early language development have shown that mothers use imitative sounds and parentese speech unintentionally and effectively to reinforce language development Pelaez et al. [1]. A general consensus across fields studying language development suggest that caregiver-infant interactions play a pivotal role in the language acquisition skills of infants. These interactions are dependent on the dynamical systems which help shape the overall development of infants regardless of home language and possible delays. The two studies reported here add to the existing research by exploring caregiver-infant interactions, environmental components such as bilingual home environments, as well as contingent and non-contingent reinforcements.

Study 1

Using a single-subject, study 1 sought to add to existing research by investigating the possible effects of an infant's bilingual home environment. Treatment conditions consisted of contingent and non-contingent reinforcers presented in both English and Spanish in addition to naturally occurring social cues such as smiling, praise and eye contact. Findings by Byers-Heinlein et al. [10] suggest that during listening, infants use "language-control mechanisms" in order to activate the specific language they are hearing. Infants that are raised in bilingual homes can learn two languages at the same time without confusing them or causing delays in their language development [10]. To this point the researchers investigated infants' accuracy of identifying objects labeled in "same-language sentences" or "switched-language sentences." The measurement of the infants' pupil size demonstrated that there was increased cognitive load during language switches, but that this was lessened when the switch was from the non-dominant to the dominant language. The results of Byers-Heinlein et al. [10] suggest that bilingual infants monitor their languages in order to ensure efficient and accurate comprehension. These findings have interesting implications for the current research because it begs the question of whether reinforcement will be equally as effective in either of the bilingual

infant's known languages, or if the infant will show a preference for one language over another. We know from Franklin et al. [11] that by six months of age, infants learn that their vocalizations have "social value" and that changes in their own speech-like vocalizations will change the degree of adult engagement that they experience. While research has demonstrated that contingent reinforcement is effective in increasing infant vocalization, no research has been conducted to demonstrate whether there are differences in the frequency of vocalization when contingent responding is delivered in English or in the home language. This study sought to expand existing research by employing an A-B-C-D-E design where caregiver vocal response is contingent on infant-initiated vocalizations and examines differences in vocalizations produced when parentese speech is delivered in English vs. Spanish (the home language).

Study 2

Study 2 contributes to the existing research of Hirsh et al. [5], which extended on Pelaez et al. [7] research on the effects of contingent maternal imitation on infant vocalizations. Hirsh et al. [5], included a comparison of multiple caregivers and determined whether findings would generalize to caregivers other than mothers. The study also sought to compare the reinforcing value of infant interactions with caregivers that spent similar amounts of times interacting with their infant Hirsh et al. [5]. Given the limited research on infant-interactions with multiple caregivers, this study explores the effect of contingent reinforcers on vocalizations based on the child's discriminatory ability to differentiate the caregivers which they interact with and compares infants of different ages and developmental trajectories to determine the functional relationship of two different caregiver vocal topographies (vocal imitation and parentese speech) and infants' frequency of vocalizations.

Caregiver interactions vary according to culture, socioeconomic status, and individual routines. The idea of differentiated interactions with multiple caregivers may influence the type, quality and quantity of verbal repertoires infants acquire over time and may influence the development of language acquisition in both typically and atypically developing infants. Hart and Risley [6] found that the amount and quality of vocalizations emitted across families resulted in differing vocal repertoires and it is thus possible that caregiver interactions may produce different vocal repertoires in infants. More recent research has shown that contingencies of reinforcements implemented by caregivers tend to influence and strengthen the development of infants' social behaviors which subsequently reduce and mitigate delays for typically developing and at-risk infants Neimy et al. [3]. This is particularly crucial as caregivers and practitioners begin to plan for early interventions that can facilitate the development of language skills which are intertwined with all other developmental domains such as cognition and social skills. It is also prudent to keep in mind that language deficits can be mitigated if training for

caregivers is conducted to increase the likelihood of reinforcing interactions that influence successful language acquisition Pelaez et al. [2]. Noting delays or absence of social skills during early infancy can also help practitioners plan for explicit and intentional interventions that include operant learning principles to address deficits and future delays Pelaez and Monlux [12]. Through visible observation of behavioral markers in communicative and social domains, practitioners and caregivers can indicate if their infant is at-risk for ASD Neimy et al. [9].

Although, at-risk behavioral markers can be observed as deficits in infants, existing literature supports that vocal imitation and parentese reinforces infant vocalizations for all infants. The study by Pelaez et al. [2] resulted in contingent maternal vocal imitations increasing infants' vocalization over baseline and effects were greater than contingent parentese speech, although both contingencies showed approximately equally effective increases in infant vocalization.

Study 1 Methods

Research Question

Study 1 aimed to extend the research on the reinforcing effects of contingent parentese speech on infant vocalizations conducted by Pelaez et al. [7] using a variation of the procedures for increasing vocalizations established by Britwum et al. [13] and adding a home language condition adapted from Neimy et al. [9]. By extending previous research this study sought to explore whether the language in which parentese is delivered has an effect on the frequency of infant vocalizations. The researcher hypothesized that immediate reinforcement of any infant vocalization would lead to an increase in the frequency of vocalizations. The researcher also hypothesized that parentese in the home language (Spanish) would have a greater effect on increasing vocalizations than when using English.

Participants

A 6-month-old typically developing female infant of Hispanic decent participated in this study. The infant was born pre-term at 37 weeks and obtained an APGAR (appearance, pulse, grimace, activity and respiration; test administered at birth to check an infant's health; scores ranging from 1-10) score of 8. The infant was exposed to English at home but experienced frequent interactions with family members in Spanish including present caregivers, aunts, uncles and grandparents.

The researcher administered the Ages & Stages Questionnaire-Third Edition (ASQ-3)-6 Month Questionnaire Squires & Bricker [14] to determine the development of the infant. Both parents were present and collaborated on their responses to each of the questions asked. The parents reported no concerns regarding the infant's overall development. The infant's scores revealed that she was above the cutoff ranges in each domain (Communication: 55, Gross Motor: 50, Fine Motor: 60, Problem Solving: 50, and Personal- Social: 40), and meeting developmental milestones as

expected.

Setting and Materials

All sessions were conducted in a quiet room of the infant's home, away from distractions and the potential for interruptions. The infant was positioned in a highchair approximately one foot away from the researcher. The researchers recorded all vocalizations using a coding sheet. The researcher required a timer, highchair and toys to be used with the infant during breaks.

Experimental Designs

An A-B-C-D-E withdrawal design was used for this study. This allowed for the researcher to determine the extent to which the infant's vocalization responses were in fact reinforced by the contingent speech (which would establish that a functional relationship exists between the dependent and independent variables). The withdrawal designed also allowed for the researcher to differentiate between the English and home language (Spanish) conditions. All phases in the study continued for a least five two-minute sessions until stability was achieved in the data for a minimum of three consecutive sessions.

Procedures

Using the modified withdrawal (A-B-C-D-E) design, the experiment consisted of five conditions: A) Baseline, B) Intervention 1 (contingent reinforcement of infant vocalizations delivered as English parentese speech), C) Control 1 (NCR-English), D) Intervention 2 (Contingent Spanish parentese speech), and E) Control 2 (NCR-Home Language/Spanish). The conditions were separated by intertrial intervals of two minutes.

Baseline phase (A): The infant's rate of vocalization was measured before intervention phases. Neither reinforcement nor intervention was presented during at the baseline phase. Prior to beginning the baseline phase, the researcher set a timer for two-minutes. The researcher interacted with the infant in the natural environment to avoid extinction-like outbursts, but no contingent reinforcement (CR) was provided. The baseline phase was conducted for at least five sessions until stability was achieved in the data.

Intervention phase 1- contingent (CR) english parentese speech (B): After baseline data was collected the researcher continued to interact with the infant in the home environment contingent on the infant-initiated vocalizations. The researcher responded to the infants-initiated vocalizations immediately after the infant took a break for air by providing parentese in English as CR. CR was provided for approximately as long as the infant's vocalization. An example of matching parentese to the length of the infant's vocalization is if the infant babbles for three seconds "gah goo ba ma" the researcher replied "Ohhhh HIII Honey" in English while concurrently smiling and making eye contact. This was repeated for five two- minute sessions until a stable rate of response was established. The infant was allowed a 10-second break before proceeding to the next two-minute session.

Control Phase 1- non-contingent (NCR) english parentese (C): For phase C, the researcher set a timer for 15 second intervals and provided the English parentese regardless of the vocalization emitted by the infant. The researcher maintained eye contact with the infant throughout the session. If the infant vocalized within two seconds of the 15-second timer (i.e. at 13, 14, or 15 seconds), the researcher waited an additional three seconds before providing their parentese statement in English. This phase served to verify that the results in phase B were functionally related to the independent variable (CR-English parentese speech).

Intervention Phase 2 – contingent (CR) home language parentese (Spanish) (D): In phase D, the researcher implemented the CR of parentese in the home language (Spanish) concurrent with eye contact, smiles and praise in response to the infant-initiated vocalizations. Like phase B the praise lasted approximately as long as the infant’s vocalization did and was delivered in an excited and happy manner. CR was provided immediately after the infant took a break for air after vocalization. Procedures were repeated for the duration of the two-minute sessions. Data was collected for a minimum of five two-minute sessions until a stable rate of responding was demonstrated.

Control Phase 2- non-contingent (NCR) home language (Spanish) parentese(E): Similar to phase C, the NCR of parentese was provided in the home language (Spanish). The researcher provided NCR every 15-seconds regardless of the vocalizations made by the infant. If the infant vocalized within two seconds of the 15-seconds timer set ((i.e. at 13, 14, or 15 seconds), the researcher waited an additional three seconds before providing parentese speech. This phase served to verify that the results from phase D were functionally related to the independent variable (contingent home language parentese). Throughout phases, if the infant got fussy or started to cry, the researcher stopped the session and tried to pacify her based on her needs in the moment (e.g., feed her, change her, rock her, or play with her). The session would resume if and when the infant calmed down. If the infant could not be calmed down after 20 seconds or more of crying or whining, the session was terminated and rescheduled for a later time. Four sessions had to be terminated due to the infant crying and were not counted toward analysis. The current study relied on the operational definition established by Pelaez et al. [2]. Infant vocalizations were operationally defined as cooing and babbling that lasts two seconds or more and are separated by one second (excluding coughing, fussing, hiccups, belching, sneezing, and whining). Vocalizations consisted of vowels or vowel-consonant combinations and those with no break in phonemes were counted as one occurrence Pelaez et al. [2]. We defined parentese as speech consisting of infant-directed “baby” talk using words and sentences in high-pitched tones, a songlike rhythm, and inflections on verbs and nouns, which was similarly defined in Britwum et al. [13] research protocol.

Dependent Variable: The dependent variable (target behavior) in the study was the frequency of infant vocalizations

(defined as cooing and babbling that lasts two seconds or more and are separated by one second excluding coughing, fussing, hiccups, belching, sneezing, and whining [2,9].

Independent Variable: The independent variables in the study were contingent reinforcement in the form of praise and 1) English parentese or 2) Home Language parentese.

Data Collection and Interobserver Agreement

Coding sheets were created for use during each session to record and code specific information and data such as: session number, frequency of infant vocalizations, whether the reinforcement was implemented correctly for each 30-second interval, and any additional notes as necessary (behavioral observations, comments, notes about the environment, interruptions, deviations from the established procedure, why the trial was disqualified- if applicable, etc.) One observer collected the data for each session, with the exception of interrater reliability observations which were conducted simultaneously by two observers. The researcher trained an independent observer and interobserver agreement was conducted for 40% of the sessions distributed between the different phases (meaning reliability was conducted at least twice in each of the phases). The same two observers conducted all of the reliability observations, one of whom was the researcher. Interobserver agreement were calculated for each 30 second interval included on the coding sheet for both infant vocalizations and whether reinforcement was correctly provided. This was calculated by dividing the intervals with agreement (both observers coded the same number of vocalizations and indicated equal instances of reinforcement) by the total number of intervals and then multiplied this number by 100 to convert it into a percentage. The average interobserver agreement for these observations was 93% (range=91-100%).

Result

The results suggest that reinforcement was effective in increasing the frequency of infant vocalizations. The data also indicate that infants who are exposed to both English and a home language (in this case, Spanish) will perform at a slightly higher rate for the home language condition than the English condition. Data on the frequency of infant vocalizations are presented in Figure 1 and in more detail in Table 1.

The infant’s changes in vocalizations indicated consistent control by the independent variable (reinforcement contingency) including a decrease in vocalizations when the NCR conditions were introduced and an increase in vocalizations during both CR phases- English and Spanish. The decrease back to baseline levels in both of the control conditions indicates verification of the increases in the intervention phases, as there was an immediate change in level of performance of the dependent variable (vocalizations) between baseline and intervention and between the intervention phases and both controls.

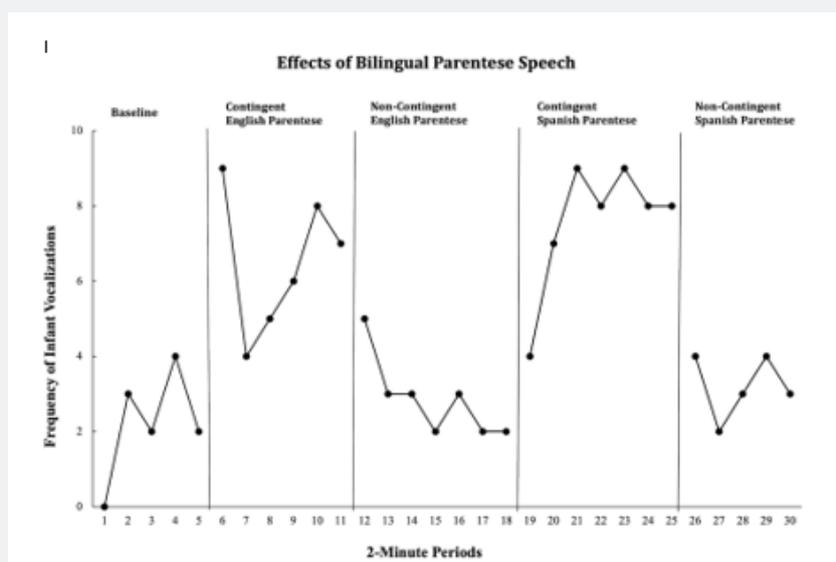


Figure 1: Effects of Contingent Parentese on the Frequency of Infant.

Table 1: Descriptive Statistics.

	Baseline (N=5)	Intervention 1: English (N=6)	Control: NCR English (N=7)	Intervention 2: Spanish (N=7)	Control: NCR Spanish (N=5)
Mean (Standard Deviation)	2.20 (0.66)	6.50 (0.76)	2.86 (0.40)	7.57 (0.65)	3.20 (0.37)
Median	2	6.5	3	8	3
Range	4	5	3	5	2
Minimum	0	4	2	4	2
Maximum	4	9	5	9	4

The results of this study confirmed the hypotheses that contingent parentese in both languages would be effective, and that parentese delivered in the home language would be more effective than contingent English parentese speech. These results are consistent with previous studies that have provided evidence suggesting that contingent parentese will increase the frequency of infant vocalizations. It also added to prior studies by introducing a home language component and demonstrating that the language in which contingent parentese reinforcement is delivered may have an effect on the frequency of infant vocalizations. For both conditions (English and Home Language) a functional relationship was established between contingent reinforcement and the number of infant vocalizations produced. In addition, because we established a no-reinforcement baseline, we were able to determine that both NCR conditions suppressed vocalizations back to baseline levels.

A single-factor analysis of variance with the number of infant vocalizations as the dependent variable was conducted. Significant effects were found between phases: Baseline and

Intervention 1: English ($P = .0025$), Intervention 1: English and Control 1: NCR English ($P = .001$), and Intervention 2: Spanish and Control 2: NCR Spanish ($P < .001$). Therefore, the results from this analysis suggest that contingent reinforcement in the form of parentese in both English and Spanish have significant effects on the dependent variable (infant-initiated vocalizations). Interestingly, the results of the single-factor ANOVA also suggest that the difference between the two intervention phases (English and Spanish) was not significant ($P = .31$), however this may be due to the infant's generally low levels of responding and the limited sessions in each phase. Further investigation in this area is warranted (Table 2).

Study 2 Methods

Research Question

Study 2 further explored a functional relationship between contingent adult vocal imitation, use of parentese speech and the frequency of infant vocalization in a typically developing infant

compared to an infant at-risk for ASD based on interactions with multiple caregivers (i.e. both mother and father). Comparing the interactions of two caregivers and the use of contingent reinforcers (CR) we sought to add to the existing research conducted by

behavior analysts which have found that infants' vocalizations can be increased by altering contingencies in the environment Neimy et al. [4].

Table 2: Single-factor Analysis of Variance.

	Baseline (N=5)	Intervention: English (N=6)	Intervention: Spanish (N=7)
Intervention 1: English	p < .0025*		
Control 1: English		p < .001*	
Intervention 2: Spanish		p < .31	
Control 2: Spanish			p < .001*

Participants

Participants included two infants and their two main caregivers. The participants were of middle socio-economic status. The first triad of participants included an 8-month-old female infant (Annie), her mother and father. Annie was of African American and Hispanic descent with English as the primary language spoken at home. Annie was a typically developing child, scoring at normal functioning levels across all developmental domain in developmental assessments. The second triad of participants included a 12-month-old male infant (Luke), his mother and father. Luke was of African American descent with English as the primary language spoken at home. Luke demonstrated below average functioning levels across several developmental domains in developmental assessments.

A formal structured interview was conducted with caregivers in order to gather information about the home environment, infant's daily routines and developmental and social history. A home environment questionnaire was provided to each caregiver at the beginning of the interview followed by the Ages and Stages Questionnaire (ASQ-3) and the Battelle Developmental Inventory (BDI-2). As indicated by the home environment questionnaire, Annie's daily routine consisted of time spent in the home with most of her time spent with her mother who worked from home due to the COVID-19 crisis and her father who spendt the most time away from home due to employment. Like Annie, Luke spent most of his daily routine in the family home with most of his time spent with his mother and siblings.

The Ages and Stages questionnaire provided to caregivers was conducted when Annie was 7 months old and Luke 11 months old. Annie scored within the above cutoff range for communication, gross motor, fine motor, problem solving and personal-social domains indicating that her development was typical and on schedule. Luke scored close to the cutoff range in gross and fine motor skills and below the cutoff range in communication, problem solving and personal-social domains indicating that there are clear developmental delays and further assessments should occur to determine appropriate interventions.

The Battelle Developmental Inventory (BDI-2) was conducted after the ASQ-3 and home environment questionnaires to confirm results previously discussed. The BDI-2 was conducted in an interview format and addressed adaptive skills (self-care), Personal Social Skills (adult-interactions and self- concept/social role), communication skills (receptive, expressive), motor skills (gross motor, fine motor), and cognitive skills (attention/memory, perception/concepts). Annie scored within normal range for all domains with an average standard score of 102 while Luke scored below average in all domains with an average standard score of 87.

Setting and Materials

Sessions were conducted virtually using a video conferencing platform with the participants in their homes. The use of a virtual platform allowed for participants from different states (Florida and Maryland) to participate in the study during the current COVID-19 pandemic crisis. Due to COVID-19 emergency measures, rapid adaptation of telehealth mediated applied behavior analysis (ABA) services have emerged Neely et al. [15]. Telehealth is likely to become an increasingly accepted and requested service delivery modality which provides opportunities for timely care and lower associated costs, remote delivery of services, potential for addressing inequities in culturally diverse populations and access of remote populations Sivaraman & Fahmine [16]. This is crucial to note for study 2 because procedures set for participants to engage virtually were carefully designed to control for confounding variables and data collection which would similarly need to be addressed in ABA service delivery. The participants were instructed to sit in a quiet room in their home free of distractions. In order to ensure that the researcher could record sessions and conduct proper observations, participants were asked to use a computer with a functional camera, audio, microphone and internet. During sessions infants sat in a highchair approximately 2 feet from the caregiver. All sessions were recorded for data analysis and interobserver agreement via a screen casting/recording program. The camera was facing both the caregiver and infant during each phase. In order to

prevent distractions, the caregiver wore headphones linked to the computer to receive directions from the researcher. During each phase the researcher's camera was turned off to avoid distractions for the infant. In the event that the infant became fussy or cried, the caregiver attempted to sooth the infant. If the caregiver could not sooth the infant the sessions would have been rescheduled; for this study both infants were able to participate with no interruptions; with Annie occasioning attention-seeking behaviors such as banging on the highchair, increasing volume and tone of non-distress vocalizations, and flailing her arms while Luke occasioned at-risk ASD like behaviors such as avoidant eye contact and lack of joint attention.

Experimental Designs

An alternating treatment design was conducted to determine the functional relationship of contingent vocal imitation and parentese speech on the frequency of infant vocalizations. The alternating treatment design followed an A-B-C-B-C sequence with a baseline (A), and intervention phases, caregiver contingent vocal imitation (B) and parentese (C). The use of an alternating treatment design in this study allowed for a rapid comparison of treatments [17]. The use of a small sample size of two infant participants and their caregivers allowed for the interpretation of individual cause and effect relationships without accessing the population at large and thus allowing for future individualization of tailored interventions for each infant to build on their verbal repertoires with each caregiver.

Procedures

Infant and caregiver interactions were observed over several days and each infant interacted with a different caregiver on separate days. Each caregiver provided the infant with contingent vocal imitation and contingent parentese by alternating conditions beginning with a baseline phase and followed by contingent reinforcements (CR). Prior to the beginning of sessions, caregivers received parent training from the researcher. Procedures and operational definitions of vocal imitations and parentese were explicitly explained and modeled to caregivers. Caregivers also received instruction during subsequent phases between sessions through headphones linked to their computer.

During the baseline phase, each caregiver was instructed to interact with the infant in the natural home environment by playing with the infant, making eye contact, and speaking to the infant naturally, providing the infant with the typical amount and type of attention normally given Neimy et al. [9]. Baseline data was collected for two-minute sessions until stability occurred for each infant-caregiver interaction. Following baseline, a contingent vocal imitation phase was conducted for two-minutes followed by a two-minute session of contingent parentese speech. Treatment phases were alternated throughout. During the vocal imitation phases, caregivers would imitate the vocalizations emitted by the infant immediately after the infant vocalized. For the parentese phases, caregivers immediately provided a brief high-pitched

voice for approximately 1-2 seconds after the infant emitted a vocalization.

Dependent Variable: The target behavior recorded was the frequency of infant vocalizations contingent on caregiver vocal imitations and parentese speech. Infant vocalizations were operationally defined as one syllable utterances composed of vowel sounds or consonant vowel sounds separated by one second including cooing and babbling Pelaez et.al. [7]. Non-examples of vocalization included coughing, fussing, crying, hiccupping, whining, sneezing, and belching Hirsh et.al. [5].

Independent Variable: The independent variable consisted of reinforcement conditions of caregiver contingent vocal imitations operationally defined as an identical vocal response to the infant's vocalization with no addition or deletion of sounds Gazdag & Warren [18] and parentese speech known as a form of infant-directed speech or "baby talk", was operationally defined as a high-pitched voice with exaggerated intonation for a 1-2 second period Pelaez et.al. [7].

Data Collection and Interobserver Agreement

The researcher trained an independent observer to facilitate calculating interobserver agreement. Operational definitions of dependent and independent variables were reviewed and agreed upon. Frequency of infant vocalizations were recorded using a data collection sheet by both observers. The researcher and observer conducted interobserver agreement (IOA) simultaneously using recordings of sessions. IOA was calculated for all of the infant vocalizations in both infant triads during each treatment phase. IOA values ranged from 75%-100% across sessions for each participant with a mean IOA of 84.38%.

Result

Results of the alternating treatments are displayed in Figures 2&3, which represent the frequency of infant vocalizations for each infant and their interactions with multiple caregivers. Visual analysis of the data suggests that infant vocalizations increased across participants for both treatments (vocal imitation and parentese speech), with vocal imitation reinforcing visibly higher frequencies of vocalization than parentese speech. Data across participants demonstrates a positive trend with some variability indicating an increase in the target behavior when each treatment was presented. Overall, the data supported previous research, suggesting that contingent vocal imitation reinforces higher frequencies of vocalizations in younger infants Pelaez et al. [2]. The data also suggests that infants vocalized at higher frequencies with adults that they interact with on a regular basis, which was determined by the initial interviews and questionnaires that indicated that there was a difference in the amount of time each caregiver spent with the infant during their typical daily routines. The data also indicates that Annie averaged higher frequencies of vocalization although she was the younger of the two participants. This could be attributed to the 12-months-old's developmental delays that suggested his overall functioning was at a much lower

stage than that of his chronological age. However, the data also indicates that regardless of developmental trajectories both reinforcers increased vocalizations. This is crucial to note because

it can help inform interventions for typically and atypically developing infants when focusing on early language acquisition skills.

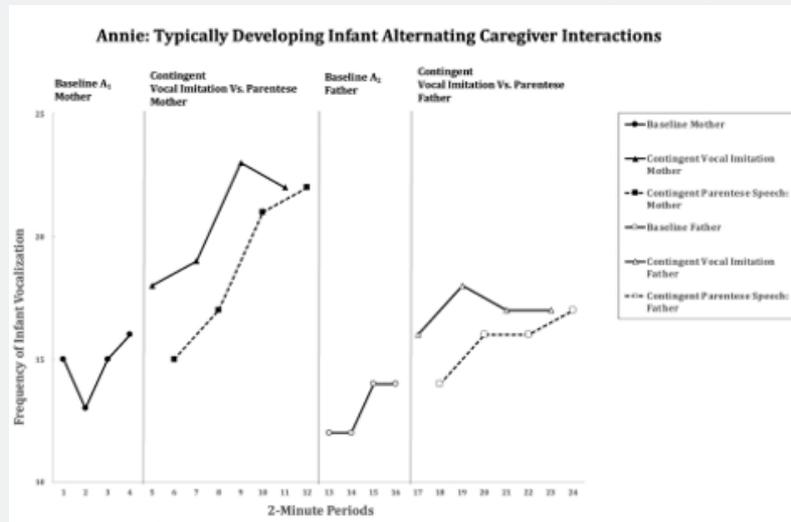


Figure 2: Frequency of Infant Vocalization across baseline and treatment conditions contingent vocal imitation and contingent parentese speech. Annie: typically developing 8-month-old infant interaction with both caregivers.

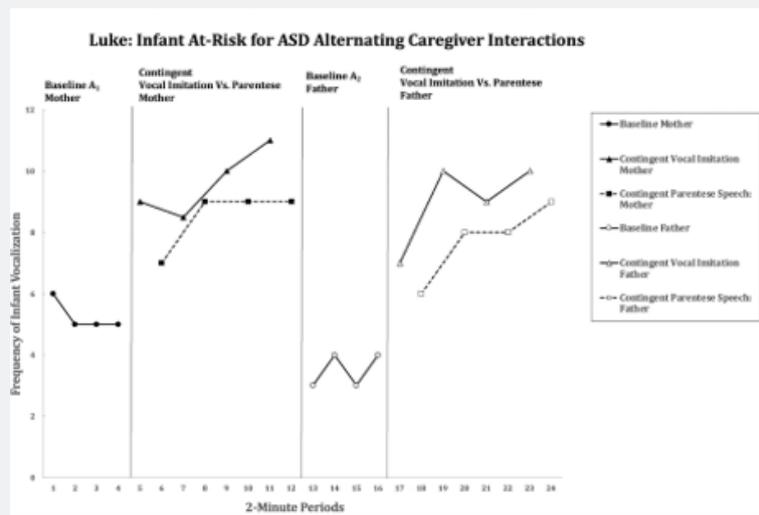


Figure 3: Frequency of Infant Vocalization across baseline and treatment conditions contingent vocal imitation and contingent parentese speech. Luke: atypically developing 12-month-old infant interaction with both caregivers.

Discussion

Study 1

Study 1 provided single subject data which added to existing research on infant vocalizations while expanding the literature on bilingual language acquisition. Although there is criticism to the limitation of single subject research, the design used in study 1 allowed the participant to function as her own control instead of being compared against a different individual or group Cooper et al. [19]. Single-subject research is an approach that is concerned with demonstrating functional relationships

between the independent and dependent variables Richards [17], which the study was striving to achieve. A single- subject design was used because this type of design is sensitive to individual differences in a subject's behavior whereas group designs are represented as averages [19], therefore the efficacy of single-subject designs depends on demonstrating that changes in the dependent variable were clearly attributable to fluctuations in the independent variable Richards [17]. Consequently, the researcher opted for a single-subject design to evaluate the effects of the applied behavioral interventions (contingent parentese in response to infant-initiated vocalizations) on the single

participant to accurately demonstrate the functional relationship between the dependent and independent variables. Although there are benefits to the single subject design, results from Study 1 cannot necessarily be generalized due to the use of one subject. Future studies would benefit from more sessions within phases, additional participants to allow for between-subjects replication, participants varying in age, and participants with a variety of home language backgrounds.

The current results do suggest that contingent parentese speech reinforces infant vocalizations within a few treatment sessions, so increasing the number of sessions would only serve to further verify the results. In addition, future studies may benefit from introducing a home language survey to determine the level of use of each language (English and the Home Language) at home with the infant (i.e. in what circumstances are each language used? How often do they speak to the infant in each language? Who speaks to the infant in which language – parents, grandparents, caretakers, visitors, etc.). This may allow for the researcher to better understand the effects of each particular language on the child. In addition to the home language survey, researchers may want to establish baseline at multiple times of the day and determine whether that is a factor in the infant's responding. This was a potential limitation of this study and could also be avoided by surveying the parents regarding what time of day would be best to conduct the experimental sessions. Another possibility for future research would be an evaluation of the longitudinal effects of reinforcement in both of these languages on verbal development of each language.

In an increasingly diverse climate, research that considers the vast differences in infants' backgrounds will be beneficial to understanding the development of language in infants and children exposed to a variety of languages at home. The findings of this study provide important insight into how infants in bilingual homes acquire language. In a society that is becoming more and more diverse, it is crucial that researchers and educators understand how various populations are exposed to and acquire language in distinct ways. According to the United States Census Bureau [20], 32.5% of the United States population is Hispanic. This number is growing at an extremely rapid rate. The languages most spoken in America besides English and Spanish are Chinese (Mandarin, Cantonese, and Hokkien), Tagalog, Vietnamese, Arabic, French, and Korean, but this list is not exhaustive. In fact, English is not even the official language in the United States, so it is conceivable that another language, such as Spanish, could grow in numbers so rapidly that may be possible to reach or exceed the numbers of English language speakers. The findings of this study open the door for vast and important future research surrounding individuals who are acquiring language in homes where more than one language is spoken. As there is now a wealth of information and evidence about infants' language development and how reinforcement affects language, researchers must know that many children are no longer exposed to only one language at home and must seek to understand how this may manifest in their

development of language.

Study 2

Collectively, both infants in study 2 demonstrated higher frequencies of vocalization with each caregiver contingent on socially reinforcing conditions (vocal imitation and parentese speech), although minor idiosyncratic differences were observed. Although both reinforcers had an effect on infant vocalization, vocal imitation showed slightly higher reinforcing qualities than parentese speech in both infants and across caregivers. The data collected, reflected similar results of existing literature and allowed for a comparison of typically and atypically developing infants and their caregivers. The questionnaires and structured interviews conducted prior to the beginning of sessions revealed the differences in the amount of time spent at home for each caregiver as well as the type and quality of activities typically used to engage with the infant. This is a crucial piece of the study because each infant's developmental functioning and individual interactions with multiple caregivers influenced the data. Although vocal imitation showed reinforcing qualities for infant vocalization across caregivers, slightly lower vocalizations were produced with caregivers whom infants spent less time with. These findings can help drive implementation of interventions with caregivers that spend less time with their infants; interventions can be modeled and explicitly taught to these caregivers in order for them to increase their reinforcing behavioral repertoire and thus enhance interactions with their infants in the limited amount of time they spend with them.

Evident data that supports the use of vocal imitation and parentese further influences the notion that providing caregivers with behavioral strategies which facilitate production and maintenance of verbal responses may effectively aid in increasing infants' verbal repertoires and overall foundational skills that can lead to more complex language and social skills Neimy et al. [3]. Practitioners that witness evidence of language deficits in infants as early as 6 months are in an advantageous position because noting early deficits facilitates the development of proactive treatments Neimy et al. [3]. This study adds to previous literature by supporting results that emphasize the effects of vocal imitation as a contingent reinforcer for increased infant vocalizations for both typically and atypically developing infants. It also extends such research by generalizing that vocal imitation is effective even when multiple caregivers use the reinforcer. Data suggesting that Annie had higher frequencies of vocalization although she was the younger of the two participants adds to literature further supporting the need for early interventions to enhance language acquisition skills. Typically developing infants' babbling progresses often becoming more refined by 10 months of age Hirsh et al. [5]; in this study Luke demonstrated such a deficit compared to Annie whose development was on par with her chronological age. The within subject comparison of data in the study supports the need for awareness of developmental deficits in older infants.

This can drive proactive measures taken to create effective early intervention programs individualized for the child. Overall, the findings have practical implications in various fields, including speech language pathology, child development, developmental psychology and early childhood education. Continued research on this topic can further support information regarding language acquisition and later academic performance for young children with and without developmental delays. This study would benefit from future replication with control procedures, which were not included primarily due to its overall feasibility through virtual platform execution. Replication of the study should also consider control procedures to avoid sequencing effects of phases [21].

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