

DEVELOPMENT OF PRELINGUISTIC SKILLS IN A CHILD WITH ASD THROUGH ABA-VB. A CLINICAL CASE

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Abstract

Children with autism spectrum disorder (ASD) often face challenges developing prelinguistic skills, delaying or preventing language acquisition. This study used an Applied Behavior Analysis and Verbal Behavior (ABA-VB) approach to teach six pivotal prelinguistic skills to a 3-year-old with ASD. The six skills include the speaking skills of (1) pointing, (2, 3) generalized imitation with and without objects, and (4) producing vocalizations; and the listening skills of (5) joint attention and (6) following simple instructions. Each of these skills were developed in independent teaching programs that included a pretest, intervention with different prompt fading phases, independent posttest, and generalization and maintenance tests. Programs were implemented through discrete trial training (DTT) in 1.5-hour sessions, 4 days a week. After a six-month intervention, the child met the acquisition criteria for all six skills. The skills were generalized with other materials, people, and contexts, and were maintained over time. Results support the effectiveness of ABA-VB for teaching prelinguistic skills and developing pivotal behaviors that promote the learning of more complex verbal skills in children with autism.

Keywords: Applied Behavior Analysis (ABA); Autism Spectrum Disorder (ASD); development milestones; prelinguistic skills; Verbal Behavior (VB).

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder defined by a series of persistent limitations in communication and social interaction, as well as the presence of restricted behavior and interests. It is listed in the DSM-5-TR as a Neurodevelopmental Disorder (APA, 2023), along with intellectual disability and communication disorders. While each individual with ASD is different, people with ASD have difficulties with emotional reciprocity, nonverbal communication, and understanding social relationships. Failures in initiating social interactions or sharing interests, difficulty establishing eye

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contact, and absence of facial expression are all symptoms. Individuals with ASD display repetitive behaviors at the motor level (stereotypes) or in speech patterns (echolalia), are excessively rigid in routines or rules, have restricted interests, and respond to sensory stimuli with high or low reactivity (APA, 2023). There has been a significant increase in the prevalence of ASD in the last half century (André et al., 2020), and it affects roughly 1% of the global population (Zeidan et al., 2022).

Autism and communication

This study focuses on the communication difficulties of individuals with ASD. Typical language development has two stages: the prelinguistic communication stage (between birth and first words) and the linguistic communication stage (after the acquisition of first words). Prelinguistic communication includes the use of gestures, eye contact, joint attention, and the emission of vocalizations. Children with ASD develop these skills with difficulty. These prelinguistic skills are related to later language skills (Crais & Ogletree, 2016). A longitudinal study by Rowe and Goldin-Meadow (2009) concluded that the use of gestures - and their combination with speech - at 18 months is a strong predictor of vocabulary and lexical skills at 42 months.

The development of prelinguistic skills occurs through imitation, which is also key in the acquisition of linguistic, instrumental, symbolic, and play skills (Escorcía & Bauxauli, 2012). Imitation skills can be divided into imitating actions with objects and without objects (*i.e.*, gestures), as well as imitating actions with semantic meaning (*e.g.*, the “hello” gesture) and without semantic meaning. Children with ASD have difficulties with all of these imitation skills. Early research with “retarded” children showed that imitation skills could be taught through discrete trials in which a model raised his arms and said, “Do this”, helping children raise their arms and immediately giving them a reinforcer (Baer et al., 1967). Lovaas (1981) taught autistic children imitation of distinct behaviors, then mixed the behaviors and built on them to teach more complex behaviors. The use of discrete trials and teaching imitation continues in contemporary research (*e.g.*, Bravo and Schwartz, 2022). One study of 60 children with ASD found that their highest-performing imitation skills involved actions with objects (Española & Gutiérrez, 2019). Teaching imitation skills can have generalized effects. For example, object imitation training spontaneously increased the vocal imitation repertoire of a subject in one study (Ishizuka & Yamamoto, 2021). Extending this finding, it is possible that learning imitation facilitates vocal reproduction.

Imitation skills are mediated by joint attention, or the ability to share experiences with others. As with imitation skills, joint attention skills are also affected in people with ASD. Joint attention is demonstrated when a child alternates their gaze between another person and an object, such as when they pick up a toy and show it to an adult (Escudero et al., 2013). Escorcía and Bauxauli (2012) observed that children with more joint attention also imitated more frequently and had more language. This finding supports the idea that joint

attention makes it possible to perform imitation tasks and get involved in social interactions - situations that are essential for acquiring language. Krstovska-Guerrero and Jones (2013) began teaching joint attention to children with autism by getting their attention with toys placed at the therapist's eye level to encourage eye contact. Later, they placed the toys a meter and a half from the children and pointed to the toys while saying, "look." The therapists guided the children's gaze with a finger from their eyes towards the toys, then they gave the children a social reinforcer and the toys.

Imitation and joint attention are "pivotal" skills for the development of language. Once they are established in a child's repertoire, they produce advances or changes in other behaviors. In other words, they make it easier for the child to expand their opportunities for interaction with the environment and the development of new skills based on already-acquired skills (Cooper et al., 2019). Knowing (a) the importance of imitation and joint attention in prelinguistic communication and (b) the difficulties with imitation and joint attention that children with ASD have, it becomes clear that methodologies supporting the development of these skills in children with ASD need to be researched and shared. Once imitation and joint attention are learned, children can develop other prelinguistic skills, language behaviors, and more complex language and communication skills.

Intervention models

Having established the importance of imitation and joint attention, the intervention method for developing those skills in children with ASD should be considered. Interventions with the greatest empirical support are individualized programs with a behavioral orientation that promote socio-communicative skills and family interaction. Best practice guidelines for treating people with autism also recommend intervention programs be structured, intensive, and in different environments to help maximize generalization (Barthélémy et al., 2019). The combination of Applied Behavior Analysis (ABA) and Verbal Behavior (VB) perspectives in an ABA-VB approach is particularly appropriate for developing prelinguistic skills.

Applied Behavior Analysis (ABA) is a popular methodology that applies general principles of learning psychology and behavior modification for the modification, maintenance, and generalization of behavior. In addition, it is focused on the development of socially relevant behaviors including communication; autonomy; and academic, playful, and social skills (Colombo, 2018). The ABA approach has been shown in numerous studies to help children with ASD improve their IQ, language and adaptive behavior, communication, and socialization (Yu et al., 2020). The improvements achieved through ABA are also superior to those achieved through eclectic treatments (Will et al., 2018). Individual programs based on ABA adjust to the individuality of each case, so they can vary in terms of duration, hourly intensity, or objectives set (The Council of Autism Service Providers, 2021). Programs can also implement different techniques (Mebarak et al., 2009), though the most common form of

ABA training is through Discrete Trial Training (DTT). DTT follows a structure comprised of: stimulus, agreed prompt, response, consequence, and waiting interval between trials. It is especially useful for teaching new behaviors, such as motor or speech skills (Smith, 2001).

Other characteristics of ABA are a before-intervention operationalization of behaviors to establish teaching goals, positive reinforcement, and data collection (Colombo, 2018). Positive reinforcement rewards behaviors that reflect teaching goals. But a behavior that is continuously reinforced cannot be considered an acquired behavior. According to the principles of learning, an acquired behavior meets the conditions of maintenance (it repeats over time without the need for artificial reinforcers) and generalization (it is shown in different contexts, with other people and materials) (Martin & Pear, 2008). Data collection is needed to assess the acquisition of behaviors. An acquired behavior can be operationalized as a behavior that is performed correctly 80% of the time in two consecutive sessions (Bravo & Schwartz, 2022). Data collection in ABA therapy provides graphical representation of the evolution of a behavior (McHugh et al., 2010). These data help determine whether there is an improvement, stagnation, or regression in learning, thereby guiding the fading of prompts and phase changes (teaching, generalization, and maintenance) (Lovaas, 1981).

As with ABA, reinforcement is key to a Verbal Behavior (VB) approach, which places focus on functional language and its elements. When a person emits a verbal response, it has consequences in the environment and is reinforced, as when a baby receives food after crying (Skinner 1957). Thus, there is a speaker who performs a behavior and a listener who reinforces it. The speaker's behavior is mediated by the consequences that verbal behavior causes in the context (Centeno & Dellagiovanna, 2019). Skinner (1957) defined six forms of verbal behavior as "verbal operant" - key to development of language and communication. The present study focuses on the mand and echoic forms of verbal behavior.

A mand is a type of response that is under motivational control, where the speaker requests a desire (*e.g.*, asking for water). It is the earliest operant in development and is essential for communicating needs and understanding the speaker-listener relationship. In a study by Drasgow et al. (2016), three children without language guided the researcher's hand towards food or pointed to it as a form of mand when they could not reach the food, suggesting that these gestures precede verbal mands. The children were trained to ask for "more" and say "please" under a methodology in which, when the food was out of reach, the therapist gave physical help to the children to perform the sign to make mands, followed by a reinforcer.

Echoic behavior occurs when the speaker repeats a word, phrase, or vocalization emitted by another person, making an "echo" of what has been heard. To promote spontaneous vocalizations and coinciding echoes, the counter-imitation of vocalizations in the first months of life (repeating sounds

made by babies) has been found to increase the production of vocalizations in children at risk of ASD (Neimy et al., 2020). In another study of echoic behavior, Shane (2016) taught a two-and-a-half-year-old girl to generalize the echoic ability through phased training. Initially, any vocalization was followed by a reinforcer in order to increase its rate. Next, vocalizations were reinforced differentially to increase the diversity of sounds emitted. Finally, the therapist emitted some of the sounds that the child usually used, reinforcing similar sounds until the child managed a perfect echoic sound (Shane 2016).

Both mands and echoics are ideal types. They often overlap and develop together. For example, Aktaş and Ciftci-Tekinarslan (2018) trained parents of three children to use echoics to train the acquisition of mands. During play sessions, parents asked their children questions such as, “What do you want?” In this way, the parents acted as models for their children to use echoics to say the name of the desired toy, then receiving the toy as a reinforcer.

Considering (a) the importance of developing prelinguistic skills such as imitation and joint attention in children with ASD and (b) the effectiveness of ABA and VB interventions among children with ASD, the current study presents a unique case implementing ABA-VB methodology to improve prelinguistic skills in a child with ASD.

Objective

The general objective of this study is to test intervention techniques derived from an Applied Behavior Analysis and Verbal Behavior perspective in the development of prelinguistic skills (pre-speaking and listening) in a child with ASD. Can the student learn pre-language skills if they are taught following an ABA-VB methodology? If so, this study would support other researchers (*e.g.*, Drasgow et al., 2016; Wang et al., 2023) and clinicians in implementing an ABA-VB approach to help children with ASD acquire prelinguistic skills.

To assess the development of prelinguistic skills, the general objective is divided into two areas with six specific objectives, shown in Table 1. Each specific objective was selected based on the milestones of language development in neurotypical children. In addition to defining the particular objectives of this case study, Table 1 highlights the goals other prelinguistic programs should aim to achieve.

Table 1. Specific prelinguistic teaching objectives derived from development Milestones and Verbal Behavior Theory

Speaker behavior	Listener behavior
1. Increase pointing to make requests.	5. Increase joint attention.
2. Increase motor imitation with objects.	6. Follow simple instructions.
3. Increase motor imitation without objects	
4. Increase spontaneous vocalizations and vocal imitation (echoics).	

Method

A case study (N=1) of a three-year-old boy with ASD and no verbal skills is presented. The research follows an AB design comprised of the baseline and treatment phases.

Participants

The participant was three years and eight months old at the beginning of the assessment, which coincided with the beginning of his regular schooling (children in Spain begin school the first fall they are three years old). He left for school with his parents and two older sisters in the mornings, and he had Therapeutic Pedagogy and Hearing and Language support at school. He did not take medication or have any relevant medical history, and his diet and sleeping routines were normal. He did not have bowel or bladder control. He began receiving therapy at the age of 2, though his parents reported the therapy produced no significant changes in his behavior, including in the area of language. The parents' reason for initial consultation was the development of language at an expressive level.

Measures

Skill assessment. To assess the child's progress, a pre-post methodology was implemented using the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008). The instrument measures a child's skill level, learning barriers, and transitions through different assessments. The present study used Level 1 of the Milestone Assessment and the Barriers to Learning Assessment. Each assessment was used (1) at baseline to assess the child's skills and establish the relevant objectives, and (2) six months later to observe the results of the intervention. The Milestone Assessment contains 170 learning and language milestones distributed in three age groups according to typical development. Level 1 Milestones-generally associated with the first age group, up to 18 months-evaluate mands and tacts, listening skills, visual perception, play, social behavior, imitation, echoes and vocalizations. Each skill is comprised of five items, and each item is scored as 0, 1/2, or 1. When a child passes all five items of a skill with full credit, the child moves on to the next level of that competency. The VB-MAPP Barrier Assessment provides information on 24 barriers to learning and language acquisition with 24 Likert scale items that describe the child's behavior, where 0 indicates the absence of learning barriers and 4 indicates the need for formal intervention to eliminate this barrier.

Preference assessment. To efficiently identify and apply reinforcers, the parent's interview included questions about the child's preferences. To specify reinforcers, stimulus pairwise trials (Fisher et al., 1992) and free operant observation in an artificial context (Pace et al., 1985) were used. During the child's initial arrival at the center and during the first bonding sessions, he was given different stimuli in groups of two. His preference between the stimuli was recorded. To assess new interests, observation intervals were carried out

periodically throughout the intervention. Different stimuli were distributed around the room, and the therapist took note of which objects he paid more attention to.

Data registration method. During the intervention, the therapist recorded how often the target behaviors occurred. In blocks of ten response opportunities, the times that correct and incorrect behavior occurred were noted. The achievement criteria for learning acquisition was 80% or more correct behavior responses of the child in two consecutive independent sessions.

Procedural integrity. A record of the integrity of the procedure assessed the effectiveness with which the therapist developed the sessions. It was developed based on the indications for the application of DTT by Smith (2001) and Lerman et al. (2016). The aim was to evaluate whether the intervention followed the agreed structure, was presented without distractions, and used appropriate materials. For the validity of the study, it was also important that the corrections and prompts were given as agreed and after a sufficient margin of time. It was also observed whether these trials were followed by a powerful, immediate reinforcer and for an adequate time. In general, the therapist's efficiency in establishing a bond, keeping the work area free of distractions, and being quick in taking data and changing materials was examined. This record was completed by an ABA observer therapist at the beginning and end of the intervention (after six months).

Interobserver agreement (IOA). To assess whether the target behavior for the child was well-defined and consistently recorded, an interobserver agreement record (IOA) was developed and applied at different moments of the intervention, as the programs were introduced at different times. Also, definitions of behaviors varied between the two measures of IOA, as learning phases for programs progressed over time. Two observers filled in a chart indicating whether the target behavior had occurred after the presentation of the stimulus a total of 20 times during the session. A simple occurrence agreement procedure was used, adding the number of times in which both agreed, divided by the number of total behaviors observed. The percentage of agreement is acceptable when it reaches 80%, although 90% or higher is preferable (Miltenberger, 2017), indicating that the defined behavior is clear and objective.

Procedure

Assessment and intervention were based on ABA-VB methodology and were carried out during the child's usual therapy sessions at a center he attends 6 hours a week. The center specializes in the treatment of autism and other disorders through Applied Behavior Analysis. An informed consent at both the initial assessment and subsequent intervention authorized data collection and the use of this data for publication. The informed consent explained the objectives of the study, the data to be collected, and the rights of the participant (and his parents), including the right of revocation. The study was approved by the ethics committee at the Rey Juan Carlos University.

Each of the six speaking and listening skills had a corresponding teaching program. Programs established a variable level of prompt to facilitate learning, though prompts faded to independent performance over time. Similarly, the number of stimuli and units presented in each program followed a progressive increase in quantity and difficulty. Programs used continuous reinforcement (fixed ratio of 1), so each correct response of the child was reinforced. This helped ensure a high response rate and a better understanding of the systematicity of the trials. Incorrect responses resulted in the child being corrected as agreed (physically, verbally, etc.) and not being given any reinforcer. Programs were divided into phases of increasing difficulty. Each phase included at least 40 rehearsals to train the skill (10 rehearsals in 4 sessions). After this training, the child needed to respond correctly to 80% of the prompts in two consecutive sessions before beginning the next phase. This criterion is somewhat conservative because of the high level of learning barriers that the child manifested. The last phase of each program was for the child to execute the skill without prompt or reinforcement. While the six skills can be divided neatly into speaking versus listening skills, the ordering of the programs was determined by which skills could build on others. Programs for (1) pointing, and (2, 3) generalized imitation with and without objects began at the start of the six-month intervention. The (4) joint attention program began after two months. After four months - by the time imitation programs were generalized - the programs for (5) producing vocalizations and (6) following simple instructions were implemented.

One of the first skills taught was the pointing skill. To begin, an object of the child's choice was presented as a stimulus. The therapist then instigated the child with a physical prompt to point at it (*i.e.*, physically directing his hand and index finger), in addition to seeking his gaze and establishing eye contact with him. When the child successfully pointed at the object, the therapist gave it to the child as a reinforcer. At the start of the program, the physical prompt was complete, but it faded over time (*e.g.*, grasping only the wrist or elbow of the child) until the child pointed independently.

At the same time as the pointing program, the therapist conducted imitation programs with and without objects. In the object imitation program, the child was taught to repeat motor actions with the use of objects. As a stimulus, the therapist verbalized, "Do this," while performing the action with the object. Again, at the beginning of the program a physical prompt moved the child's hands to imitate the therapist's actions. Eventually, this physical prompt faded away. To ensure that the child's actions were a process of imitation and not mere play, (a) two distractions were introduced into the child's visual field, and (b) new actions to be imitated were added to ensure generalization. Regarding imitation without an object, the performance of motor actions such as clapping was taught. Again, the stimulus was the therapist verbalizing, "Do this," while doing the action. Initially, a total physical prompt was given before fading over time. Gradually, new movements were introduced to imitate autonomously, such as touching the head or belly.

From the beginning of intervention, the therapist would informally bring toys to eye level to encourage eye contact. This continued in a joint attention program that began formally after the second month of intervention. The skill was systematically taught by first leaving the toy/object on the table between the child and the therapist and progressively moving it away. If the child triangulated his gaze between therapist and the object, a social reinforcer was applied, and the toy was given to the child.

Similar to joint attention, to increase the production of vocalizations, an informal program of counter-imitation of the sounds emitted by the child was implemented from the beginning of the intervention. There were no specific achievement criteria or structured recordings. Once the child had acquired the ability to imitate - four months after the start of intervention - a program of echoic vocalizations was initiated. The child was instructed to repeat isolated syllables. Sounds that he emitted naturally were used at the beginning of the program, reinforcing the first instance in which any sound was emitted. Later, approximations of the sound were reinforced until the perfect echoic was achieved. This was followed by the echoic of identical syllables chained together, such as “mama” (mom), or “coco” (coconut), building the child’s first words. In addition to this program, echoics were used as a mand function for the request for reinforcers, such as repeating “pa” to ask for plastilina (modeling clay).

Finally, a program for following simple instructions was also implemented during the fourth month of intervention. The program was established for the promotion of receptive language in the child, and initial stimuli were the instructions, “sit down,” and “give me five.” As with the other programs, the child received total physical help to guide his initial responses. For example, being taken to a chair and sat down. Physical prompts faded, and other instructions that arose in a natural context were introduced, including: “come”, “give me a kiss”, “say hello”, and “say goodbye”.

For each program, once the data suggested a skill had been learned and did not need any intermediate prompts or reinforcers, a generalization test was applied. For this test, several trials of the program were carried out, but with new units, in a different environment, and with a different therapist. If the child responded correctly at least 80% of the time to these new conditions, the skill program went into maintenance. Maintenance entailed working random and interspersed units of the skill in later sessions using a lower reinforcer rate.

Data analysis

Based on prior literature and methods for implementing similar programs, descriptive statistics comprise the bulk of this study. A pre-post comparison of VB-MAPP Milestone Assessment and Barriers to Learning Assessment scores (Sundberg, 2008) revealed the child’s progress and overall success of the program.

Specific objectives - the six prelinguistic skills - were pursued according to the teaching programs described above. The success rate of behaviors was tracked graphically across sessions, consistent with other ABA therapies (McHugh et al., 2010). Behaviors that were performed correctly 80% of the time in two

consecutive sessions (Bravo & Schwarz, 2022) were considered acquired, and prompts were subsequently faded.

Procedural integrity was measured as the therapist's success rate in implementing the procedures. Based on Smith (2001) and Lerman et al. (2016), an independent ABA observer judged the therapist across a variety of therapeutic skills. And a simple occurrence agreement procedure was used to measure interobserver agreement (Miltenberger, 2017). An independent observer rated the child's successful behaviors in a therapy session, which was then compared with the therapist's ratings of the child's successful behaviors in that same session.

Results

Preferences assessment

In a first consultation, the parents said the child only showed interest in painting and Pocoyo videos. Testing by pairs of stimuli and through free operant observation, the child was also inclined towards bubbles, balls, pilates balls, pop-it style toys, and snap-on puzzles. Subsequent evaluations added reinforcers of: modeling clay, a trampoline, cause-effect games, and sensory tubes. Social contact and tickling generated the most positive reactions from the child.

VB-MAPP

The initial assessment included a general measure of developmental milestones. The VB-MAPP Milestone Assessment indicated a very low level, with no listening or speaking skills (mands or tacts), motor imitation, or independent play. The child did show some basic visual perception skills of object tracking and grasp, as well as an interest in people. After the six-month intervention, another VB-MAPP Milestone Assessment revealed improvements in visual perception, play, imitation, being able to explore objects, match the sample, participating in games, and imitating gross, fine, and object motor actions. The child acquired the maximum score in visual perception skills, with play and imitation nearly reaching this milestone as well. In language skills, the mand of "water" (/GUA/) was only achieved with prompts after six months. Figure 1 shows these overall improvements.

	Mand	Tact	Listener	VP/MTS	Play	Social	Imitation
5							
4							
3							
2							
1							

Note: Light gray cells correspond to the results of the pre-evaluation. Dark gray cells correspond to the improved results after six months of intervention.

Figure 1. VB-MAPP Milestone Assessment tool (Level 1) (six-month difference)

In terms of learning barriers, the VB-MAPP Barrier Assessment tool revealed several problem areas before intervention, especially in areas of motor imitation, verbal and listening repertoire, matching skills and conditioned discrimination, motivational operations, and reinforcement dependency. After the six-month intervention, five of the barriers remained stable, but those related to imitation, sample matching, listening repertoire, motivational operations, and reinforcement dependency decreased drastically. Figure 2 shows the child's learning barriers pre- and post-intervention.

	Negative Behavior		Instructional Control		Mand Repertoire		Tact Repertoire		Echoic Repertoire		Motor Imitation	
4												
3												
2												
1												
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post

	VP/MTS		Listener Repertoires		Intraverbal Repertoire		Social Skills		Prompt Dependent		Scrolling Responses	
4												
3												
2												
1									NA		NA	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post

	Scanning Skills		Conditional Discrimination		Generalize		Motivating Operations		Response Weakens MO		Reinforcement Dependent	
4												
3												
2												
1					NA							
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post

	Self-Stimulation		Articulation Problems		Obsessive-Compulsive		Hyperactivity		Eye Contact		Sensory Defensiveness	
4												
3												
2												
1												
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post

Note: Light gray cells correspond to the results of the pre-evaluation. Dark gray cells correspond to the improved results after six months of intervention. Some skills have the acronym NA ("not applicable"), as they were not assessable during the first application of the tool.

Figure 2. VB-MAPP Milestone Assessment tool (Level 1) (six-month difference)

Procedure

While the VB-MAPP suggests the intervention had some positive impacts based on measurements at two points in time, the specific programs were assessed in individual sessions. The following line graphs are a record of trials from throughout the intervention. The horizontal axis specifies the session, and the vertical axis represents the percentage of correct responses when testing a skill.

The child's pointing skills were nonexistent at baseline, but he consistently performed well across each phase of this skill. As Figure 3 shows, each phase was completed in the minimum time possible (*i.e.*, 4 rehearsal sessions and at least 2 test sessions to respond correctly at least 80% of the time). In spite of the good performance, the behavior did not occur independently until two months after the beginning of the intervention. After a generalization test, the child used the behavior in different contexts and with other people, spontaneously asking for a toy, for example.

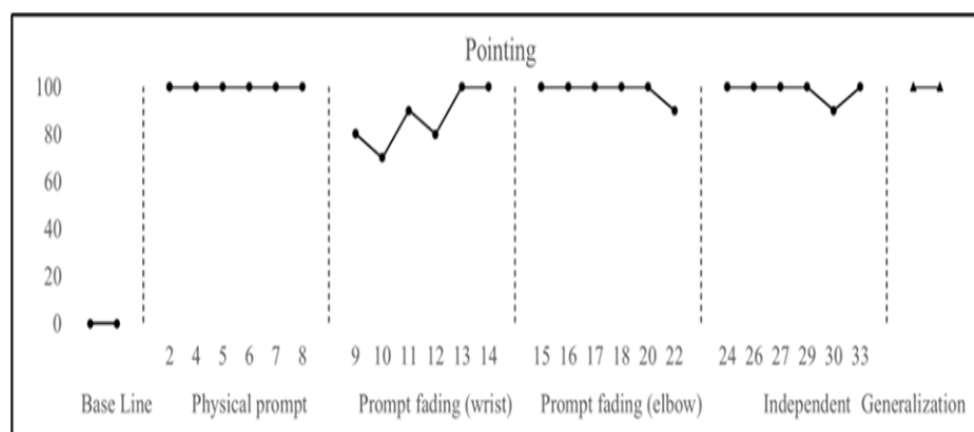


Figure 3. Pointing program. Success rate from baseline to prompt fading and independency

Object imitation phases are displayed in Figure 4. The first units of imitation - playing the maraca and piano, putting away toys, playing a xylophone, constructions, cutting fruit, and stacking cubes - were acquired after two months of intervention. Later, he was taught to turn pages, push a toy car, fit rings, move beads through a maze, and close Russian dolls. Over the course of the third month, he successfully bounced a ball, spun a Rubik's cube, and grabbed small items with tweezers. This represented 16 imitation units acquired. The child progressively increased the actions to be imitated until generalizing the learning to other units (playing other instruments, putting on a helmet, etc.). After four months of intervention, spontaneous imitations began to be observed in a natural context. From that point, the therapist only worked on the object imitation program sporadically and with a social reinforcer for its maintenance.

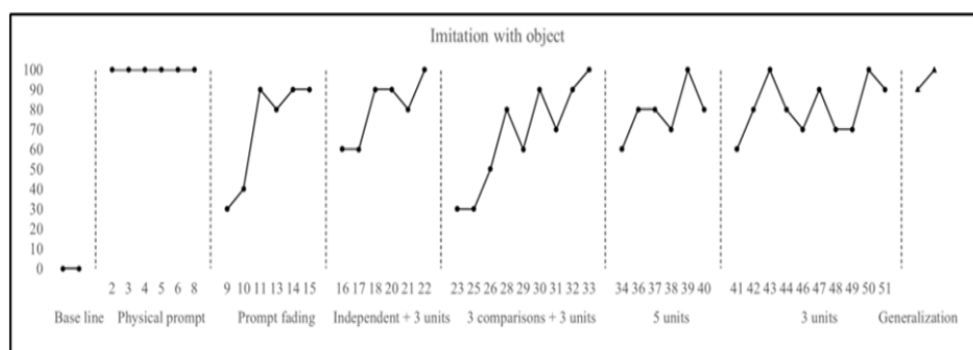


Figure 4. Object imitation program. Success rate from baseline to prompt fading and independency

Imitation without an object - shown in Figure 5 - displayed difficulties similar to imitation with an object. Initially, and at baseline, imitation of stomping was observed on occasion, but the skill was not integrated in an imitation repertory. By two months, the child had learned to imitate clapping; hitting the table; touching the floor, his head, and belly; and tapping his mouth to produce sounds. In a second phase of gestures, the child could imitate touching the wall, waving hello, and touching his legs and nose. In the fourth month, he imitated touching his ears, eyes, and palm of his hand; raising his arms; blowing; and sticking out his tongue. When the program concluded, 17 imitation actions had been acquired. Spontaneous imitations such as snapping, blowing, tapping his index fingers, jumping, and touching his foot were observed in generalized contexts. The skill continued to be tested in a maintenance format until the intervention concluded.

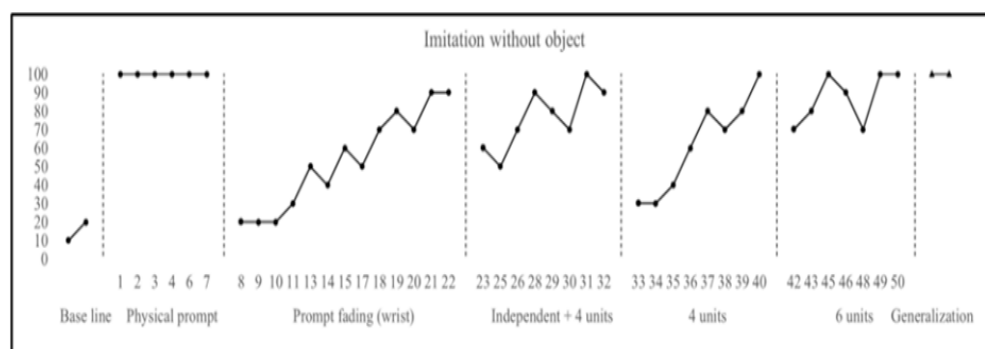


Figure 5. Imitation without objects program. Success rate from baseline to prompt fading and independency

Figure 6 shows the progress of the joint attention program. After two months of intervention, the therapist began the program informally (no data collected), bringing objects to the therapist's eye level to seek eye contact with the child. While each phase needed more than the minimum time (*i.e.*, 6 sessions), the prompts were faded, and the joint attention was acquired and generalized with other objects, people, and contexts. A skill maintenance program continued until the end of the intervention.

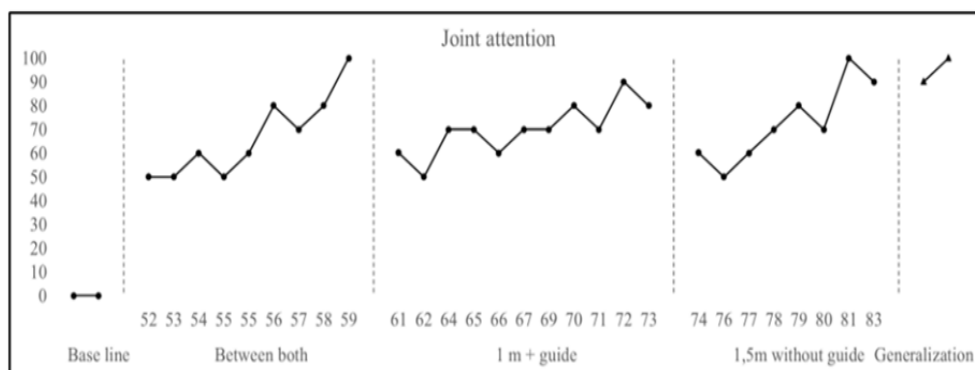


Figure 6. Joint attention program. Success rate from baseline to prompt fading and independency

From the beginning of the intervention, the therapist counter-imitated sounds that the child made. But it was not until imitation programs had been generalized after four months that the program of vocalization production and echoics began, represented in Figure 7. This program began with the reinforcement of any vocalization, and the child quickly acquired the behavior of emitting sounds immediately after the therapist. After a month, the spontaneous emission of the word “Hello” was observed upon entering the center, a word that proceeded to be trained every day and with different people. The final phase of the program concluded after three months, as the child acquired the ability to produce chained syllables (a base of building words).

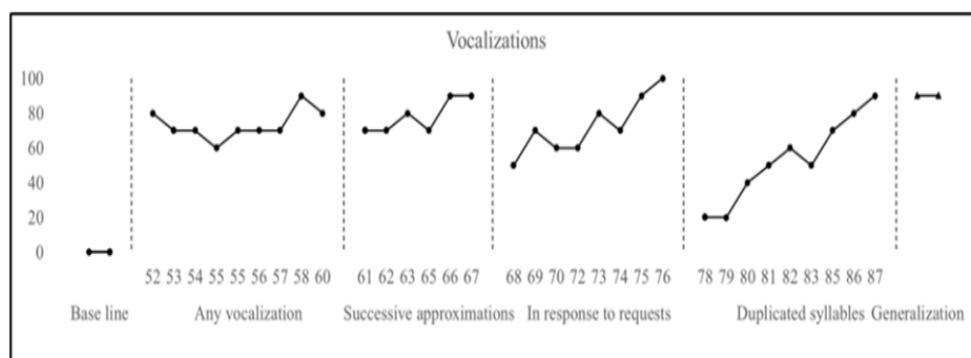


Figure 7. Echoics or vocal imitation program. Success rate from baseline to prompt fading and independency

Figure 8 represents the child’s skill at following simple instructions. He had difficulties for independent performance. For example, the “sit” instruction was followed more slowly than the “give me five” instruction of the same phase. Once these two units were acquired, though, the instructions: “come”, “give me a kiss”, “say hello” (vocalization), and “say goodbye” (gesture) were introduced. The child generalized this skill with other people and contexts, after less than two months of teaching.

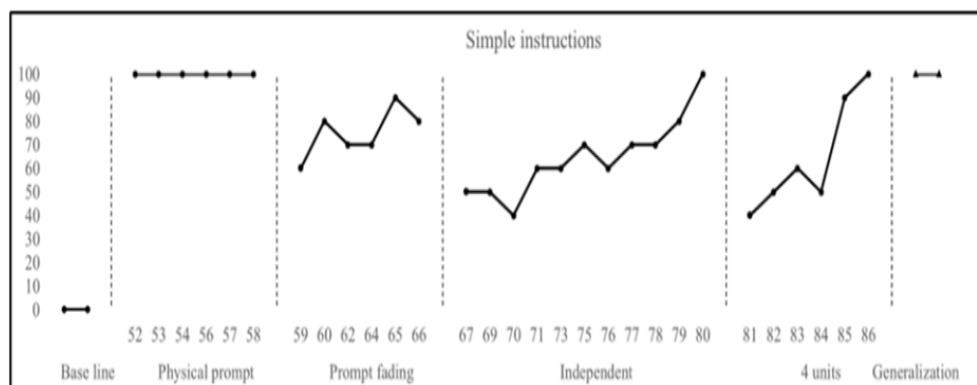


Figure 8. Simple instruction comprehension program. Success rate from baseline to prompt fading and independency

Assessing the integrity of procedures

A first evaluation of the therapist was made two months after starting the intervention. The therapist was rated highly, at least 90%, in 17 of the 21 items evaluated. Regarding the poorly-rated items, the therapist only changed the material quickly 60% of the time and only verbalized “the ... is over” when withdrawing a reinforcer 40% of the time. The therapist was trained on these last two items. At the end of the intervention, the therapist was rated as performing at 90 or 100% across all items, displaying improved performance. These results are shown in Table 2.

Table 2. Integrity of procedures. Success rate of therapist in therapeutic skills, as assessed by an independent observer

Item	2 months	6 months
<i>Course of the session</i>		
The therapist spends at least 5 minutes of the session to establishing a bond	100%	100%
The therapist is quick in taking data	80%	100%
The therapist is quick in changing material	60%	90%
The therapist follows guidelines for behavioral problems	100%	100%
The therapist keeps the workspace clean and free of distractions	80%	90%
<i>Trials</i>		
There is a time between trials greater than 5 seconds	100%	100%
There is no distracting material or stimuli during the trials	100%	100%
At least 10 trials of the program are carried out during the session	100%	100%
The trials follow the structure: S ^D - R - C	100%	100%
<i>Presentation of the stimulus</i>		
The therapist gives a clear and intelligible order or verbalization	100%	100%
Appropriate material is used	100%	100%
The number of stimuli agreed for the program is presented	100%	100%
<i>Corrections and prompts</i>		
The therapist waits for the response to be completed before giving the correction	90%	100%

Note: Adaptation according to recommendations by Smith (2001) and Lerman et al. (2016).

Table 2. Integrity of procedures. Success rate of therapist in therapeutic skills, as assessed by an independent observer - *continued*

Item	2 months	6 months
<i>Course of the session</i>		
The therapist gives the correction as prescribed	100%	100%
The therapist applies the stipulated prompt for the program	90%	100%
The therapist responds, reinforces, or corrects at the prescribed latency	90%	100%
<i>Reinforcer</i>		
The reinforcer is given with less than 3 seconds of latency, from the end of the response	90%	100%
The reinforcer is given according to the agreed reinforcement interval	100%	100%
The therapist uses a reinforcer adjusted to the difficulty of the task	100%	100%
The reinforcer is given for an appropriate period of time	100%	100%
Withdrawal of the reinforcer is accompanied by, "the ... is over"	40%	100%

Note: Adaptation according to recommendations by Smith (2001) and Lerman et al. (2016).

To address the validity of the data and intervention, interobserver agreement results are shown in Table 3. After a stimulus was presented 20 times, observers generally agreed when a behavior occurred. High agreement (90% and higher) gives confidence that the data is valid. The lowest IOA was with imitation skills (repeats motor action), both with and without an object, at 3 months. That said, even those scores were acceptable (80%), and IOA was higher for more specific imitation skills at the conclusion of the intervention. Overall, IOA scores give confidence that data from the in-session skill rehearsals and tests was collected and reported correctly.

Table 3. Interobserver Agreement (IOA) results at 2 and 6 months

2 months	6 months
Points with index finger to an object and makes eye contact with therapist. IOA = 90%	Points with index finger to an object and alternates gaze between therapist and object. IOA = 100%
Alternates gaze between therapist and object of mutual interest. IOA = 95%	Alternates gaze between therapist and object that mediates interest at that moment. IOA = 100%
Repeats motor action with object previously performed by therapist. IOA = 80%	Repeats motor action with the correct object and in an identical manner to the therapist. IOA = 100%
Repeats motor action without object previously performed by therapist. IOA = 80%	Repeats motor action without object in a completely identical manner to the therapist. IOA = 95%
Repeats a vocalization emitted by the therapist. Not applied at the beginning of the intervention.	Repeats the same vocalization, in terms of phoneme and number of syllables, in less than 3 seconds. IOA = 95%
Responds to simple instructions. Not applied at the beginning of the intervention.	Responds, in less than 3 seconds, to simple instructions. IOA = 100%

Discussions

This study combines an ABA-VB framework to develop prelinguistic skills with Discrete Trial Training (DTT) and the VB-MAPP instrument. This unique approach has both theoretical and clinical significance.

Applied Behavior Analysis (ABA) has been shown to be effective in a multitude of studies and meta-analyses for teaching children with autism spectrum disorder (Wang et al., 2023). According to Skinner's (1957) Verbal Behavior (VB), prelinguistic skills are a requirement for language acquisition. The combination of these perspectives makes an ABA-VB intervention a productive approach for prelinguistic children with ASD. The findings of the present study support this approach. A six-month intervention with a 3-year-old child with ASD achieved the study's six specific objectives: pointing, generalized imitation with and without objects, joint attention skills, producing echoic vocalizations, and following simple instructions.

Specifying and naming the ABA-VB approach is important. Existing research on developing language in children with autism may not be framed as ABA (*e.g.*, Aktaş and Ciftci-Tekinarslan, 2018) or VB (*e.g.*, Neimy et al., 2020). By highlighting the origins of the approach, this study encourages others to adopt the perspective - as Wang et al. (2023) does to an extent - and consider the implications of the perspective. For example, while the outcome of developing and growing language is the focus of many researchers and clinicians, the ABA-VB framework in this study helped put the focus on developing prelinguistic skills which then led to the desired outcome.

In addition to achieving the six specific objectives, the VB-MAPP instrument showed that the intervention had a number of other positive impacts. The child started therapy with a score of 2.5/35 on the Level 1 Milestone Assessment, and that score increased to 18/35 after six months of intervention. Of note, the child's visual perception skills reached all the milestones set for Level 1, and - as treatment has continued beyond this six-month intervention - it is expected that the child will proceed to achieve some Level 2 milestones. As milestones increased over the intervention, the VB-MAPP Barrier Assessment tool showed that learning barriers decreased for nine of the eighteen skills in which difficulties were found. Even for barriers that did not decrease according to the assessment tool (*e.g.*, social or instructional control), qualitative improvements were observed. For example, the child was observed to have fewer behavioral problems, fewer complaints about the withdrawal of the reinforcer, greater bond with the school staff, more shared play situations with other children, and improvements in the articulation of vocalizations. However, these behaviors were not developed to the same level as the other skills or did not meet the criteria for obtaining lower scores in the quantitative Barrier Assessment.

Using the VB-MAPP instrument quantified the unintended benefits of the intervention due to the broad scope of the instrument. While the focus on specific outcomes can help communicate a clear story (*e.g.*, Neimy et al., 2020), the reality is that interventions and therapies can have wide-ranging impacts. The

VB-MAPP can be used as a tool to measure outcomes (*e.g.*, Wang et al., 2023), but the present study suggests its utility for other research in capturing additional effects of interventions.

Of note here is that the child attended therapy six hours a week. Including absences due to holidays or illness, the child received approximately 140 hours of treatment focused on this intervention over six months. This is a relatively short treatment time considering the breadth of objectives and initial learning barriers. As a comparison, the intervention described in Wang et al. (2023) occurred with 14 hours of formal therapy over 8 weeks, though (a) children were not prelinguistic, (b) parents were trained to provide an additional 28 hours of therapy during that time, and (c) the study implemented a Pivotal Response Treatment (PRT) rather than the more common Discrete Trial Training (DTT). Shane's (2016) study was with non-vocal children using DTT, and the quickest subject increased echoic vocalizations in eight hours, spread out over 94 sessions across four months. There seems to be a balance between total number of hours of intervention and spreading those hours out over time for better retention, but it is unclear what the best approach is. While it seems likely the child in this study would have improved more quickly with a more intensive intervention, this study supports previous findings that brief sessions can increase skills over longer interventions.

The findings of the study are of clinical and theoretical importance and suggest the suitability of ABA-VB for the development of prelinguistic skills. That said, the study is limited by being a single case study. Having more subjects would increase the external validity of the study. As presented, the single case study may have been affected by variables outside the scope of the study, specifically the child's parents and teachers.

The advances made during the intervention encouraged the parents to become more involved in their child's therapy. The parents initiated other advances during this intervention, such as acquired toilet training and improved play skills. This parent-led growth impacted the intervention. For example, parental work on play increased the number of reinforcers useful in therapy. It is also likely that the family carried out a high number of discrete trials that were within the scope of the study but were not recorded. For example, parents likely rehearsed the vocalization program, instigating the child to repeat syllables or short words such as "mama". Rehearsing programs at home would contribute to generalizing behaviors due to changing the context. The "spontaneous" growth in performance in instructional and vocalization programs just after the vacation period - when there were no formal sessions - was likely due to the child practicing at home and highlights the essential role of reinforcing behavior in a natural context with this type of intervention.

In addition to parental work, other skills outside the scope of this study were developed concurrently with prelinguistic skills in the intervention center. For example, the intervention center spent time developing the child's matching-to-sample skill. This work by the intervention center may have had an impact on

the results. The child received Therapeutic Pedagogy and Hearing and Language support in the center. If the center integrated work, techniques, or lessons from this study into other instructions or vocalizations, it would have reinforced and positively affected the results of this study. For example, the child's pointing skill seemed to be acquired with some ease. This is probably due to its utility in family and school contexts. Similarly, the child quickly learned the instructions, "give me five", "give me a kiss", "say hello", and "say goodbye". Outside the context of the intervention, the child likely received social reinforcement on a daily basis for following these instructions at the center and at home.

There was a large amount of positive involvement by parents and teachers. That said, the study would be stronger if psychoeducation and ABA training had been included for parents (as done by Nefdt, 2010) and teachers (as done by Robinson, 2011). Being able to direct, measure, and control for parent and teacher influence could have resulted in more hours of formal work with the child. Presently, though, it should be acknowledged that accidental training occurred in a number of contexts. In addition to the above limitation regarding accidental training, any single case study has limitations. The variability between the different subjects and the impossibility of controlling for external variables encourages caution before generalizing the results of a case study (Roussos, 2007). Besides being a single case study, the use of an AB research design - useful for comparing behavioral changes with respect to a baseline - is not efficient in affirming the causes of behavior change or establishing functional and/or causal relationships because there may be external factors that affect the intervention (Cooper, 2019). Some external factors for this case, including parental and center work, are mentioned above.

In spite of the limitations of a single case study, the use of single cases emphasizes the importance of the subject in behavioral research. The focus provided by single case designs make it easier to (a) adapt to the circumstances surrounding the case and (b) provide accurate data about individual performance or variability between programs. And the AB design implemented here is appropriate as the study involved clinical practice where behavior change had greater relevance than identifying the exact causes of behavior (Cooper, 2019). The validity of this study is supported by the inclusion of measures to assess interobserver agreement and procedural integrity. While ABA-VB therapy is individualistic, these measures give confidence that - if the same scenario arose - the study would be replicable.

Conclusions

The present study endorses using ABA-VB methodology for achieving the prelinguistic skills of: pointing, imitation, and joint attention behaviors, as well as producing vocalizations and understanding simple mands. While it does have some limitations, this study is unique in its combination of an ABA-VB framework to develop prelinguistic skills with the implementation of Discrete

Trial Training and the VB-MAPP instrument to capture ancillary benefits of intervention. It joins other studies to provide collective support for an ABA-VB approach in clinical therapy, across a variety of patients and objectives.

Ethics statement

The study was approved by the Ethics Committee for Research at the Rey Juan Carlos University (internal registration number: 0211202335023) on January 4, 2024.

Conflicts of interest

The authors declare no conflict of interest.

Author contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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