LI-AR: An integration of technology and ABA methodology to improve communicative behavior in autism

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Abstract. Previous research on the relative benefits of Speech Generating Device (SGD) as Augmentative and Alternative Communication Systems (AACs) has indicated controversial results regarding the effectiveness on improving communication skills and vocal production and on decreasing problem behaviors for children with autism spectrum disorder (ASD). The Language Interface for AAC Rehabilitation (LI-AR), is a new type of SGD. Its software creates innovations for teaching social interaction skills. Unlike the most popular SGDs, during the training with LI-AR, the vocal output is fully managed by a communication partner/therapist. The software is based on Applied Behavior Analysis methodology, and it allows to personalize teaching procedure in an automated way. The study presents the changes in communication skills and speech production reached by a child with ASD, after the LI-AR training. Results show a significant increase in communicative behaviors and a statistically significant improvement in the quality of speech production.

Keywords: Speech Generating Device, Augmentative and Alternative Communication, Autism.

1 Introduction

According to the National Institute on Deafness and Other Communication Disorders (NIDCD, 2010), about 25% of people with ASD are unable to use language naturally to communicate.
AAC tools offer a communication forms that may make it easier for children with ASD to communicate their needs. Three forms of AAC used with children with ASD include unaided approaches (e.g., signs and gestures), low-tech image-based systems (e.g., PECS), and "hi-tech" speech generating device systems (SGDs) [1].
The effectiveness of an AAC method depends on the ability to customize the tool with which the child will interact.
SGDs are devices designed to produce recorded or synthesized vocal outputs. They are designed to accommodate a variety of configurations that allow for customization and individualization, which is particularly helpful for students with severely limited language skills [2].

Many SGD studies demonstrated an increase in manding skills [3,4,5,6] while a few studies demonstrated a more general increase in vocal production [4] or other communicative and social interaction skills [7].
LI-AR is a new type of SGD. Unlike the most popular SGDs, during the training with LI-AR, the vocal output is fully managed by a communication partner (therapist). Through a Bluetooth device, the therapist decides to activate the vocal output only if the student has successfully completed the communication task, approaching the therapist and delivering him the tablet, as for the Exchange Phase II of PECS [8]. The LI-AR procedure focuses on "exchange" and "interaction" with the communication partner as pivotal behaviors to communicate. Using this procedure, the communication does not take place without interaction. The LI-AR procedure is innovative in the field of SGDs as it requires the child to approach his communicative partner and start an interaction with him before being able to issue the communication act.
The theoretical background that inspired LI-AR is based on the Applied Behavior Analysis methodology and on the concept of "Mand" as proposed by Skinner in his Verbal Behavior theory (1957) [9].
For the first time, with LI-AR, these methodologies merge the new technologies capable of increasing the motivation to communicate and interact with the external environment (eg audio-video technology, NFC, Bluetooth, wi-fi, Augmented Reality, Virtual Reality).
The aim of the present study is to observe the effects of the LI-AR training on communication skills and vocal production in a child with ASD and communication impairment.

2 Method

2.1 Participants

The study was attended by Dario, a 4-years-old boy with an autism spectrum disorder diagnosis. He did not use language in a functional way, he presented some echolalia of portions of words and generally monosyllabic vocalizations; a sign language training had been introduced, but it was unsuccessful due to Dario's propensity for scrolling and was subsequently discontinued. Dario had never used and SGD before the study. Communication and fine-motor skills were previously assessed thought the Vineland test. Results showed a value of ≤ 2.0 years for communication skills and a value ≥ 1.0 years for the fine-motor motor skills.

2.2 Materials and Settings

The study was conducted in a room 5 m by 3 m, in the presence of a, therapist and an assistant as prompter. The room contained a table, and two chairs positioned one in front of the other. The LI-AR software was installed on an Android Tablet 6.0. The tablet was always present on the table during the sessions.

2.3 Procedure

At the beginning of the study a preference assessment was conducted according to the multiple stimulus-without-replacement assessment procedure [10].
An A-B-A single subject design [11] was used to compare performance before, during and after the training with LI-AR.
The baseline sessions lasted 10 min during which the therapist kept the student engaged in work or play activities and created 5 opportunities to request preferred items, showing the child the most motivating objects, arranged on a tray, positioned to be visible but not reachable by the child.
During the training session the student was thought to use the tablet to request what he wanted. The tool provides five distinct phases, in this study, the student attended three of these phases and a fourth phase adapted for the study, as follow:
Phase I The child is in presence of his major reinforcement. When his motivational operation (MO) is revealed, the therapist prompted the student to drag the image corresponding to the desired item towards the box positioned at the top of the screen (Fig. 1). This action will produce the vocal output and the student obtain his reinforcer.
Phase II In this phase the student learned to "exchange". The vocal output was produced by an external action of the therapist, only after the child has given the tablet to the therapist. During this phase, the therapist works on distance and persistence, gradually moving himself and the tablet away from the child.
Phase III In this phase pictures showed on the screen were managed by the therapist. Some distractors were randomly presented on the screen (Fig. 2) in order to teach the discrimination skill.
Phase IV In this phase pictures on the screen were categorically divided in different sheets attainable by swiping from right to left and vice versa on the tablet screen (Fig. 3). The student was completely free to choose his motivation. Each complete exchange was considered a functional communication behavior.

Fig. 1 Phase I/II layout

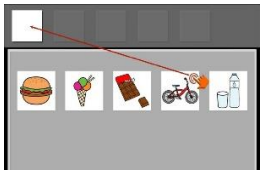

Fig 2. Phase III layout

Fig 3. Phase IV layout

Follow-up: Two months after the last observation, three probe sessions were proposed to observe the maintenance of the acquisitions. These sessions were arranged as for the baseline.
To observe changes in communicative behaviors, we recorded the percentage of occurrence of request and other communicative behaviors. Vocal production was recorded during 10 min sessions divided into 20 intervals of 30 sec. We calculated an index of "quality of speech" for each request occasion: 0 points were attributed if no vocalization occurred; 0.5 points for non-functional and not understandable vocalization; 1 points for each vocalization that was functional and understandable, but not completely pronounced (e.g., at least half of the syllables with which the original word is composed); 2 points for understandable and functional vocalization. (Figure 2).

2.4 Results

During the baseline (Fig. 4), Dario did not show functional communicative behaviors. He presented some not understandable vocalizations and few approximations of words. He reached the 100% of communicative behavior after 4 probe sessions during the training. A statistical analysis confirmed the results of the visual inspection. It was possible to observe a statistically significant change in the trend of communicative behavior, with a p-value <.001. These data were analyzed by a second independent observer for the 50% of the sessions. An Interval by Interval IOA method showed an accordance of 95%.

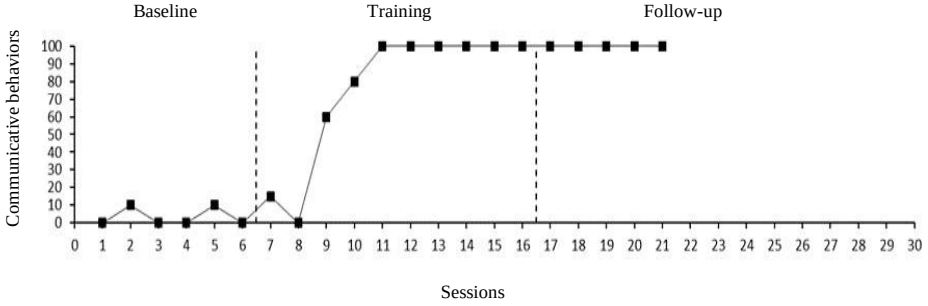

Fig. 4. Percentage of intervals in which a communicative behavior appears (understandable vocalization, word production, pointing, sign, use of LI-AR.

The graph in Figure 5 shows the trend of Dario's speech productions. The visual inspection revealed that the vocal production increased in terms of quality, from an average score of 0.4 during the baseline to 1 point during the follow-up, confirming an improvement in the "quality of speech". The quantity of attempts was stable with a slight decrease at the beginning of treatment. At the middle of the treatment Dario showed, for the first time, understandable and functional vocalization. These data were analyzed by a second independent observer for the 50% of the sessions. An Interval by Interval IOA method shown an accordance of 95%.

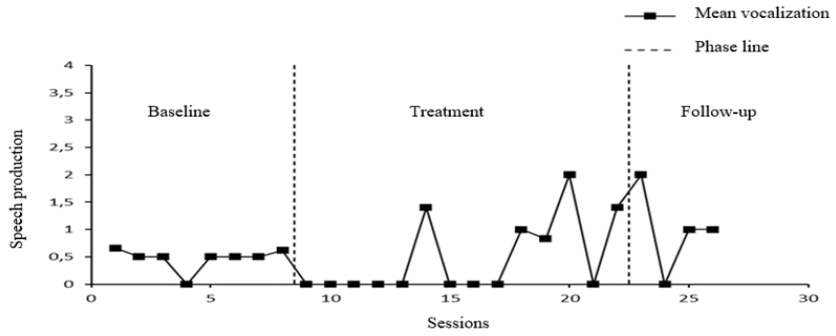

Fig. 5. Quality and quantity of vocal production

During the baseline Dario obtained a maximum of speech quality score of 0.66, after training he reached a maximum score of 2, indicating that the child tended to emit more often words that were both grammatically and functionally correct. Moreover, results indicated an average score of 2 during the follow-up, confirming the consistency of these improvements.

3 Discussion

The first aim of the study was to determine if children with a diagnosis of ASD could be taught to use LI-AR for requesting purposes. The data indicated that LI-AR was an effective tool for Dario to improve his communicative skills.
The second aim of the study concerned whether children with communication problem could improve their vocal production using LI-AR. Results revealed that Dario has obtained an improvement in vocal production (Fig. 5). Dario showed vocalization at the beginning of the study. During the treatment, he acquired the ability to produce whole words, completely understandable. These results revealed that an AAC training did not interfere with the development of vocal communication and that instead, it can be extremely useful to improve the quality of speech production.
These results confirmed the literature according which the digitalization of training and assessment tools can facilitate learning processes and increase motivation in patients with ASD [12,13].
Nonetheless, this study extends the existing literature in two ways: it demonstrates that an adapted ABA protocol can be successfully used to teach communication through an SGD; children with ASD and few vocal repertoire can improve in speech production through the use of an AAC tool.

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