

TEACHING FOLLOWING INSTRUCTIONS AND RESPONDING SKILLS TO CHILDREN WITH AUTISM WITH AN AI-SUPPORTED MOBILE APPLICATION

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Abstract

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that affects learning, behavior, social interaction, and communication skills in individuals. The prevalence of ASD has been on the rise, with a 317% increase in diagnoses between 2000 and 2023. To address the growing demand for interventions and therapies for individuals with ASD, technological advancements have introduced new opportunities in education. Mobile applications, particularly those supported by artificial intelligence (AI), have shown promise in teaching academic, communication, and social skills to individuals with ASD. YanYana is an AI-supported mobile application designed for this purpose. This study aims to assess the effectiveness of YanYana, an iPad-based AI-supported mobile application, in improving instruction and response skills in three children with ASD aged 3 to 7 years. The research methodology involved participant criteria, session settings, and a detailed description of YanYana's features and usage. Interobserver reliability, procedural fidelity, and an experimental design were also explained. Results indicate that YanYana effectively facilitated progress in answering questions and following instructions for the participants. The study underscores the potential of AI-supported applications like YanYana in tailoring educational experiences for children with ASD. While research in AI's role in ASD has mainly focused on diagnosis, this study contributes to the field of education and highlights the need for further research. It also acknowledges the application's developmental improvements and recommends expanding the scope of future studies. In conclusion, YanYana demonstrates promise in enhancing the educational experiences of children with ASD. However, the study's limitations, such as a small sample size and the need for maintenance data, suggest avenues for future research and improvements in AI-based interventions for ASD.

Keywords: Autism, technology, artificial intelligence (AI), iPad.

1 INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder caused by differences in the brain. ASD may cause some differences in individuals' learning, behavior, social interaction, and communication skills. According to the American Centers for Disease Prevention and Control (CDC), approximately 1 out of every 36 children is diagnosed with ASD. The number of children diagnosed with ASD has increased by 317% between 2000 and 2023 [1]. With the increasing prevalence of ASD, the demands of families, teachers, and educators for intervention, therapy, and treatment options have also increased. Technological developments in the last twenty years have enabled educators to employ new and novel technologies and applications in the education of children with ASD. Mobile applications have been used to teach academic, communication, and social skills in many studies, and the literature suggests that they have been mostly effective [2]. Technology-supported teaching and interventions have been reported as an evidence-based practice in the National Clearinghouse on Autism Evidence and Practice report [3]. Mobile applications supported by artificial intelligence (AI) have recently become popular as AI has great potential for providing services to individuals with ASD and typically developing individuals [4,5]. YanYana is an example of an AI-supported mobile application specially designed and developed for individuals with ASD. With this in mind, it may be worth investigating the effects of such technologies on the education of children with ASD. This can open new opportunities for technology-supported teaching and intervention in ASD. The aim of this study is to measure the effectiveness of YANYANA, an iPad-based, AI-supported mobile application, on the following instruction and responding skills of three children with ASD between the ages of 3 and 7 years old.

2 METHODOLOGY

2.1 Participants

For the purpose of this research inclusion criteria for the participants were as follows: a) having one-word verbal utterances, b) being able to imitate a single word when asked to imitate, c) being interested in the tablet according to information received from the family, d) being able to engage with the screen for at least two minutes when the tablet screen is on. Based on these inclusion criteria three children with an official ASD diagnosis were included in the study. Two participants were boys and one was a girl, and their ages ranged from 3 to 7 years old.

2.2 Setting and sessions

The sessions for all participants took place in children's own classrooms located in the Sobe Foundation. The rooms were typical special education classrooms with student desks, closets, shelves, and toys. The sessions were held twice a week, two or three times a day. The application, YanYana, was running for about 5 to 10 minutes on an iPad during the sessions. At each session, the teacher opened the YanYana and placed it in front of the child on a table. The teacher only intervened if the child wanted to exit YanYana, and did not let the child exit the app. Apart from this, the teacher did not intervene. In 30% of the sessions, a second observer was present in the classroom where the sessions were held. The second observer collected inter-observer reliability data.

2.3 Yanyana

The application, YanYana, is an artificial intelligence-based educational application specially developed for children with ASD. This application, which has audio and image processing capabilities, aims to help teachers teach targeted behaviors to students with ASD. The app has three different interactive characters: a boy named Yan, a girl named Yana, and a robot named Robi. The image of the YanYana characters is displayed in Figure 1. Teachers define the target behaviors they want to teach students using the "YanYana" admin panel. The admin panel is accessible via a website. The image of the YanYana admin panel is displayed in Figure 2. Once the target behavior is selected, the app is ready for children's use. The application starts with the characters' warm welcome and introduction that aim to motivate the children. A lesson for the target behavior follows this introduction. For example, a character asks the child "What's your name?". If the child does not answer the question, then one of the characters in YanYana answers this question and states the child's name to model the target behavior. The character also gives prompts like "Tell me, your name was Ahmet!". It provides a hint and helps the child to start learning. In this way, children learn targeted behaviors in an interactive and fun environment by watching cartoons. The "YanYana" application aims to increase engagement and motivation in a desirable digital platform for children with ASD. At the same time, it also allows teachers to offer customized instruction to their students that suits their needs. This application has been developed to contribute to developing the communication and social interaction skills of children with ASD.



Figure 1. The Image of YanYana Characters In the Application

Resim	Adı	SoyAdı	Doğum Tarihi	Cinsiyet	Telefon	Eğitmen1	Eğitmen2	Yakın1	Yakın2	Gelişim Seviyesi	Durum	Oluşturma Tarihi	Güncellenme Tarihi
	Charlie	Walsh	23 Mar 2017 00:00	ERKEK	+90 (555) 505-5050	Jack Black	Laura Rossi	Mother	Father	-	AKTİF	23 Mar 2023 18:12	24 Mar 2023 16:24
	Fiona	Wilson	17 Mar 2019 00:00	KADIN	+90 (333) 333-3334	Laura Rossi	Adrian Radoi	Mother	Father	-	AKTİF	17 Mar 2023 19:18	23 Mar 2023 14:57
	Frank	Bell	17 Mar 2020 00:00	ERKEK	+90 (333) 333-3333	Laura Rossi	Adrian Radoi	Mother	Father	-	AKTİF	17 Mar 2023 19:13	24 Mar 2023 16:25
	Richard	Goldsmith	17 Mar 2020 00:00	ERKEK	+90 (111) 111-1111	Laura Rossi	Adrian Radoi	Mother	Father	-	AKTİF	17 Mar 2023 18:49	24 Mar 2023 16:25
	Luna	Beck	17 Mar 2020 00:00	KADIN	+44 (924) 928-3899	Laura Rossi	Adrian Radoi	Jennie	Cedric	-	AKTİF	17 Mar 2023 16:33	24 Mar 2023 16:26
	Hande	Tekinbaş	14 Şub 2023 00:00	KADIN	+90 (536) 949-4949	Eğitmen Eğitmen2		annesi	babası	-	AKTİF	14 Mar 2023 15:36	23 Mar 2023 15:00

Figure 2. A Screenshot of the Admin Panel in YanYana

2.4 Interobserver agreement

In this research, two independent individuals were assigned to evaluate the behavior of three children with ASD. First, these individuals observed the children's behaviors separately and independently and recorded these observations in the inter-observer reliability form. Later, an inter-observer reliability analysis was conducted for the data collected by the two observers. The inter-observer reliability was calculated as 93% indicating that the measurements made during the research are consistent and reliable.

2.5 Procedural fidelity

In this research, an AI-supported application, YanYana, was used to teach target skills to children with ASD. YanYana application has the capacity to fully meet the required standards while teaching new skills. Due to using an AI-supported application instead of a teacher as a practitioner, there was no need to measure the procedural fidelity. The AI-supported application can accurately monitor, record, and analyze the parameters requested during teaching. This capacity possessed by the artificial intelligence application ensures that the results are obtained with high accuracy. Consequently, it has been widely acknowledged that artificial intelligence applications are considered to be inherently comprehensive and dependable, with limited dedicated scrutiny directed towards assessing their intrinsic reliability.

2.6 Experimental design

In this research, a multiple probe across participant single-case experimental research designs was used to evaluate the effectiveness of an AI-supported mobile application in teaching the target skills of following instructions and answering questions to children with ASD [6]. The research includes (a) baseline phase, (b) intervention phase, and (c) generalization phases.

2.7 Intervention

During this study, an AI-based mobile application named "YanYana" was used to support the learning processes of children with ASD. The execution stages of the research are as follows:

a) Participant Preparation and Starting to Training

An individualized account has been set up for each participant, facilitating their access to the application upon successful login. Teachers defined the target behaviors to students through the "YanYana" admin panel. The interactive phase of the application commences as the teacher launches the 'YanYana' application and places it within the child's proximity. Teachers refrained from intervening during the application's utilization by the participating children. However, in instances where the children attempted to close the application, the teacher intervened.

b) Target Behavior Training

Within the application, there are target behaviors customized based on children's individual needs. With the first two participants, the questions were: "What is your name?" "How old are you?" "Where are you from?". With the first two children, the examination focused on the participants' proficiency in responding to these questions. For the third participant, the

investigation centered on assessing the aptitude of the third participant in executing instructions related to actions such as clapping, pointing to the nose, and raising the fingers.

c) Feedback and Prompting Procedures

Based on the accuracy or inaccuracy of the children's responses to the questions asked by YanYana, the characters within the application exhibited varying reactions. When a child provided a correct answer or executed an instruction accurately, the animated characters Yan, Yana, and Robi within the application conveyed their jubilation and enthusiasm. Conversely, when a child's response was incorrect, or they failed to comply with the instruction, the robotic character named 'Robi' extended the opportunity for the child to rectify their response by providing a helpful hint. After two hints were provided by Robi, in cases where the child could not answer the question correctly, the character 'Yana' facilitated a transition to a different target skill by stating, 'In any case, let's attempt this later'.

d) End of the Session

Upon the presentation of all designated target skills to each participating child within a given scenario, the YanYana application was subsequently concluded and the training session was terminated. Thus, the design and implementation of the 'YanYana' application were oriented towards providing personalized and interactive support for the educational journey of children with ASD. While the application effectively boosted children's motivation to learn, it also played a pivotal role in facilitating the acquisition of individualized target behaviors.

2.8 Generalization

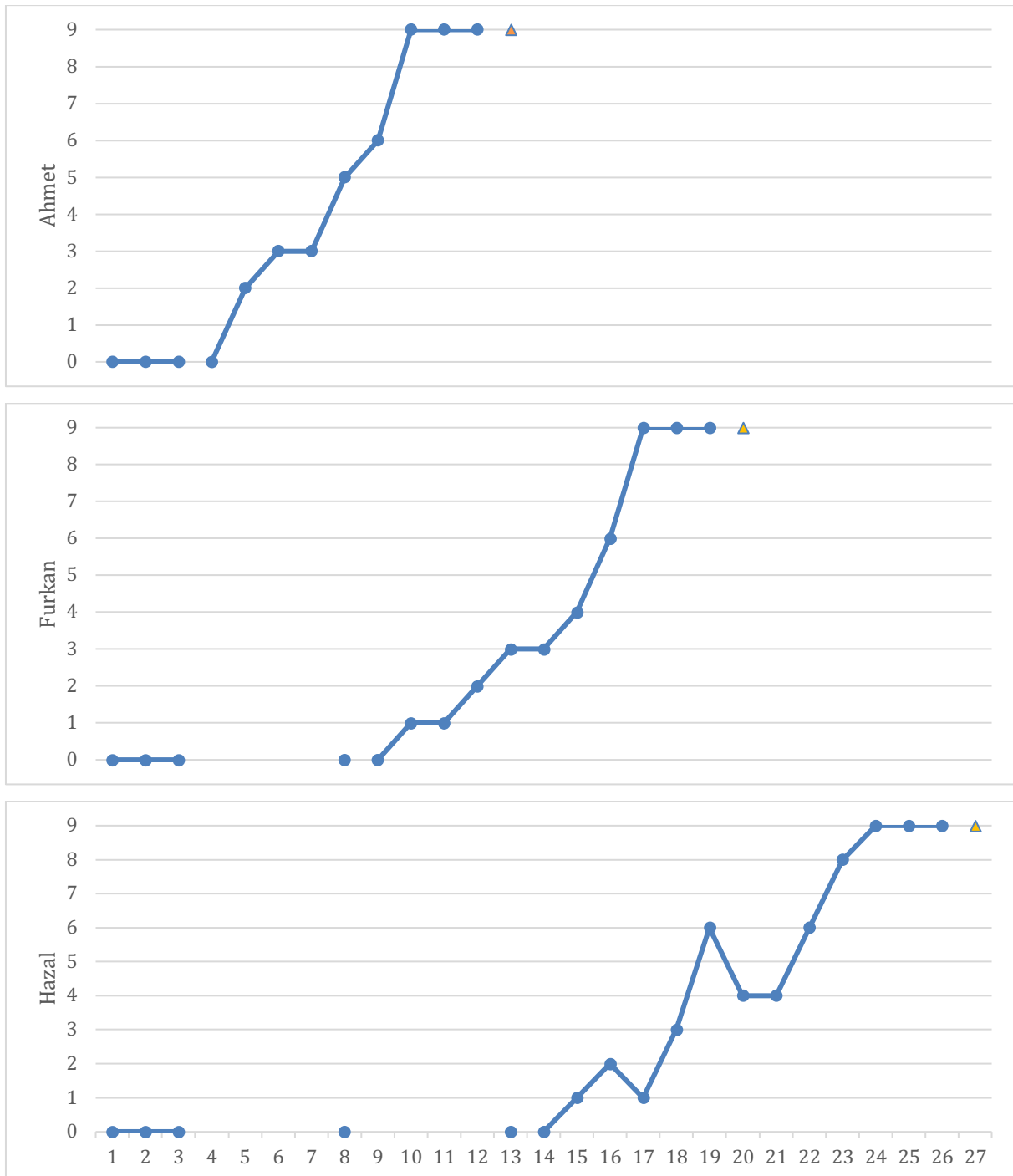
A generalization session was conducted as part of this study following the training sessions. The generalization sessions aimed to ascertain the extent to which children with ASD who had acquired the ability to respond to inquiries and carry out instructions via the YanYana application could apply these learned skills in real-life situations. During the generalization session, participants' own teachers asked the participants the questions or instructions that had been administered through the YanYana application.

3 RESULTS

Throughout the research, an investigation was conducted into the proficiency of answering questions, as demonstrated by Ahmet and Hazal, and the fulfillment of instructions, as exhibited by Furkan. The research findings are shown in Table 1.

As per the findings, it is evident that the baseline data for all three participating children is zero. Ahmet and Hazal did not respond to the posed questions, while Furkan failed to execute any of the three presented instructions accurately. The intervention was initially initiated with Ahmet. In the second session, Ahmet demonstrated progress by providing his first correct responses, and successfully answering two of the nine questions. Significant progress was observed in Ahmet during the 8th session of the intervention. On this particular day, prob data were again collected for Furkan and Hazal. With a score of zero for Furkan and Hazal during probes, we interpret that the progress in Ahmet's score was due to the training delivered by the YanYana application. After these probes, the intervention phase started for Furkan, and in two consequent intervention sessions, he answered one of the nine instructions correctly. Following the observed progress in Furkan, during the 5th session, prob data for Hazal were subsequently recorded, revealing her inability to respond to the posed questions. These findings indicate that the progress observed in Ahmet and Furkan can be attributed to deliberate practice. Ultimately, practice sessions were initiated with Hazal, and after 11 sessions, notable progress was evident as Hazal successfully answered all questions posed to her with accuracy. Following the attainment of target behaviors by all three students, three sets of stable data were recorded. Subsequently, a final generalization session was organized. During the generalization session, the target skills that the students had acquired through YanYana were presented to them by their own teachers. It was noted that all three students consistently demonstrated the acquired skills when asked by their teachers. Furthermore, they successfully generalized these skills to real-world contexts.

Table 2. The findings involving Ahmet, Furkan, and Hazal with the utilization of YanYana.



4 CONCLUSIONS

YanYana is an AI-supported educational platform designed specifically for individuals with ASD through the unique capabilities of the AI, the necessary skills tailored to each child can be incorporated into their individual profile via the admin portal. This personalized approach enables the instruction of skills aligned with the specific requirements of each child. This application can process both images and sounds, allowing for the delivery of skills aligned with the intended objectives of applied behavior analysis strategies to the students. It processes the responses provided by the student in a manner consistent with the application of reinforcement or error correction, contingent upon the accuracy or inaccuracy of the student's response. This research represents the inaugural scientific investigation aimed at evaluating the potential efficacy of the application, whose development remains in progress, in delivering beneficial outcomes for individuals diagnosed with ASD. To this end, the study sought to

facilitate correct responses to three questions posed to two children with ASD and instruct three specific tasks to another child with ASD. The research outcomes affirm the effectiveness of the application in successfully imparting the targeted skills to these individuals. An examination of the body of research conducted in the domain of ASD reveals a prevalent focus on studies about the utilization of AI for diagnosing individuals with ASD, as evidenced by the extensive literature [7, 8, 9]. In addition, a few studies have tried to use AI in the education of individuals with ASD. For example, a particular study leveraged AI within the context of creating social stories designed to facilitate the teaching of social skills to individuals diagnosed with ASD. Hence, this approach provided an avenue for delivering interactive instruction in contrast to conventional social stories. It tailored the content to the child's individual level, furnished consistent feedback, and fostered generalization, as documented in previous research [10]. To gain a more precise understanding of the prospective advantages of AI, to ascertain its strengths and weaknesses in contrast to conventional methodologies, and to discern how it can be seamlessly integrated into existing educational paradigms, it is imperative that further research in this realm be undertaken. In this sense, this research can guide the development of AI applications and research in the education of children with ASD. In addition, research on the education of individuals with ASD generally reports that behavioral training programs are effective for individuals with ASD [11]. Nevertheless, owing to the predominantly individualized nature of behavioral interventions for children, the scarcity of specialists proficient in this domain poses a formidable challenge. Furthermore, the escalating prevalence of ASD compounds the issue, leaving families grappling with the impediments to accessing these crucial behavioral interventions [12]. Hence, there exists a pronounced exigency for the development and implementation of innovative solutions that hold the potential to efficaciously address the educational needs of individuals diagnosed with ASD. The swiftly advancing realm of AI technology in recent years holds promise in potentially fulfilling this need.

After the conclusion of the research, efforts were undertaken to identify and rectify certain issues associated with the YanYana application. After the conclusion of the research, assessments were conducted to identify areas requiring enhancement in relation to the application. Initiatives were set in motion to address these issues and implement improvements in the forthcoming version. Furthermore, it is important to acknowledge that the findings of this research are constrained by their applicability to a limited sample comprising only three children diagnosed with ASD and the examination of two specific target skills." Hence, it is strongly advised that future research endeavors consider employing the YanYana application with a more extensive cohort of children diagnosed with ASD. Additionally, its utilization in instructing a wider range of target skills should be explored. Within the scope of this research, a generalization session was meticulously arranged to assess the extent to which the skills instructed through YanYana could be transferred to diverse scenarios. During this session, the teachers at the school administered the instructions typically taught through the YanYana application. For future research endeavors, it is advisable to expand the scope of the generalization session by involving a larger number of participants. Additionally, it is recommended to replicate the session in various settings, including those involving parents and caregivers, beyond the immediate purview of the participating children's teachers. Maintenance data were not collected as part of this study, primarily due to the constraints imposed by limited time. For forthcoming studies, it is advisable to explore the enduring effects of the YanYana application by assessing whether its outcomes persist over 2, 4, and 6 weeks following its initial implementation.

ACKNOWLEDGEMENTS

Throughout the developmental phase of the artificial intelligence program YanYana, integral for the execution of this research, important assistance was sought from experts in artificial intelligence, mobile application development, and animation design from Innova and Sebit companies. Furthermore, the invaluable expertise of professionals from the Selçuklu Autism Individuals Educational Foundation in Applied Behavior Analysis (ABA) was instrumental in shaping this endeavor.

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