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Infant Vocalizations and Imitation as a Result of Adult Contingent Imitation

Martha Pelaez and Alexa R. Borroto
Florida International University

Jacqueline Carrow
Caldwell University

Previous studies have shown that vocal imitation is critical in the development of early language acquisition; however, few studies have evaluated the use of socially mediated reinforcement to increase infant vocal imitation. This brief report contributes to the existing literature by demonstrating the impact that adult vocal imitation may have on the frequency of infant vocalizations. Specifically, the present study compared the use of contingent and noncontingent adult responses following infant vocalizations and infant vocal imitation of 3 infants of typical development ranging from 3 to 14 months of age. By implementing an alternating treatment design, results suggested that adult contingent vocal imitation produces the highest frequency of infant vocalization and infant vocal imitation.

Keywords: infant vocalizations, infant imitation, vocal imitation, socially mediated reinforcement, reinforcers

The study of language development in infants and the variables that influence its expansion has generated great interest among developmental psychologists and behaviorists in the past few decades. Oller, Eilers, Neal, and Schwartz (1999) suggested that there are four stages of vocal development in the first year of life: (a) phonation stage, (b) primitive articulation stage, (c) expansion stage, and (d) canonical stage. The phonation stage takes place during the first 2 months of age, where infants begin to produce natural sounds such as coughing and grunting (Oller et al., 1999). Between 2 and 3 months, in the primitive articulation stage, infants start "gooing" and coordinating their lips and tongue producing consonant-like sounds. Following is the expansion stage, beginning at 4 to 5 months, where vowel sounds emerge and infants explore the pitch and intensity of their voices. Finally, around 6 to 7 months during the canonical stage, infants produce well-formed syllables and sounds similar to those that occur in speech (Oller et al., 1999).

Although there is abundant information about vocalization stages, little is known about what causes these vocalizations to change and develop over time (Kuhl & Meltzoff, 1996). Some behaviorists argue that along with anatomical changes in the vocal tract, infants also listen to sounds in their environment and attempt to imitate or produce what they hear (Gratier & Devouche, 2011; Kuhl & Meltzoff, 1996; Masur & Olson, 2008). The literature claims that infants may begin to pick up elements of language as early as prenatal development. In other words, learning begins while in the mother's womb. A study developed by Mampe, Friederici, Christophe, and Wermke (2009) assessed the melody of 30 French and 30 German newborn cries. Their results showed that the French group consistently produced rising melody patterns, whereas the German group reliably produced falling melody patterns, supporting the influ-

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Martha Pelaez and Alexa R. Borroto, Department of Leadership and Professional Studies, College of Arts, Sciences, and Education, Florida International University; Jacqueline Carrow, Center for Autism and Applied Behavior Analysis, Caldwell University.

Correspondence concerning this article should be addressed to Alexa R. Borroto, Department of Leadership and Professional Studies, School of Education, 242-B, College of Arts, Sciences, and Education, Florida International University, Miami, FL 33199. E-mail: alexaborroto@gmail.com

ence of environmental variables on speech prosody. By 3 months of age, Gratier and Devouche (2011) demonstrated that 10- to 13-week-old infants continue to imitate their mother's prosodic contours (i.e., the pitch, loudness, and duration of their sounds), as well as begin to select specific pitched sounds to imitate. Similarly, Kuhl and Meltzoff (1996) found that infants, ranging from 12 to 20 weeks of age, produced vocalizations resembling vowel sounds played through a videotape.

Vocal imitation has also been considered as crucial to language development and language acquisition (Franklin et al., 2014; Hsu, Fogel, & Cooper, 2000; Masur & Olson, 2008; Ross & Greer, 2003; Pelaez & Moniux, 2017; Tarbox, Madrid, Aguilar, Jacobo, & Schiff, 2009). The existing research findings suggest 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 (Hart & Risley, 1995; Masur & Olson, 2008; Masur & Eichorst, 2002; Yoshikawa, Asada, Hosoda, & Koga, 2003). For instance, Masur and Olson (2008) studied mother and infant imitative responses to each other during daily tasks (e.g., bath time and play time) to measure if mother responses influenced infant imitation rates and if infant responses predicted increased vocabulary acquisition. The authors found that toddlers' imitation of nonfamiliar words was associated with language improvement and more extensive vocabulary. Specifically, the children who were highly responsive and reacted to their maternal vocalizations were more "lexically advanced" than children who were less responsive and imitated fewer sounds and actions. These children also began to incorporate socially responsive words into their responses (Masur & Olson, 2008).

Piaget (1962) was one of the first psychologists to empirically find that infants are able to imitate adult sounds. He suggested that vocal imitation progresses as infants grow and develop (Gazdag & Warren, 2000; Piaget, 1962). Specifically, infants go through six stages of voluntary vocal imitation: "(1) vocal contagion or reflexes, (2) interactive copying of sounds, (3) systematic rehearsal of sounds in the repertoire, (4) exploratory copying of novel sounds, (5) increased flexibility at imitating novel events, and (6) deferred imitation" (Piaget, 1962 as cited in Mercado, Mantell, & Pfordresher, 2014, p. 9). Other researchers, such as Snow (1981), have proposed simpler vocal imitation theories stating that infants typically progress from partial imitations, to exact imitation, to expanded or modified imitations.

Through observations of mother–infant dyads, it is frequently seen that mothers often effectively teach language unintentionally to typical developing children using frequent repetitions and prompts (Masse, McNeil, Wagner, & Quetsch, 2016). Specifically, we see that parents will initiate and respond to infant vocalizations with either imitative sounds or motherese speech (Bendixen & Pelaez, 2010; Pelaez, Virués-Ortega, & Gewirtz, 2011a, 2011b). Our research shows that parents play a large role in an infant's vocal learning partly due to the reinforcing effects of parental reinforcing contingencies (Neimy, Pelaez, Carrow, Monlux, & Tarbox, 2017). Early research by Haugan and McIntire (1972) investigated the effects of three types of reinforcement (i.e., food, tactile stimulation, and adult vocal imitation) on the vocalizations of 3- to 6-month-old infants. The authors found that adult vocalization was the most effective in helping infants produce higher rate of vocalizations. An explanation for this outcome may be that parent vocalizations are repeatedly paired with unconditioned and conditioned reinforcers early on, such as providing access to preferred stimuli such as food and tactile stimulation.

More recent research strategies have been to reinforce infant vocalizations with maternal contingent vocal imitation during face-to-face interactions. Pelaez et al. (2011b) analyzed the reinforcing effects of contingent vocal imitation across 17 infant–parent dyads using a reversal probe B-A-B design. Caregivers were taught to directly echo or imitate the vocalizations emitted by their 3-month-old infants, contingent on appropriate infant vocalizations. Their data revealed that contingent parental vocal imitation increased the overall frequency of infant vocalizations across all participants. In another replication, Bendixen and Pelaez (2010) investigated the reinforcing effects of both contingent vocal imitation and contingent motherese speech on the rate of vocalizations in a 12-month-old infant. Their results and those of Pelaez et al. (2011a) illustrated and replicated the finding that both forms of contingent reinforcement increased overall rates of vocalizations, compared with baseline and control conditions. Interestingly, McRoberts, McDonough, and Lakusta (2009) also reported that infants of different ages preferred maternal repetition, a dimension of maternal vocal imitation, as a form of stimulation.

In addition, Pelaez et al. (2011a) emphasized that caregiver contingent imitation has major benefits for language development. Specifically, they argued that when mothers imitate their child's vocalizations, it is more likely that the child will be able to reproduce the adult's vocalizations because they are the same as their own. We also know that adult contingent vocal imitation may facilitate the development of spontaneous imitation skills of mentally retarded children. For example, Gazdag and Warren (2000) studied the effects of adult contingent vocal imitation on the development of vocal imitation skills of three children with mental retardation and found positive increases in the children's imitation.

In sum, social consequences in the form of attention can be idiosyncratic and individualized, and so, identification of preferred social attention is warranted before developing procedures to promote early vocalizations. However, there is still lack of research examining which stimuli could serve as reinforcers for infant vocal imitation. The purpose of the present study is to evaluate reinforcement procedures consisting of adult contingent vocal imitation and noncontingent vocal stimuli to measure their effects on the rate of infant vocalizations and vocal imitations. This study adds to the literature by examining variables specific to the delivery and form of adult vocal stimulation, which may play a role in nurturing language development at a very early age.

Method

Participants

Three female infants participated in this study. Holly was 3 months, Rachel was 8 months, and Leslie was 14 months at the start of the study. All participants were of Hispanic descent with Spanish as the primary language at home. The three infants were of typical development; the mothers reported no prenatal or postnatal complications during pregnancy. In addition, all the mothers completed the Developmental Profile–Third Edition assessment (Alpern, 2007) to determine developmental strengths and weaknesses for each participant. All participants scored in the normal functioning level across all five domains (i.e., Physical, Adaptive Behavior, Social–Emotional, Cognitive, and Communication).

Setting and Apparatus

The study was conducted in a quiet room of each participant's home. Rachel and Leslie were each sat in a high chair approximately 2 ft away from the primary female experimenter. Holly was either sat in a high chair or positioned lying down on a changing bed. All sessions were recorded to permit data analysis and interobserver agreement. If an infant was fussy or crying, the infant was soothed by rocking her side to side or giving her a toy in an attempt to calm her down. The session was terminated and rescheduled for a later time if the infant continued to fuss or cry for more than 1 min.

Design

An alternating treatment design (A-B-C-B-C-B-C) was implemented to compare contingent vocal imitation and noncontingent vocal stimuli conditions. In an alternating treatment design, the two conditions are conducted concurrently to alter the target response. The presentation of the treatment conditions was counterbalanced to reduce order-of-treatment effects (Hains & Baer, 1989; Richards, Taylor, & Ramasamy, 2014).

All the sessions were 2 min in duration. Baseline (A) was established before the introduction of treatment. Data were gathered on infant vocalizations and vocal imitations without any programmed consequences. During the intervention sessions (B-C), data were collected until a stable rate of responding was demonstrated for three consecutive sessions. B is the contingent vocal imitation intervention, and C is the noncontingent vocal stimuli intervention. The order of the conditions was randomly selected (i.e., coin toss).

Dependent Variables

The primary dependent variables were the frequency of infant vocalizations and the percentage of correct infant vocal imitation. Vocalizations are operationally defined as one-syllable utterances or more separated by 1-s interresponse time (Pelaez et al., 2011b). Infant vocal imitation was defined as a vocal response identical to the vocal model (Ross & Greer, 2003).

Independent Variables

The independent variables implemented were two reinforcement conditions, that is, adult contingent vocal imitation and adult noncontingent vocal stimuli following infant vocal behavior. Adult contingent imitation was defined as any instance of an identical vocal response to the infant's vocal response (Gazdag & Warren, 2000). Adult noncontingent vocal stimuli occurred when the primary investigator repeated her own vocal responses aloud regardless of the vocalizations the infant emitted at that time (Pelaez et al., 2011b). More on this next.

Intervention Procedure

Before the intervention, four 2-min baseline sessions were conducted. Next, the treatment conditions were implemented in sessions with two 2-min conditions (one contingent vocal and then one noncontingent), a 15-s test phase after each condition, and a 1-min break between conditions. During the contingent vocal imitation condition, if the infant emitted a vocalization, the primary investigator imitated the infant's vocalization. During the noncontingent vocal stimuli condition, the investigator listened to a recording of previous vocal responses and repeated them aloud regardless of the vocalizations the infant was emitting (independently). In using this yoke control procedure, the idea is to provide the same density of stimulation during the noncontingent condition as in the contingent condition. During the noncontingent condition, the investigator listened to the recording through earphones to match her own vocal responses that she emitted earlier in the preceding contingent condition. In both conditions, the investigator paused for 15 s and waited for the child's imitation response. A response was considered an imitation response if the infant imitated the same phonemes produced by the adult. Typical developing 3-month-old infants are able to imitate behaviors and vocalizations that they have already produced; thus, a correct response was scored if the reproduction was identical. If the infant emitted an approximation to the vocal model, it was scored as an incorrect response.

Interobserver Agreement

The primary investigator trained a research assistant, blind to the study, to conduct reliability observations. The secondary observer scored 75% of sessions for primary behavior measures. Interobserver agreement was calculated by dividing the number of intervals both observers agreed the behavior occurred by the total number of intervals either observer recorded as an occurrence of the target behavior. The resulting ratio was then multiplied by 100 to obtain the interobserver agreement percentage. Mean interobserver agreement was 93% for infant vocalization and 90% for infant imitation.

Results

Figure 1 displays frequency of infant vocalizations under both treatment conditions. Three trends in the data are apparent in this visual presentation. First, visual analysis of the data suggests that although there is some variability, there was an immediate change in the level of the target behavior when either intervention was presented. Second, it is apparent that all the infants, regardless of age, produced more vocalizations during the adult contingent vocal imitation condition than during the adult noncontingent vocal stimuli condition. Third, visual analysis of the data indicates that the older infants produced more frequent vocalizations. Holly, the youngest participant, produced a mean of 21 vocalizations, as compared with Leslie, the oldest participant, who produced a mean of 34 vocalizations during the contingent vocal imitation condition.

Figure 2 displays the percentage of correct infant vocal imitations under both treatment conditions. Analysis of data shows higher percentage of correct responding of infant imitation during the contingent vocal imitation condition. Specifically, Holly vocally imitated 37%, Rachel vocally imitated 37%, and Leslie vocally imitated 62% of opportunities. Imitations after the noncontingent conditions were

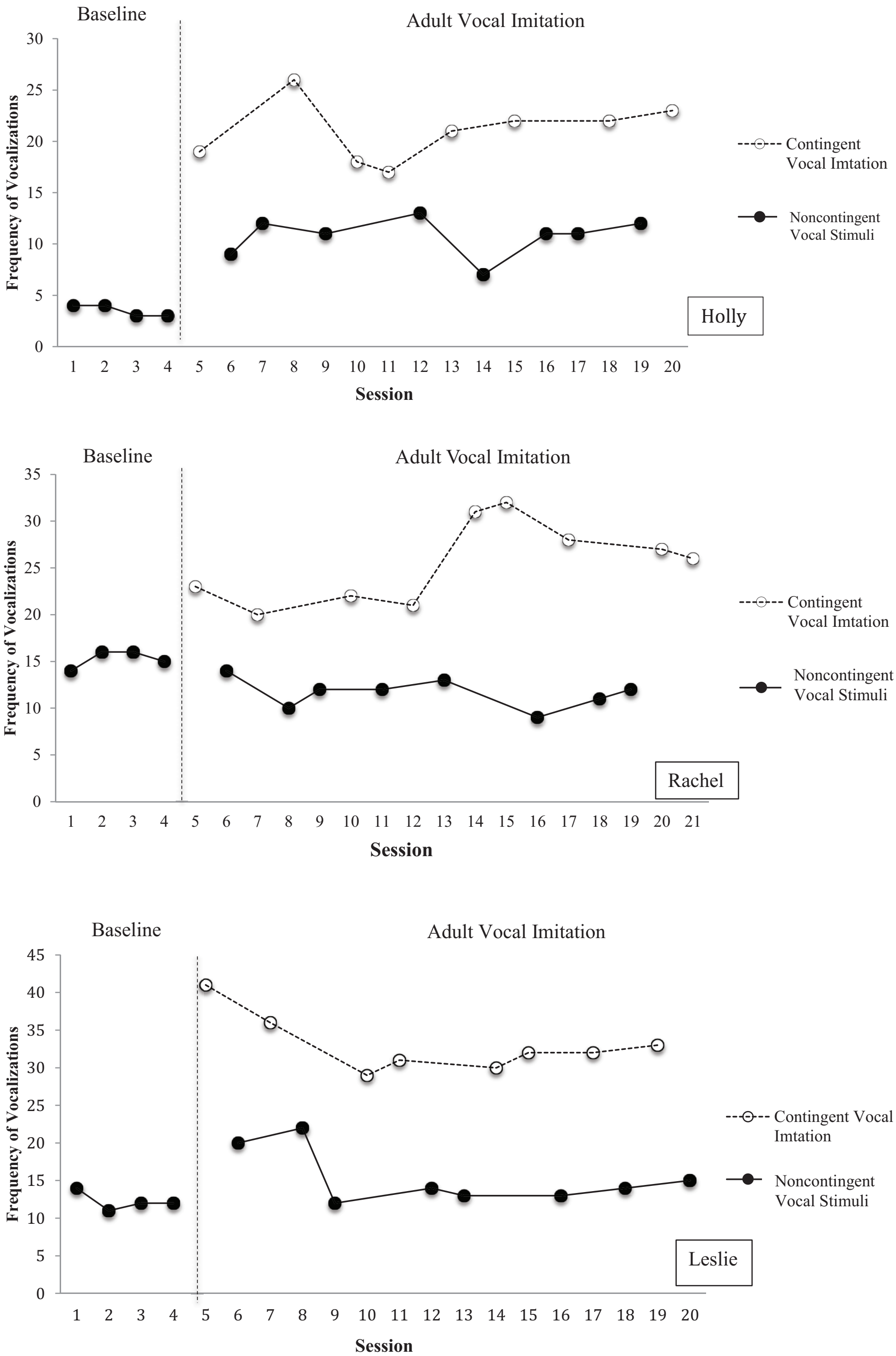

Figure 1. Frequency of infant vocalizations under adult contingent vocal imitation (open circles) versus adult noncontingent vocal stimuli (closed circles) using an alternating treatment design.

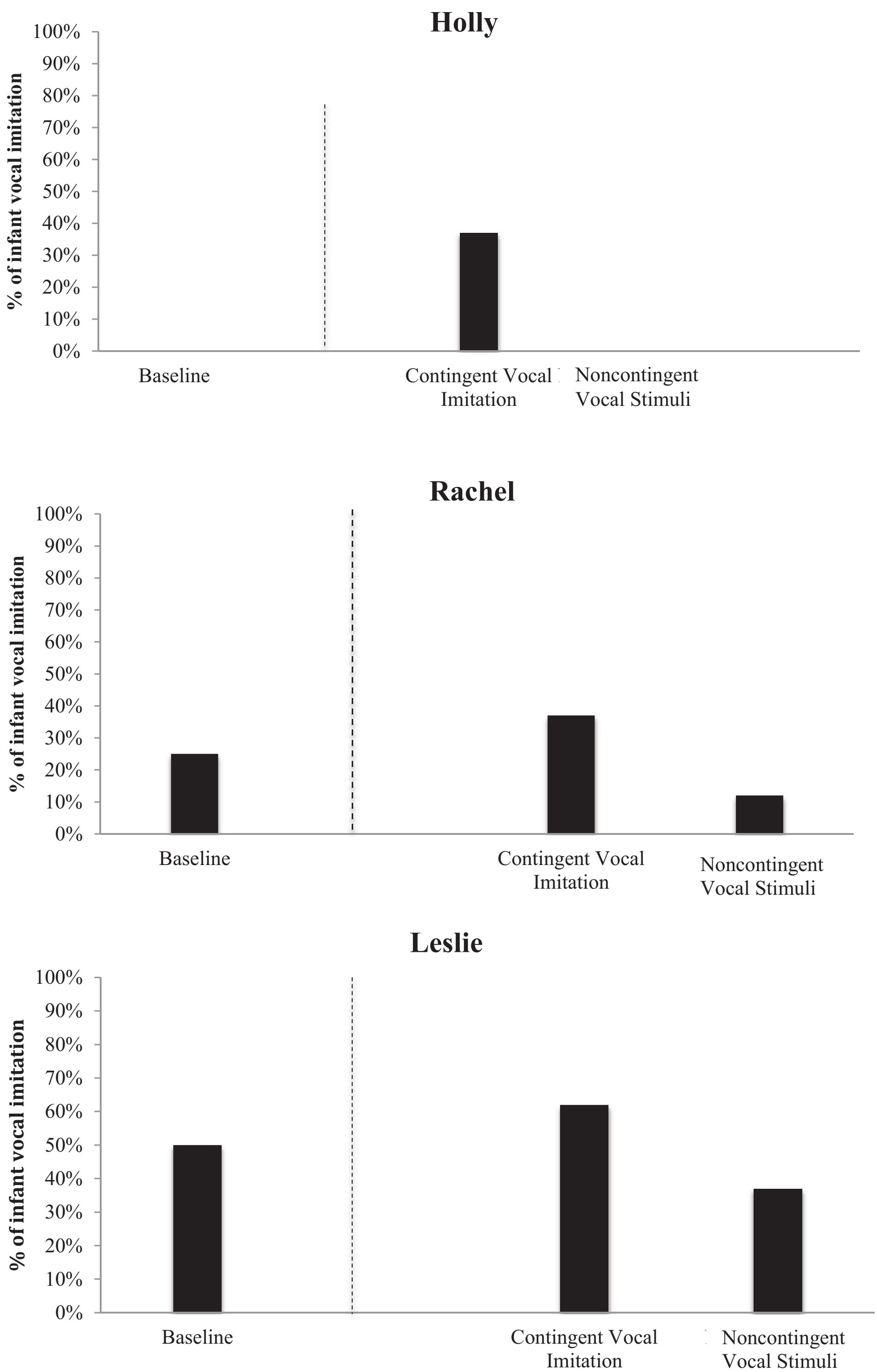

Figure 2. Percentage of correct infant vocal imitation in eight-block trials.

observed at lower levels—Holly imitated 0%, Rachel imitated 12%, and Leslie imitated 37% of opportunities.

Discussion

Findings showed that a functional relationship was established between the dependent and independent variables. All the infants, regardless of age, produced a higher rate of vocalizations during the adult contingent vocal imitation condition compared with the noncontingent condition. Our results support previous findings in the literature. Additionally, it is important to note that there was an increase in the number of vocalizations in the first two sessions of Leslie's noncontingent vocal stimuli condition. It was possible that the examiner inadvertently reinforced some vocalizations during these conditions. Nevertheless, there was clear differentiation between the treatment conditions. If this study is replicated in the future, it is suggested to add a 3- to 5-s delay to avoid this possibility.

The contingent vocal imitation served as a reinforcer for infant vocal imitations as well. Infants imitated adult vocalizations at a higher frequency after the contingent vocal imitation condition than after the noncontingent vocal stimuli condition. Finally, the results indicated that the older the infant, the higher the rate of vocalizations and imitations produced. Reason for this finding is because as infants grow, they are more aware of their surroundings, have a more developed vocal track, and are consequently more likely to produce speech and imitate adult speech (Oller et al., 1999; Piaget, 1962).

Although expected results appear to be promising, there are a few limitations to this study. For instance, because the primary investigator imitated the infants' previously produced vocalizations, it is difficult to conclude whether the infants imitated or simply reproduced their previously emitted vocalizations. The primary investigator conducted the procedure rather than the participants' caregivers; thus, infants may have produced fewer vocalizations due to an unfamiliar adult present in the room. Future research should evaluate additional variables that would influence responding to social attention contingencies, such as the familiar and unfamiliar mediators and environments. Finally, all three participants were female, limiting the generality of the examined procedures. Researchers should include male infants as well and a larger sample size to strengthen the external validity of the procedures.

These findings have practical implications in the fields of speech and language pathology and child developmental psychology. Practitioners can design interventions for infants who are at risk of delayed language development, young children with a language disorder, or even children diagnosed with autism. We know that frequent exposure to language during infancy can have positive benefits in school age, such as increased verbal abilities and improved academic performance (Hart & Risley, 1995). In addition, according to Pelaez et al. (2011b), infant vocal production improves speech segmentation ability, which is an essential prerequisite for language acquisition. By evaluating the efficacy of contingent vocal reinforcement to promote infant vocalizations, clinicians and parents can use the aforementioned assessment and experimental procedures to increase the effectiveness of target behaviors and provide consequences that are more readily found in the natural environment.

References

Alpern, G. D. (2007). *Developmental Profile 3 (DP-3)*. Los Angeles, CA: Western Psychological Services.

Bendixen, M. I., & Pelaez, M. (2010). Effects of contingent maternal imitation vs. contingent motherese speech on infant canonical babbling. In M. S. Plathotnik, S. M. Nielsen, & D. M. Pane (Eds.), *Proceedings of the Ninth Annual College of Education & Graduate Student Network Research Conference* (pp. 2–6). Miami, FL: Florida International University.

Franklin, B., Warlaumont, A. S., Messinger, D., Bene, E., Nathani Iyer, S., Lee, C. C., . . . Oller, D. K. (2014). Effects of parental interaction on infant vocalization rate, variability, and vocal type. *Language Learning and Development, 10,* 279–296. http://dx.doi.org/10.1080/15475441.2013.849176

Gazdag, G., & Warren, S. (2000). Effects of adult contingent imitation on development of young children's vocal imitation. *Journal of Early Intervention, 23,* 24–35. http://dx.doi.org/10.1177/10538151000230010701

Gratier, M., & Devouche, E. (2011). Imitation and repetition of prosodic contour in vocal interaction at 3 months. *American Psychological Association, 47,* 67–76.

Hains, A. H., & Baer, D. M. (1989). Interaction effects in multielement designs: Inevitable, desirable, and ignorable. *Journal of Applied Behavior Analysis, 22,* 57–69. http://dx.doi.org/10.1901/jaba.1989.22-57

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experiences of young American children*. Baltimore, MD: Brooks.

Haugan, G., & McIntire, R. (1972). Comparisons of vocal imitation, tactile stimulation, and food as reinforcers for instant vocalizations. *Developmental Psychology, 6,* 201–209. http://dx.doi.org/10.1037/h0032089

Hsu, H., Fogel, A., & Cooper, R. (2000). Infant vocal development during the first six months: Speech quality and melodic complexity. *Infant and Child Development, 9,* 1–16. http://dx.doi.org/10.1002/(SICI)1522-7219(200003)9:1<1::AID-ICD210>3.0.CO;2-V

Kuhl, P. K., & Meltzoff, A. N. (1996). Infant vocalizations in response to speech: Vocal imitation and developmental change. *Journal of the Acoustical Society of America, 100,* 2425–2438. http://dx.doi.org/10.1121/1.417951

McRoberts, G. W., McDonough, C. and Lakusta, L. (2009). The role of verbal repetition in the development of infant speech preferences from 4 to 14 months of Age, *Infancy, 14,* 162–194. http://dx.doi.org/10.1080/15250000802707062

Mampe, B., Friederici, A. D., Christophe, A., & Wermke, K. (2009). Newborns' cry melody is shaped by their native language. *Current Biology, 19,* 1994–1997. http://dx.doi.org/10.1016/j.cub.2009.09.064

Masse, J. J., McNeil, C. B., Wagner, S., & Quetsch, L. B. (2016). Examining the efficacy of parent–child therapy with children on the autism spectrum. *Journal of Child and Family Studies, 25,* 2508–2525.

Masur, E. F., & Olson, J. (2008). Mothers' and infants' responses to their partners' spontaneous action and vocal/verbal imitation. *Infant Behavior and Development, 31,* 704–715. http://dx.doi.org/10.1016/j.infbeh.2008.04.005

Masur, F., & Eichorst, D. (2002). Infants' spontaneous imitation of novel versus familiar words: Relations to observational and maternal report measures of the lexicons. *ProQuest Social Sciences Premium Collection, 48,* 405–426.

Mercado, E., III, Mantell, J., & Pfordresher, P. (2014). Imitating sounds: A cognitive approach to understanding vocal imitation. *Comparative Cognition and Behavior Reviews, 9,* 17–74. http://dx.doi.org/10.3819/ccbr.2014.90002

Neimy, H., Pelaez, M., Carrow, J., Monlux, K., & Tarbox, J. (2017). Infants at risk of autism and developmental disorders: Establishing early social skills. *Behavioral Development Bulletin, 22,* 6–22. http://dx.doi.org/10.1037/bdb0000046

Oller, D. K., Eilers, R. E., Neal, A. R., & Schwartz, H. K. (1999). Precursors to speech in infancy: The prediction of speech and language disorders. *Journal of Communication Disorders, 32,* 223–245. http://dx.doi.org/10.1016/S0021-9924(99)00013-1

Pelaez, M., & Monlux, K. (2017). Operant conditioning methodologies to investigate infant learning. *European Journal of Behavior Analysis, 18,* 212–241. http://dx.doi.org/10.1080/15021149.2017.1412633

Pelaez, M., Virués-Ortega, J., & Gewirtz, J. L. (2011a). Contingent and non-contingent reinforcement with maternal vocal imitation and motherese speech: Effects of infant vocalizations. *Journal of Applied Behavior Analysis, 12,* 277–287. http://dx.doi.org/10.1080/15021149.2011.11434370

Pelaez, M., Virués-Ortega, J., & Gewirtz, J. L. (2011b). Reinforcement of vocalizations through contingent vocal imitation. *Journal of Applied Behavior Analysis, 44,* 33–40. http://dx.doi.org/10.1901/jaba.2011.44-33

Piaget, J. (1962). *Play, dreams, and imitation in childhood*. New York, NY: Norton.

Richards, S., Taylor, R., & Ramasamy, R. (2014). *Single subject research: Applications in educational setting and clinical setting*. Belmont, CA: Wadsworth.

Ross, D. E., & Greer, R. D. (2003). Generalized imitation and the mand: Inducing first instances of speech in young children with autism. *Research in Developmental Disabilities, 24,* 58–74. http://dx.doi.org/10.1016/S0891-4222(02)00167-1

Snow, C. E. (1981). The uses of imitation. *Journal of Child Language, 8,* 205–212.

Tarbox, J., Madrid, W., Aguilar, B., Jacobo, W., & Schiff, A. (2009). Use of chaining to increase complexity of echoics in children with autism. *Journal of Applied Behavior Analysis, 42,* 901–906. http://dx.doi.org/10.1901/jaba.2009.42-901

Yoshikawa, Y., Asada, M., Hosoda, K., & Koga, J. (2003). A constructivist approach to infants' vowel acquisition through mother-infant interaction. *Connection Science, 15,* 245–258.

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