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Research Article

Early Echoic Imitation Predicts Reduction in Autism Spectrum Disorder (ASD) Symptoms: A Retrospective Study of Toddlers

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ABSTRACT

The American Psychiatric Association (APA) (2013) describes Autism Spectrum Disorder (ASD) to include deficits in social interaction and communication skills. Delayed speech affects the severity of ASD symptoms. Therefore, evidence-based treatment is essential to reduce language delays in children with ASD. Skinner proposed that echoic behavior was essential for language skills. Thus, echoic behavior might reduce the severity of symptoms. The current study examined verbal skills that predict the efficacy of Applied Behavior Analysis (ABA) intervention. Participants included 143 children between 21-40-month-old from families with varied language backgrounds in an urban center-based ABA program. Before enrollment, the children were tested with the Bayley Scales of Infant and Toddler Development-third edition (BSID), Childhood Autism Rating Scale-second edition (CARS-2) and the Verbal Behavior Milestones Assessment and Placement Program (VBMAPP). The children were classified into five groups by degree of symptom reduction at the end of the program. These groups were compared for cognitive development, language skills, echoic vocal (echoic behavior) and non-echoic vocal behavior they displayed at program entry. Children with the greatest reduction in ASD symptoms had the highest pre-intervention echoic behavior and the largest difference between echoic behavior and non-echoic vocal behavior. Results show that early echoic behavior predicted reduction in ASD symptoms. This study shows that early vocal imitation may be predictive of ASD symptom reduction and ABA efficacy.

Keywords: Autism spectrum disorder; Language development; Echoic imitation; Early intervention

INTRODUCTION

Imitation is a social transaction that has been well established as a mechanism of learning. It is the basic mechanism of what has come to be known as social learning [1-2]. Its importance has been seen in one of the most basic human characteristics, spoken language [3]. According to the American Psychiatric Association (APA) (2013), a primary characteristic of children with autism include challenges in social interaction and communication skills [4]. Lack of speech is a key factor affecting the severity of autism [5]. Early diagnosis and treatment can reduce the symptoms of this disorder and its severity. In this regard, evidence-based treatment is necessary to reduce language delays in children with autism because their symptoms are complex and set them apart from typically developing children [6]. Some children manifest uncommon speech patterns such as echolalia (repetition of phrases heard beforehand) and lack social responsiveness with others [7]. Few children with autism remain nonverbal and fail to gain language after intervention is introduced [7]. Communication deficits in children with autism lead professionals (researchers, clinicians and teachers) to treat language delays in early childhood through evidence-based interventions [8].

Imitation among developing children typically refers to the modeling of gestures, actions, sounds and words used by adults and other children. This behavior facilitates children to develop social and communication skills in early childhood. Imitation, an essential developmental skill, continues throughout life [9-11]. For the first two years after birth, imitation skills such as copying the actions, facial expressions, verbal cues and speech of adults rapidly develop in a complex manner. Such progress facilitates learning, engaging with the social environment and interacting in social situations [12-16]. Children with Autism Spectrum Disorder (ASD) may show delays in the ability to imitate [17-19]. This delay affects language and social development [20-24]. Furthermore, the commonly used interventions for children with ASD rely on their imitation skills. A lack of imitation skills may impact the effectiveness of such interventions [25-27]. Nielsen, et al., [28] conducted a study on the imitation skills of 34 children with autism spectrum disorders in

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Received: 31-May-2024, Manuscript No. AUO-24-31186; **Editor assigned:** 03-Jun-2024, PreQC No. AUO-24-31186 (PQ); **Reviewed:** 17-Jun-2024, QC No. AUO-24-31186; **Revised:** 24-Jun-2024, Manuscript No. AUO-24-31186 (R); **Published:** 02-Jul-2024, DOI: 10.35248/2165-7890.24.14.400

Citation: Yanchik A, Lax LE, Irshad G, Vietze P (2024) Early Echoic Imitation Predicts Reduction in Autism Spectrum Disorder (ASD) Symptoms: A Retrospective Study of Toddlers. Autism-Open Access. 14:400

comparison with children with Down syndrome. Results showed that, despite high performance in object-directed imitation, the ability to imitate the model is linked with communication skills. Imitation skills are important for the acquisition of general developmental skills as well making imitation intervention crucial to include in early intervention for children with ASD [26].

Echoic imitation

An echoic is a verbal behavior that refers to the imitation of someone else's verbal behavior. It's useful for parents and teachers to model desired responses [27]. Children with language delays can be treated by using echoics as stimuli [28]. Researchers use alternative methods for non-verbal children, such as rapid motor imitation training and stimulus-stimulus pairing procedures [8]. In rapid motor imitation training a child is taught to imitate with the help of several motor actions and then reinforced to continue it [29,30]. One study found that the number of echoics significantly increased during the rapid motor imitation condition among non-verbal children compared to the control group [31,32]. Sundberg, et al., [33] demonstrated the benefits of stimulus-stimulus pairing procedures to increase vocal behaviors. Rader, et al., [34] implemented this same procedures founding a significant increase in vocalizations for nonverbal children with autism.

Applied Behavior Analysis (ABA) has been repeatedly shown to be effective at reducing symptoms of autism and improving adaptive behavior, language and cognition [33-37]. One of the persistent questions in the literature is why do some children with autism demonstrate developmental improvements as a result of being exposed to ABA and some children fail to improve? One possible answer is that the children who make developmental progress after receiving ABA early in their lives may have different skills at baseline. The current study was conducted to identify baseline characteristics predictive of intervention efficacy. There are many baseline factors that could be considered. Since delayed language is one of the key symptoms of autism, language skills might provide a clue as to the most likely answer. It is also possible that children diagnosed with ASD with higher cognitive or language ability will be more responsive to ABA early intervention.

The current study

The current study was conducted to examine why some children with autism improve as a result of being exposed to ABA and some children fail to improve. It is possible that children diagnosed with ASD with higher cognitive or language ability will be more responsive to ABA early intervention. Since delayed language is one of the key symptoms of autism, it is reasonable to suspect that baseline language ability may be predictive of intervention effectiveness. More specifically, a prerequisite to language, imitation, may be a key skill. The current study tested these three possible candidate predictors: Cognitive development, general language development and imitation.

Hypotheses

Hypothesis 1: Toddlers with autism who have greater reduced scores on the Childhood Autism Rating Scale-second edition (CARS-2) after ABA intervention will have higher Bayley cognitive scores prior to the intervention than those who have less or no reduced scores on the CARS-2.

Hypothesis 2: Toddlers with autism who have greater reduced scores on the CARS-2 after ABA intervention will have higher Bayley language scores prior to the intervention than those who have less or no reduced scores on the CARS-2.

Hypothesis 3: Toddlers with autism who have greater reduced scores on the CARS-2 after ABA intervention will have higher vocal imitation (echoic behavior) skills prior to the intervention than those who have less or no reduced scores on the CARS-2.

Hypothesis 4: Toddlers with the highest pretest vocal imitation (echoic behavior) will show high scores on the Post-test Bayley language after the ABA intervention.

MATERIALS AND METHODS

Participants

Participants in this study included 168 children who had been diagnosed with ASD ranging in age from 21-40 months at enrollment (m=28). 25 participants were removed due to missing data leaving 143 participants with complete scores. Participants came from families whose Fix parentheses: English (52%), Chinese (29%), Spanish (17%). There were 118 males and 25 females in the study sample. The children in this study were enrolled in an ABA center-based program in which they received intervention based on the principles of ABA.

Prior to enrollment, the children were tested with the Bayley Scales of Infant and Toddler Development-third edition (BSID), the Childhood Autism Rating Scale-second edition (CARS-2) and the Verbal Behavior Milestones Assessment and Placement Program assessment (VBMAPP) [38-40]. Each was administered by a psychologist (in the case of the BSID and CARS-2) or special educator (VBMAPP). Prior to "aging out" of the program, the children were again tested with all three instruments. Thus, there are pre- and post-intervention scores on the three sets of measures.

Assessment instruments

Bayley Scales of Infant Development-third edition (BSID): The BSID are derived from the Bayley Scales of Infant Development and were revised as The Bayley Scales of Infant Development-second edition (BSID-II) [38,41,42]. The Bayley-III evaluates infant and toddler cognitive, language and motor development by direct observation and probing with graded tasks. These scales show good predictive validity with the WPPSI-III [43]. In addition, the Bayley-III includes parent-rating scales that a parent can use to rate an infant's social-emotional and adaptive behavior. The results reported in this study are based on the cognitive and language scales.

Verbal Behavior Milestones Assessment and Placement Program (VBMAPP): The VBMAPP is an instrument that is used to assess language and related behavioral milestones using ABA principles [40]. It is widely used with children diagnosed with developmental disabilities and autism. The VBMAPP is a criterion-referenced assessment that can generate quantitative data. Each child is tested on a variety of behavioral domains necessary for the acquisition of language and social skills. These include tacts, mands, echoic, imitation and other skills. Each child is observed and queried, using this rating scale with several different prompts to assign a score. The VBMAPP provides three summary scores: (1) Milestones, (2) Barriers and (3) Transitions. Milestones are the rating on each of the separate (behavioral) domains. It represents 170 language and

social milestones across three developmental levels. The VBMAPP tracks over 1,000 skills that support the milestones and is used to record and track a child's progress. Therefore, milestones can be measured quantitatively to document learning as an outcome for research purposes. The higher the milestone score, the better the child's progress. It is expected that the child who is responsive to intervention will have a milestone score that increases as a result of intervention because the behavioral domains represent intervention targets. The barriers assessment of 24 language and learning barriers is based on rating the child's behaviors that interfere with or challenge the child's ability to achieve milestones. The barriers score is expected to decline as a result of intervention if the child is responsive to the intervention. The transition assessment identifies the skills needed for a successful transition to less restrictive learning environments. It is expected that the transition score will increase if the intervention is successful. It is used to measure participant's progress and the effectiveness of the intervention. A scoring manual serves to guide the observer who evaluates the child at the beginning of the program and upon exiting it. This study only examined selected milestone scores. The current study only focused on verbal imitation (echoic), imitation and vocal behavior milestones taken from the VBMAPP [44].

Childhood Autism Rating Scale-second edition (CARS-2): The CARS-2 is a revision of the Childhood Autism Rating Scale [39]. It is a 15-item rating scale used by the examiner to determine whether the child has problems with sensory-motor, language, social, cognitive and other skills specific to autism spectrum disorder. It was designed to help differentiate children with specific autism symptoms from children with other developmental disorders. Originally developed in 1971, it is one of the instruments that has been reliably used to identify children with autism [45]. The CARS developers reported an excellent internal consistency reliability index of 0.94, good inter-rater reliability of 0.71 and reasonable test-retest reliability of 0.88. Clinical ratings during a CARS assessment were correlated with CARS scores to establish a criterion validity indicator of 0.81, a reasonable validity index. A concurrent validity study reported high agreement between the CARS-2 and the Autism Diagnostic Observation Schedule-Generic (ADOS-G) [46]. This research team reported Cohen's kappa of 0.62, substantial agreement between the ADOS-G and the CARS-2. Chlebowski, et al., [47] reported similar results. Children who had raw scores below 30 were considered not to have autism while those who scored 30 or above were described as having autism [48].

Procedures

Children were referred to the early intervention center-based ABA program at a community-based early intervention program in New York city after admission to the New York state Early Intervention Program (EIP). Children were assigned to an ABA classroom program based on their Individualized Family Service Plan (IFSP). Each IFSP is developed with representation from the family, the evaluation team and an Early Intervention Official Designee (EIOD). The IFSP mandates the quantity and frequency of each service for an eligible child. Beginning with enrollment, each child was tested by a licensed psychologist using the BSID, third edition and the Childhood Autism Rating Scale, second edition (CARS-2). The Bayley-III subscales administered were the cognitive, receptive and expressive language and the fine and gross motor scales. The social-emotional and adaptive behavior scale was administered by interviewing the parent. The VBMAPP was completed by the teaching staff after observing the child. Just prior to leaving the program they were again administered the Bayley scales, CARS-2 and the VBMAPP.

The Early Intervention Program (EIP)

The program where this study was conducted is an early intervention center that serves children with autism spectrum disorders and other developmental disorders from 18 months to three years of age. Children attend the program 5 days a week for 2 hour sessions each day. The program observes typical school holidays and is closed for religious holidays. The average number of hours of intervention each participant received was 292.74 (Standard Deviation (SD)=174.75).

The program follows a least restrictive environment model that offers many learning opportunities in a variety of settings such as individual instruction sessions and group activities occurring in the classrooms along with activities occurring in local community settings. This provides children with the least restrictive type of support necessary to learn. The center staff use applied behavior analysis procedures such as those developed by Baer, et al., [46] to train paraprofessionals in implementing teaching procedures with procedural integrity. An integral part of the treatment plan for the enrolled children was based on these principles to guide the process of assessing, designing and implementing skill acquisition and challenging behavior reduction procedures. The staff used individually based teaching methods to teach each child new skills. The teaching staff provides appropriate teaching methods for each child. The methods used for the child are based on observations and assessments. Teaching begins at the child's skill level to build mastery, independence and foundation skills. Teaching focuses on developing the child's skills in all developmental domains including, cognitive, social, behavioral, motor, language and adaptive. Teaching occurs in a one-to-one format with small group and whole group learning activities throughout each session.

The traditional instructional approach in the program uses the principles of Discrete Trial Teaching (DTT). This method isolates skills into smaller component sub-skills taught intensely with frequent delivery of reinforcement and the repetition of teaching trials. Children in the classroom are taught essential foundation-level skills. The approach assumes that students in the classroom will benefit from intensive, structured, one-to-one instruction.

RESULTS

To establish that the ABA early intervention program produced changes in the toddlers' tested behavior, each of the behaviors of interest was examined to determine whether they had changed from the pretest to the posttest. Table 1 shows the results of pre-testing and post-testing scores for CARS-2, VBMAPP milestones, Echoic imitation, Motor imitation, Vocal behavior; and Bayley Cognitive and Language subscales (Table 1).

Table 1: Summary statistics for dependent variables (n=143).

	Pretest mean	Pretest SD	Posttest mean	Posttest SD	t test	p
CARS-2	32.92	7	28.78	8.5	7.11	.000
VBMAPP milestones	26.9	20.79	74.95	42.14	17.96	.000
Echoic imitation	2.45	3.03	4.29	3.65	4.07	.000

Vocal behavior	1.92	1.66	3.85	1.78	14.27	.000
Motor imitation	2.43	2.69	5.85	3.07	6.12	.000
Bayley cognitive	76.68	15	86.65	13.16	9.62	.000
Bayley language	61.69	16.12	78.09	19.86	14.09	.000

Note: SD: Standard Deviation; t: T-Test; p: Probability value; CARS-2: Childhood Autism Rating Scale-second edition; VBMAPP: Verbal Behavior Milestones Assessment and Placement Program.

To test the differences between pretest and posttest scores, correlated t-tests were calculated for each behavior. As can be seen in Table 1, all the t-tests were statistically significant at $p<0.001$. The CARS-2 scores decreased significantly while all of the other measures increased. It should be noted that the mean CARS-2 score on the pretest was 32.92, indicating that the group as a whole was above the cutoff criterion of 30, while the mean CARS-2 posttest score was 28.92 indicating that the group as a whole was below the autism cutoff criterion. The three sub scores on the VBMAPP all showed statistically significant improvements. The mean BSID cognitive scores on the pretest were in the borderline range but increased to the average range on the post-test. The mean BSID language scores were in the Low range on the pretest and increased to the borderline range on the post-test.

The sample was stratified according to the amount of change in the CARS-2 score between the pre-test and post-test. Children were arranged in rank order from greatest difference to smallest difference. The children were then grouped into 5 groups according to the size of the difference in Standard Deviation (SDs) they had changed, using the standard deviation of 10 as the measure of change. These groups ranging from 1 or more SD change to no change, as illustrated in Table 2.

Table 2: Distribution of children with reduced Autism Spectrum Disorder (ASD) symptoms.

Group name	Change in score	N changed	Proportion changed
1	1 or more SD	27.5	19.23%
2	½ SD	28.6	20.00%
3	¼ SD	24.2	16.92%
4	0 to ¼ SD	23.09	16.15%
5	Least or no change	39.59	27.69%

Note: SD: Standard Deviation; N: Number.

Hypothesis 1 predicted that toddlers with autism whose scores on the CARS-2 had larger reductions after ABA will have higher Bayley cognitive scores prior to the intervention than those who have less or no reduced scores on the CARS-2. To test hypothesis 1, a one-way ANOVA was conducted comparing the 5 groups for Bayley cognitive pretest scores. This analysis showed that, although there were some apparent differences between the five groups there was no significant difference between the groups ($F(4,137)=0.365$, $p=832$). These results are shown in Figure 1.

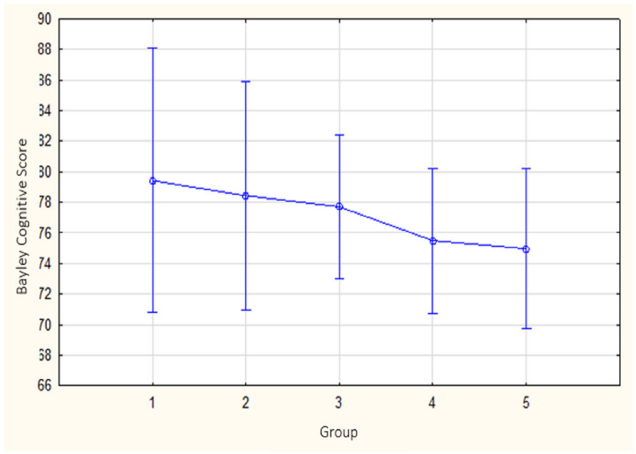

Figure 1: Effect of baseline Childhood Autism Rating Scale-second edition (CARS-2) scores on treatment outcome.

Hypothesis 2 predicted that the 5 groups would vary in pretest Bayley language scores. An Analysis of Variance (ANOVA) conducted showed no significant difference among the 5 groups ($F(4,134)=1.209$, $p=0.34$). This is illustrated in Figure 2.

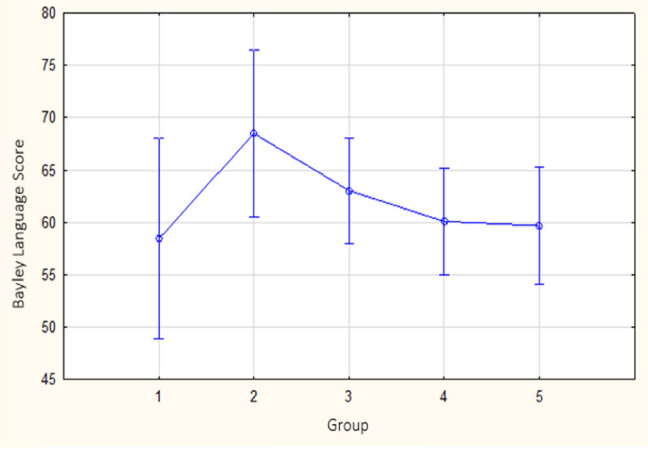

Figure 2: Effect of baseline Bayley Scales of Infant and Toddler Development-third edition (BSID) language scores on treatment outcome.

In order to test the third hypothesis, a mixed model repeated measure ANOVA was conducted comparing the 5 groups for two types of pretest vocal behavior (Echoic and Vocal). The comparison between echoic and vocal behavior was made to test whether echoic behavior in the pretest differentiated the groups from vocal behavior which was not imitative. This analysis revealed a statistically significant interaction between the CARS difference groups and the two behaviors ($F(4,137)=2.721$, $p=0.0321$). This interaction is illustrated in Figure 3.

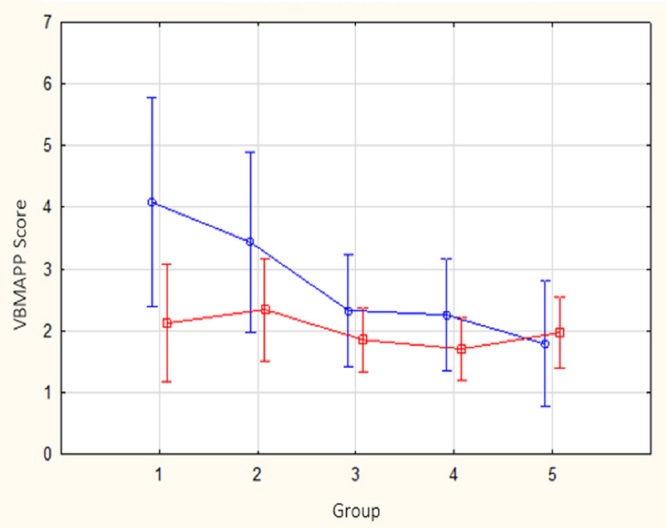

Figure 3: Effect of baseline echoic and vocal behavior scores on treatment outcome. **Note:** (): Echoic behavior; (): Vocal behavior.

A Duncan post-hoc test was conducted to evaluate the difference between echoic and vocal behavior among the 5 groups. Results for groups 1 and 2 revealed that echoic behaviors were statistically higher than vocal behavior ($p<0.01$ and $p<0.02$ respectively), while none of the other comparisons showed significant differences.

The results of the one-way ANOVA of pretest vocal behavior from the VBMAPP were not statistically different across the five groups ($F(4,137)=0.46$, $p=0.77$). Similarly, the one-way ANOVA of pretest motor imitation from VBMAPP across five groups was not significant ($F(4,137)=0.97$, $p=0.43$).

DISCUSSION

The current study examined a set of hypotheses to determine the relationship between pre-intervention echoic imitation and reduction of autism symptoms in a culturally diverse community-based early intervention program. All toddlers who were diagnosed with autism in this study were exposed to an ABA early intervention. The scores on CARS-2, VBMAPP milestones, echoic imitation, motor imitation, vocal behavior, Bayley cognitive score and Bayley language score were recorded and compared prior to and after attending ABA training. The children were divided into 5 groups based on the degree of reduction in autism symptoms represented by CARS-2 scores. In the first three groups, those who had already developed early echoic behavior showed the most significant reduction in symptoms of ASD after ABA compared to non-echoic vocal behavior.

The previous literature has shown that the techniques that incorporate ABA (the verbal behavior approach) can increase verbal and non-verbal communication skills in children with ASD [49,50]. While analyzing the association between imitation and autism, one study found their indirect relationship i.e., children with low autism severity have good imitation skills and vice versa. In addition, Espanola, et al., [51] found that expressive and receptive language correlates with vocal and facial imitation.

One study that surveyed past literature reviewing published papers in ABA-focused journals from 2001 to 2017 found that only 2% of research was focused on echoics while the majority of research was dedicated to mands (53%), tacts (33%) and intraverbals (23%) [52]. This review showed a serious gap in the literature on language interventions for children with ASD. There has been very little focus on the study of echoics. We maintain and the current study supports, that echoics are extremely important in the development of language, especially in children with ASD. The findings of the current study uncover the direct impact of early echoic skills on the language and communication development of children with ASD as well as possibly its key role as a necessary condition for language development in children with ASD.

Using the current study as a basis, it would be important to test whether directly teaching echoic skills in toddlers diagnosed with ASD would have the same effects as the benefits seen with naturally occurring echoic skill development. If that were the case, then it would be crucial that assessment of echoic skills and intervention to teach echoics would be essential in any early intervention effort with young children who have ASD. In two single-subject experiments, Ross, et al., [31] and Bridges [53] investigated whether increasing non-verbal imitation would also increase the use of echoics. Both of these studies found positive support for their hypothesis. Teaching non-verbal imitation served to increase their participant's use of echoics. However, in both cases the children were older than three years of age. What remains to explore is whether this method or any other method, could be used to increase the echoics in toddlers with ASD. It might also be important to analyze how much teaching of echoic imitation is required to yield the maximum effective outcome for the language skills of children with ASD.

Recently, a study provided 30 sessions of verbal and echoic communication skills intervention for children with ASD ranging in age from 1 to 17 years, n=23 [54]. The researchers presented teaching with two different methods: online, using computer-supported therapy (e.g. an Alexa dot device) or using human therapists. They found no significant difference in echoic imitation skills between the two modes, though both were successful in stimulating verbal and echoic communication skills. Treatment modality and curriculum should also be considered. In addition, how parents or caregivers can be taught to provide echoic imitation skills at home could be explored.

Future research might include longitudinal studies to examine the development of language skills as an outcome of teaching echoic communication skills in children with ASD. Children with high baseline echoic skills no longer met the cut-off score on the CARS-2. These results indicate that echoic skills may ameliorate ASD symptoms. Therefore, a diagnosis of ASD could be made after receiving echoic intervention. Alternatively, early intervention programs for children with ASD should include assessment of echoic imitation.

CONCLUSION

The current study showed that early echoic (vocal) imitation is an important factor of speech and language in toddlers while reducing the symptoms of ASD compared to early motor imitation and non-echoic vocal behavior. These results held for the three groups that showed the greatest reduction in symptoms of ASD. Additionally, the children who had the greatest reduction in symptoms of ASD showed the highest level of pre-intervention echoic behavior and the largest difference between echoic behavior and non-echoic vocal behavior. The findings suggest that early echoic behaviors

are particularly predictive of ABA efficacy. Early intervention may want to focus on increasing echoic behavior in toddlers showing early signs of ASD. The previous studies supported the effectiveness of ABA therapy in reducing symptoms of autism, but this study indicated the importance of early echoic imitation which can give promising results in the improvement of language development among children with ASD.

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