



IMPROVING LISTENER RESPONDING SKILL USING BEE-BOT® IN AUTISM SPECTRUM DISORDER: CASE STUDY

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Abstract:

Children with autism spectrum disorder may have a variety of communication deficits. Their communication difficulties include language delay, limited vocabulary, inability to speak words, echolalia or repetitive use of phonemes, words, or phrases, absence of eye-contact during communication, and poor non-verbal communication skills. Moreover, some of them are nonverbal so they have to learn how to communicate by using alternative and augmentative communication techniques. Some children on the spectrum in order to improve their receptive and expressive communication skills need to work on a highly structured therapeutic environment and others need to work on a natural environment. Educational robotics can be a successful tool for children on the spectrum in order to improve communicational skills. The main goal of this study is to implement Bee-Bot® robotic toy as a supportive tool for a child with autism in order to improve his listener responding skill across actions. The results showed that during speech and Applied Behavior Analysis intervention, the child improved his receptive skill in a more funny and educational way. Researchers identified that by using Bee-Bot®, the participant communicated intensively and participated to the activity more enthusiastically than using the traditional method of teaching at the table. Nevertheless, researchers should implement generalization and maintenance procedures to ensure that the participant will be able to apply the learned behavior and skill outside of the learning environment and continue to practice the acquired skill over time.

Keywords: autism spectrum disorder, communication, robotics, Bee-Bot®, listener responding, speech therapy, applied behavior analysis

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1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that can cause communication, social, and behavioral deficits, and at the same time it is characterized by repetitive and stereotyped patterns of behaviors and/or interests. The term “spectrum” refers to a wide range of symptoms and severity. Autism has become a public health concern all over the worldwide with the estimated prevalence being 1 in 54 children (Maenner et al., 2020).

Autism can affect verbal and non-verbal communication, social interaction, expressive and receptive communication. It is important to mention that these characteristics vary in degree and intensity from individual to individual (Chaldi, 2020). Their characteristics and symptoms are based on the Diagnostic and Statistical Manual of Mental Disorders (5th Edition) or DSM-5 which has been produced by the American Psychiatric Association (APA). DSM-5 is a very useful assessment tool as it lists the signs of autism and it helps clinicians to better understand ASD, identify lack of skills, and develop appropriate treatment plan (Pratt, Hopf, & Larriba – Quest, 2017).

Some individuals with ASD may be presented with repetitive and challenging behaviors, limited communication and social skills and others may be autonomous who require only limited support (Thomaidis et al., 2020). Moreover, children with developmental disabilities are struggling and sometimes are unable to respond to the spoken language of other people (i.e., receptive language skill). As a result, they do not respond to their names (i.e., responding to name skill), they cannot follow instructions, they do not respond to familiar voices, they cannot identify the right color or shape during reading activities. If these kids will not acquire and build their language receptive skills, then they will miss important learning opportunities which results in delay of spoken language (Grow & Le Blanc, 2013). Listener responding is a form of verbal behavior that requires the individual (i.e., listener) to appropriately respond to another's verbal behavior.

In order to develop listener receptive skills, a variety of interventions take place. The most known are the intensive early behavioral intervention and the applied behavior analysis. Through these interventions, therapists (i.e., speech therapists, behavior therapists) design behavioral programs in order to teach children on the spectrum how to appropriately respond to their names, to follow simple instructions, complete activities in context and to receptively identify items/actions/emotions, etc.

Nevertheless, for children on the spectrum it is difficult to learn new skills (i.e., social, communicational, functional etc.) and sometimes their therapy intervention turns to be challenging and unsuccessful. In order to address all these challenges, various treatment methods have been proposed, one of these is the robot-based autism therapy.

In recent years, researchers explore the use of robots in order to develop and master therapeutic objectives for children with autism. Even though robot-based autism therapy has been introduced in clinical settings studies revealed its effectiveness on

improving social, communication, and emotional deficits on kids with ASD (Guillian, Ricks, Atherton, Colton, Goodrich, & Brinton, 2010).

This research study aims to reflect on the effectiveness of robotics (Bee-Bot in our case) in a rehabilitative intervention in order to build listener responding skills to a child who has been diagnosed with ASD. Our goal was to develop receptive identification skills of behaviors (actions) using the robotic toy Bee-Bot®.

2. Participant

The participant of the study is a 5-year and 3 months old toddler who has been diagnosed with ASD and his home language is Greek. He has been receiving therapy 6 hours per week on his Intensive Behavior Intervention (IBI) program for the past 8 months. During the assessment, using the VB-MAPP assessment tool, we found that our participant has strong imitation skills (fine and gross motor skills), he can follow complex instructions (more than two-steps instructions), he has strong scanning and eye-contact skills and he does not engage in any challenging behaviors (e.g., aggression).

Nevertheless, the result of the assessment showed deficits on his listener responding and tacting skills. Our client was struggling to verbally communicate with the clinician, to tact and to identify everyday actions (e.g., brushing teeth, sleeping, eating, drinking, etc.). The preference assessment showed that his highly preferred item was bubbles.

Before the intervention, we informed our participant's parents about our study, and we obtained their written permission (through consent form) in order to implement it with their son. Thus, we explained to them the purpose of the study, the procedures that would be used, and how the data would be used and by whom.

The activity took place in a private speech rehabilitation institute in Patra, Greece serving clients on the autism spectrum disorder. It is important to mention that our client had previously mastered preposition and direction skills in order to be able to use Bee-Bot® appropriately. The Bee-Bot® preparation lasted six weeks, 15 minutes per week.

3. Method

3.1 Preference Assessment

The objective of the intervention was that our participant would be able to program Bee-Bot® in order to move it to the right action card that was asked from the clinician. The materials used for this procedure were the robotic toy Bee-Bot® and six colorful cards of common everyday actions. Whenever our participant responded correctly, he had access to his reinforcer (i.e., bubble).

Through reinforcement assessment procedure, clinicians are able to identify the items and the activities that individuals find reinforcing [Figure 1].

In our study, we implemented paired-choice preference assessment during which we placed two items (stimuli) in front of our participant and we allowed him to select

one at a time. Once the child engaged with the selected item, then we presented another trial of two other items. The item that our participant selected most of the time was the most highly preferred item which would be used during the intervention.

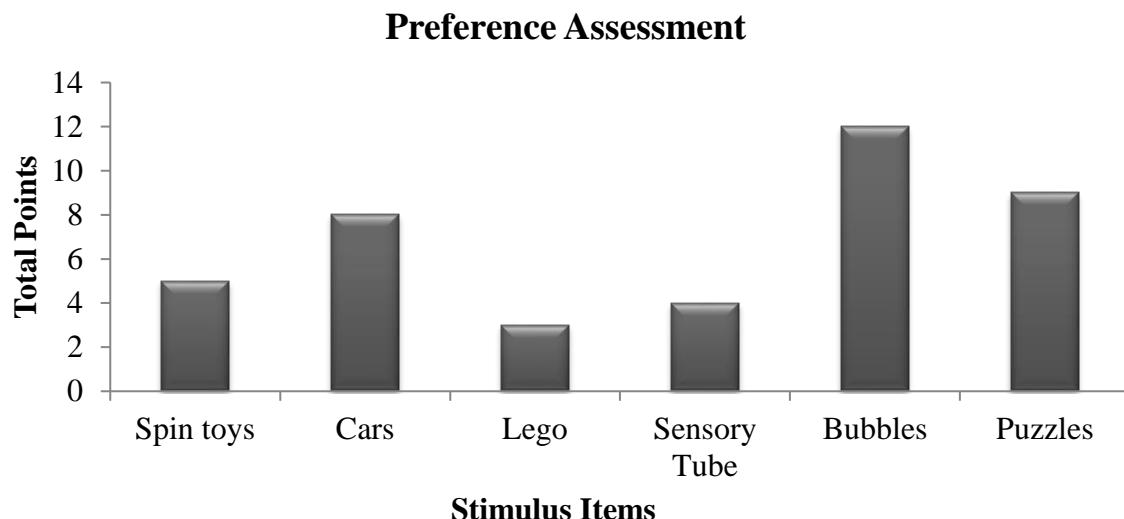


Figure 1: Paired – choice stimulus preference assessment across six preferred items (stimuli)

3.2 Bee-Bot®

Bee-Bot is an educational robotic toy which has the form of a bee and can be programmed in order to move towards different directions (i.e., forward, backward, turn left and right). It is a small rechargeable robot that can be programmed to move up to 40 steps by 15 cm per step. Bee-Bot® resembles a bee which flashes its eyes and makes sounds in order to be more attractive to children. Studies showed that Bee-Bot® is a great tool for teaching sequencing, directions, and developing receptive and expressive language skills in typical and non-typical kids (Mantzanidou, 2020).

Bee-Bot® is designed to be used by children aged three years old and older. The colorful bee-looking robot contains a USB charger and can be activated with a switch on its bottom. Also, it includes several buttons which are the following: "pause", "reset", "go" and the four directional buttons that we mentioned above [Image 1]. Bee-Bot® can follow sequence of up to 40 movement commands and once these commands have been inputted, then the robot can start moving once the child has selected the "go" button. If the child wants to stop the robot, he has to push the "pause" button and then the "reset" button in order to select a new sequence. Bee-Bot® should be used on hard and smooth surfaces in order to be able to complete accurate movements.

Children can easily understand how to use Bee-Bot® with minimal and simple instructions. This robot gives kids the opportunity to find ways in order to solve problems in a funny way.



Image 1: Educational robotic toy, Bee-Bot®

3.3 Procedure

Our current targets were 6 different common everyday actions (i.e., eating, sleeping, drinking, throwing, brushing, and cleaning) [Image 2] presented in colorful cards. Each action language development educational photo card measures 15 x 10 cm making them suitable for children with ASD.

In our study we implemented a task of listener responding across behaviors (actions) by placing the demand "Find the man who is eating". Then the child had to adjust Bee-Bot® based on clinician's demand/ instruction and once he was able to do that correctly, he had access to his preferred reinforcer (i.e., bubbles).

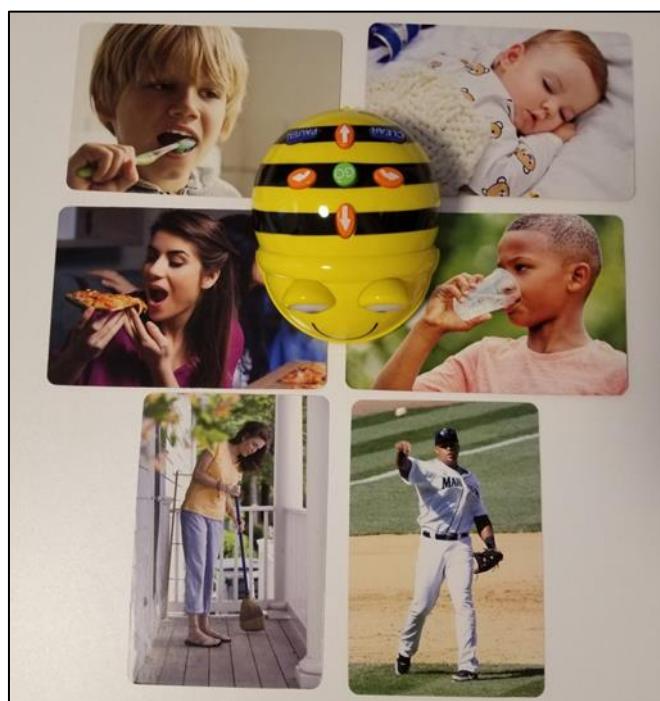


Image 2: Cards with common everyday actions

During listener responding task our participant had to find the picture that was presented and asked by the clinician, by adjusting Bee-Bot® to move to the target-card (clinician says "Find the girl who is eating" and the child adjusts Bee-Bot® in order to be moved to the card of eating).

Our mastery criterion was 100% across 2 consecutive sessions or 80% across 3 consecutive sessions. Mastery criterion is an important concept in Applied Behavior Analysis and in behavioral interventions as it determines the number of independent (without prompts) correct responses over a number of trials needed for a target skill in order to be considered mastered. The higher mastery criterion means higher individual's performance.

Moreover, mastery criterion focuses on the level of performance, the total number of responses within a treatment session and the frequency of observations.

Initially, we used a mat template where we placed the cards of actions and the Bee-Bot on the starting spot. On the first task, the child had to work on his listener responding skills. More specifically, the therapist placed the demand and the child had to adjust the robot in order to move to it to the right card [Image 3].

If the child errored during this step, the therapist provided full physical prompt (FPP) in order to help the participant to move the Bee-Bot to the right target action- card.



Image 3: Participant adjusts Bee-Bot®

4. Results

For our data collection we used trial – by - trial procedure. A correct trial consisted of the child finding the right action card when was asked to do so. We graphed daily percentage of correct listener responding skills on separate graphs and at the same time we recorded our data on a skill tracking form.

The result of this study is that by using educational robot, during our speech and ABA interventions, with children on the spectrum we can improve their language receptive skills in a more funny and educational way. We identified by using Bee-Bot that our child communicated intensively and was participating to the activity more enthusiastically than using the traditional method of teaching.

During the introduction of listener responding task our participant was able to correctly choose an action suggested by the clinician and was able to independently adjust Bee-Bot®. Because the child was not able to identify the "cleaning" and "throwing" action cards the therapist had to guide him with full physical prompt and gradually fade prompt until the child was able to find the target cards.

The participant initially after 5 trials with therapist's full physical prompt for each card (i.e., cleaning and throwing), moved to partial physical prompt where he stayed for 3 trials. Finally, he moved to independent level. Regarding the rest of the action cards, the participant mastered them on the 2nd trial scoring 100% across two consecutive sessions.

It is very important to mention that during the procedure the child acted happily and did not try to escape from the structured area.

5. Conclusions and Discussion

The main goal of our study was to examine if by using an educational robotic toy, such as Bee-Bot® for a child on the spectrum, would improve his listener responding skills across actions, compared to implementing the same programming without a robot. We discovered that our participant was willing to participate more intensively to the activity when the robot was presented compared with our previous sessions which took place on the table using the action cards only.

Our participant mastered 4 out of 6 action cards within 2 sessions and the rest of the cards within 10 sessions in contrast to the traditional intensive behavior intervention where we spent 10 sessions for each action card. These results can be considered as encouraging supporting using robots during behavioral intervention activities.

In addition, we suggest Bee-Bot® to be used across a variety of behavioral intervention programs (such as tacting) or even trying to introduce different educational robots.

The results of this research study can be used in order to make changes in the way activities for children with ASD are planned and implemented as our study reflects the effectiveness of Bee-Bot® as a mediator between developing new skills and kids with ASD.

Nevertheless, some of our study limitations are the need for wider generalization and maintenance of the acquired skills and the small size of our sample.

Funding statement

This project did not receive any funding.

Human rights and informed consent statements

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation. Informed consent was obtained from parents for being included in the study.

Conflict of Interest Statement

The authors declare no conflicts of interests.

About the Authors

Dimitra Chaldi is a Speech – Language Pathologist at “Speech Rehabilitation Institute – Chaldi D.”. She is also a Lecturer at University of Peloponnese (Department of Speech – Language Pathology), PhD. Student in Medicine, LSVT-LOUD Certified S-LP Clinician, PROMPT-Bridging Certified S-LP, A Hanen® Certified “It Takes Two to Talk” S-LP. She completed her Master’s Degree in Disability Studies with specialization in Applied Behavior Analysis (ABA) at Brock University, Canada.

Garyfalia Mantzanidou is a Kindergarten teacher. She is passionate with Educational Robotics and she has been involved to many Erasmus projects through the last couple of years. She has also been trained to Lumiere technique and she is teaching her students how to design and use educational robotics in her classroom.

References

- Chaldi, D. (2020). Increasing Vocal Repertoire in order to Reduce Screaming Behavior in Toddler with Autism. *International Journal of Educational Innovation*, 2 (1), 100 – 106
- Grow, L., & LeBlanc, L. (2013). Teaching receptive language skills: recommendations for instructors. *Behavior analysis in practice*, 6(1), 56–75. <https://doi.org/10.1007/BF03391791>
- Guillian, N., Ricks, D., Atherton, A., Colton, M., Goodrich, M., & Brinton, B. (2010, October, 10-13). Detailed Requirements for Robots in Autism Therapy [Paper Presentation]. Proceedings of the IEEE International Conference on Systems, Man and Cybernetics, Istanbul, Turkey.
- Maenner, M. J., Shaw, K. A., Baio, J., et al. (2020). Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years — Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2016. *Surveillance Summaries*, 69 (4), 1 – 12. <https://doi.org/10.3390/jcm9072163>
- Mantzanidou G. (2020). Educational Robotics in Kindergarten, a Case Study. In: Merdan M., Lepuschitz W., Koppensteiner G., Balogh R., Obdržálek D. (eds) *Robotics in Education. RiE 2019. Advances in Intelligent Systems and Computing*, vol 1023. Springer, Cham. https://doi.org/10.1007/978-3-030-26945-6_5

- Pratt, C., Hopf, R., & Larriba – Quest, K. (2017). Characteristics of individuals with an autism spectrum disorder (ASD). *The Reporter*, 21 (17). Retrieved from <https://www.iidc.indiana.edu/pages/characteristics>
- Thomaidis, L., Mavroeidi, N., Richardson, C., Choleva, A., Damianos, G., Bolias, K., & Tsolia, M. (2020). Autism Spectrum Disorders in Greece: Nationwide Prevalence in 10-11 Year-Old Children and Regional Disparities. *Journal of clinical medicine*, 9(7), 2163.

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