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Improving Social Communication Level for Mildly Autistic Children Using Video Call-Based Mobile Application Game

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ABSTRACT

Mildly autistic children lack effective social communication skills, making it crucial to utilize modern technology to elevate their social communication and help them blend in with their community. This study improved social communication skills for preschool children aged 4-6 with mild autism by using a mobile application game that relies on video conferencing technology, personalized experience, positive reinforcement, and an AI text-to-speech algorithm. A survey filled out by 2,536 autistic individuals and medical professionals optimized the application's UI/UX to their likings. After the implementation of the application, an experiment was conducted with two groups: 300 participants who used the application for 12 weeks (1 hour daily) and a control group of 100 who did not use the application. The effectiveness of the application in improving social communication with consideration for gender and demographic areas was tested. Both groups were assessed before and after the experiment using the standard Social Communication Questionnaire. The results of an unpaired t-test indicated a significant difference in social communication between the experimental group and the control group with a P-value of 0.0001. An unpaired t-test found no significant difference in social communication levels between participants from urban or rural regions, nor between male or female participants. This concluded that the application is an effective tool to improve social communication skills for mildly autistic children all around the country three times more than regular therapy, regardless of their gender or socioeconomic background, taking the first step towards the formation of a global network for mildly autistic children.

1. Introduction

Autism is a neurodevelopmental disorder characterized by delays in social and communication skills along with stereotyped behavior and interest patterns (Yousef et al., 2021). Children with Autism Spectrum Disorder (ASD) struggle to acquire language skills and comprehend what people are saying to them. They frequently struggle with verbal cues as well as eye contact, facial expressions, and hand movements. The intellectual and social growth of children with mild autism affects their capacity for language and communication. This is because they might be unable to interpret facial expressions and distinct verbal tones, as well as body language. According to the CDC, 1 in 36 children globally suffer from autism (CDC,2022). What is more challenging is that it is widely known that raising a kid with a disability puts a lot of demands on parents (U.S. Department of Health and Human Services, 2023). The preparation, support, and socializing chances for parents of children with impairments are lacking in our society. Due to the problematic behaviors and delays their kid displays, many parents of autistic children feel unwelcome in public settings, and their families' social circles may change or significantly shrink leading to lack of social communication between autistic children.

Teaching mild autistic kids stronger communication skills is essential if they are to reach their full potential. There are several methods, but the one that caters to the requirements and interests of the child the best is the one that begins early, in the preschool years (Soares et al.,2021). It is important to address the child's behavior and communication skills, and frequent positive reinforcements are necessary. Many mild autistic children respond well to highly structured, focused programs (Ibrahimagic et al., 2021). To ensure that the treatment program becomes a regular part of the child's life, it should involve parents, other family members or friends. This study aimed to improve social communication skills for preschool children aged 4-6 with mild autism.

2. Existing solutions

The prior interventions for improving social communication for mildly autistic children especially used in Egypt have been analyzed stating their advantages and disadvantages as shown in Tab.1.

Table 1

The pre-existing solutions to improve social communication for autistic children in Egypt

Solution	Description	Advantages	Disadvantages
Social skills training (SST) (Soares et al.,2021)	It targets social skills deficits using computer-based programs, avatars, and therapeutic robots.	-Reduction of anxiety caused by social interactions -Minimal distractions	-Requires transportation -Time-intensive training.
Speech Blubs 2 (Tran et al., 2021)	A speech therapy app for toddlers and kids aged 1-8. It uses video modeling from real kids to help kids practice new words.	- Consist of a video of a child saying a word: quickly, slowly, and then quickly again - The videos allow kids to watch the child's mouth moving as they say the word.	- The application is not made specifically for autistic children - Not free.

Mobile game apps present a comfortable environment for autistic kids to learn new skills (Wainer, et al.,2010). However, static mobile applications games increase screen time. High quantity screen exposure is linked with low language skills, but high-quality screen exposure is linked with high language skills (Bridges et al., 2019). There are several successful uses of video conferencing in the provision of mental health care (Weger, 2012). Combining these two technologies could help generate an intervention to help mildly autistic children develop social communication skills.

3. Research question

Can we improve the social communication level for preschool mild autistic children (males and females) ages 4-6 from rural Upper Egypt and urban Lower Egypt by using a mobile application game that relies on video call?

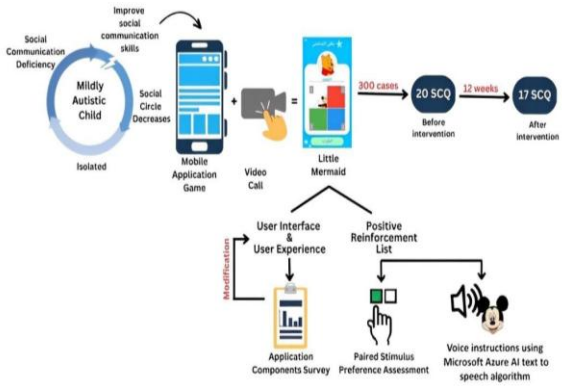
4. Hypotheses

- Video call technology can be utilised via a mobile application game to improve the social communication for preschool mild autistic children (ages 4-6) in a significant way compared to typical programs.
- The elevation in social communication for mild autistic children that use the application in urban areas of Lower Egypt will be more than that of their peers in rural areas of Upper Egypt provided that parents in urban areas have more access to educational resources (Priz et al., 2017) .
- The elevation in social communication of female mild autistic children that use the application will be similar to that of male autistic children.

5. Methods & Procedures

Figure 1

Graphical representation of the procedures



Implementation:

1. The UI/UX of the application was designed using colors that are appealing for autistic children (Gaines et al.,2011)

2. An automated personalised positive reinforcement list based on Paired Stimulus preference assessment (Missouri, 2017) was featured in the application to:

- Prioritize children preferred stimuli from a set of options
- Overcome the fear from using video call
- Ensure the continuation of using the application

3. Application Components Survey was designed, then filled by 2,536 autistic individuals and medical professionals to optimize the application to their likings and make sure the application goals are met

4. The application was built using Flutter cross platform language as shown in Fig.1

5. Social Communication Questionnaire (SCQ) (Snow.,1970) was filled by the parents to assess the social communication of the cases

6. Mild autistic children (ages 4-6) were recruited from Al Amal Autism Centers, with its two branches in Sharkya and Luxor by inclusion and exclusion criteria according to age

7. 300 male and female cases (150 from Upper Egypt and 150 from Lower Egypt) communicated through video call to complete a puzzle game by using the application for a duration of 12 weeks at the rate of 1 hour daily. An additional 100 participants did not try the application to serve as a control group

8. Each case was provided the positive reinforcements they chose gradually from least to most

9. SCQ was conducted for the second time after the end of the 12 weeks

10. Analysis for the data was conducted using t-test (unpaired/paired)

11. As a follow up, SCQ was conducted again 4 weeks after experimentation to test the effects of stopping the use of the application on the SCQ results

6. Application Goals

- Have friendly UX (user experience) and UI (user interface) for autistic children with colors that:
  - Improve attention - Have calming effect
- Encourage autistic children to talk to each other by asking questions and giving responses through video call
- Improve the act of describing things for autistic children by playing group games like a puzzle
- Provide an automated positive reinforcement for each child that is built based on each child's likings

Generation of the personalized automated positive reinforcement list:

- **Why?**

ABA (Applied Behavior Analysis) therapy relies on positive reinforcement, increasing the likelihood that the behavior will occur again.

- **How?**

Paired Stimulus (PS) preference assessment is used to generate a personalized positive reinforcement list that prioritizes children preferred stimuli from a set of options

- **Where?**

This was implemented by showing multiple sets of 2 choices of positive stimuli for children to choose from as shown in Fig.2.

- **When?**

The medical professional assisted the child participant to complete the personalized positive reinforcement list during the first setting of using the application.

Figure 2

The flow of the personalized positive reinforcement list

7. Experimentation

1. **Application components survey:**

- Aim:

To optimize the application to autistic children likings and validate the effectiveness of every component in the application

- **Participants:**

2,536 Autistic Children & Medical Professionals

Where: 436 centers for autism

How: The psychologist would explain it to the child

- **Survey verification:**

Verified by the qualified scientist

- **Scale:**

Likert Scale

- **Survey components**

The survey consisted of 13 questions to ask about the following aspects of the application's interface:

- Background color
- Button color
- Positive reinforcement
- Puzzle

2. Application experimentation:

- Intervention:

The intervention is a mobile application designed to improve social communication skills of mild autistic children. The application includes video call based group games that target specific social communication skills: making eye contact, initiating conversation, and responding to social cues. The application will be available for download on the participants' devices and will be used for 1 hour daily, seven days per week, for 12 weeks.

- Outcome measures:

The primary outcome measure will be the Social Communication Questionnaire (SCQ) Current, which is a 40-item, short screening tool for parents that focuses on questions about social communication that are likely to be noticed by primary care givers (Tran et al., 2021). The SCQ only accepts dichotomous "yes" or "no" answers, and each scored item is worth one point for abnormal behavior and zero points for neither the absence of abnormal behavior/normal behavior. The sensitivity of the questionnaire is 89.2% and its specificity is 84.3%. The use of the SCQ was validated by Dr. Hazem Shalaby.

- **Independent variable:** Demographic Area and Gender

- **Dependent variable:** Social Communication Level

- **Participants:** An Experimental Group of 300 mild autistic children aged 4 to 6

Experimental Group					
300 Child Participants					
150 Lower Egypt			150 Upper Egypt		
50 F.F	50 F.M	50 M.M	50 F.F	50 F.M	50 M.M
20 SCQ refrence					

KEY
M = male
F = female
SCQ = Social Communication questionnaire results

Control Group					
100 Child Participants					
50 Lower Egypt			50 Upper Egypt		
20 F.F	10 F.M	20 M.M	20 F.F	10 F.M	20 M.M
20 SCQ reference					

Control group:

There are additional 100 mild autistic did not try the application to serve as the control groups with the following specifications:

Recruitment:

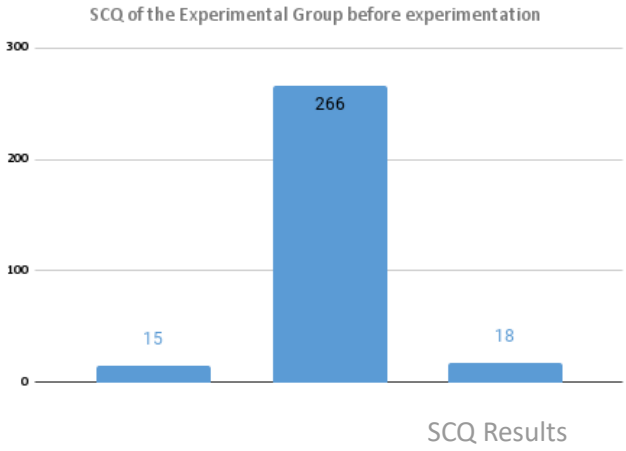
The cases from Lower Egypt (urban regions) are obtained from Al Amal Center for Autistic Children, Zagazig, Sharkya branch and the cases from Upper Egypt (rural regions) are obtained from Luxor city, Luxor branch of the same center under the supervision of Dr. Hazem Shalaby, the owner of the center

Experiment procedures:

1. The standard Social Communication Questionnaire Current (SCQ) is filled by the parents of the cases prior to the experimentation to assess the Social Communication level. After collecting the SCQ results before experimentation, it was found that they range between 19, 20 and 21, where 266 out of the 300 participants were 20 so 20 SCQ was set as a reference to facilitate the analysis later as shown in Fig.3.

Figure 3

The SCQ results of the participants before the experimentation



2. The application is tried by the 300 cases in groups of 4 for a duration of 12 weeks at the rate of 1 game daily under the supervision of the researchers as follow:

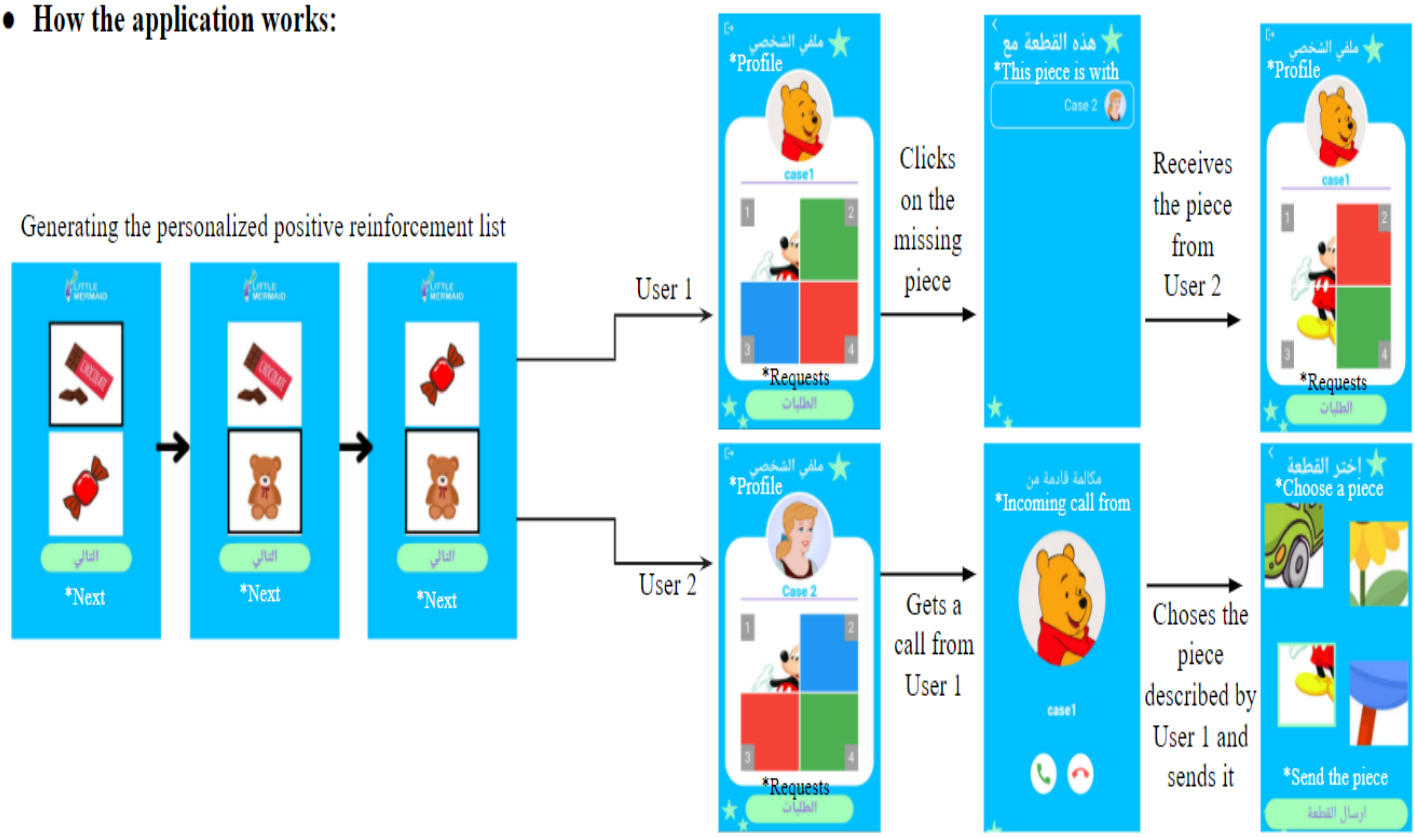
- An account is created on the application for every child
- Images of positive reinforcements are displayed on the screen in Paired Stimulus Preference Assessment (PS) (Wainer, et al.,2010), which systematically presentes all the selected items paired with each other and alternating sides of presentation. In this step, an automatic personalised positive reinforcement will be generated in the application based on the child choices
- A profile appears for the case with his/her first name only and a puzzle with 3 missing pieces
- The case presses on one of the missing pieces of the puzzle and a list of other cases that has this puzzle piece displayed in front of him/her

- The case presses on one of the displayed cases and perform a video call with him/her. In this stage, the child asks for the missing puzzle piece in his profile by describing its color and content verbally to the child at the other side of the call as shown in Fig.4
- The other case for whom the puzzle piece was described sends the puzzle piece and it immediately appears on the profile of the first case, repeating this for the two other pieces until the puzzle is completed by the case ensuring the communication with 3 other cases
- After the puzzle is finished, a screen appears showing one of the positive reinforcements that the child chooses. This positive reinforcement will be the last one in the order of preferences of the child to ensure that the positive reinforcements will be given gradually from the least to the most

Figure 4

An illustration of how the application works

- **How the application works:**



3. The Social Communication Questionnaire is conducted for the second time after the end of the 12 weeks' duration to evaluate the usefulness and efficiency of the application

4. Finally, Social Communication Questionnaire is conducted again 4 weeks after the end of the program as a follow up for the validity of the program

8. Results & Analysis

1. Application Component Survey:

A sample of the answers to questions in the survey as shown in Fig.5 and Fig.6 has led to a modification in the UI of the application as shown in Fig.7.

Figure 5

The ratings of the participants to the use of purple color in the application

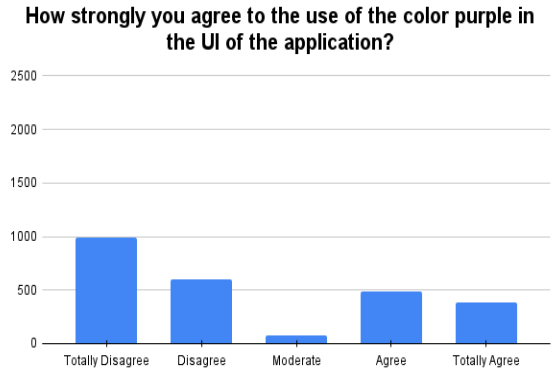
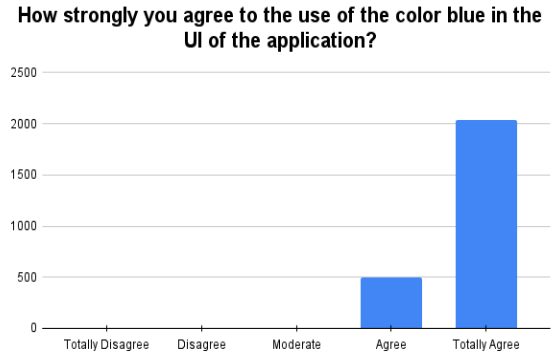


Figure 6

The ratings of the participants to the use of blue color in the application



- The answers indicated higher rates for the use of the color blue than the color purple as the main color for the application
- The puzzle pieces were of little contrast and had to be modified to cartoon puzzles
- About 68% of the participants totally supported the use of the personalized positive reinforcement list

Modifications made to the application based on the answers of the Application Components Survey

Quantitative analysis:

Unpaired t-test indicated a statically significant variance between the social communication of the Control Group after regular therapy and the Experimental Group after trying the application

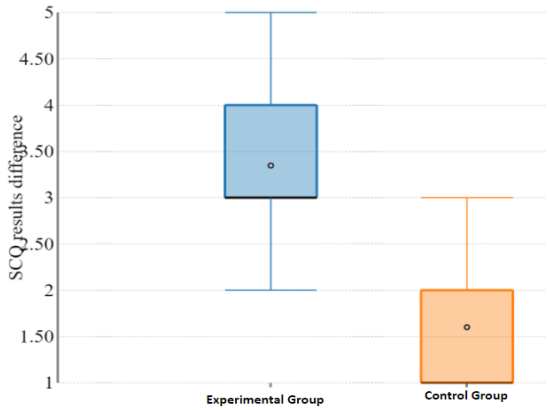
- P-value = 0.0001
- The mean of Control Group SCQ results after regular therapy minus Experimental Group SCQ results after using the application equals 1.7

Paired t-test indicated a statically significant variance between the elevation in social communication of the Control Group that did not try the application and the Experimental Group that tried the application as shown in Fig. 8.

- P-value = 0.0001
- 95% confidence interval of this difference: From 2.80 to 3.02

Figure 8

The difference in SCQ results between the Control Group that did not try the application and the Experimental Group that used the application

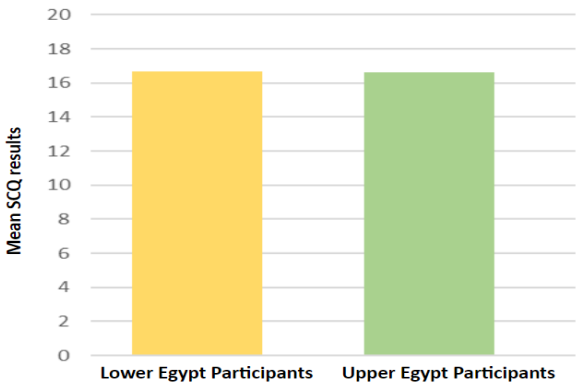


Further **subgroup analysis** was made using unpaired t-test to evaluate the presence of any difference between the elevations of social communication of:

- Upper Egypt participants or Lower Egypt participants.
- Male or female participants
- Unpaired t-test determined no significant difference between the elevation of social communication between participants from Lower Egypt and Upper Egypt

Figure 9

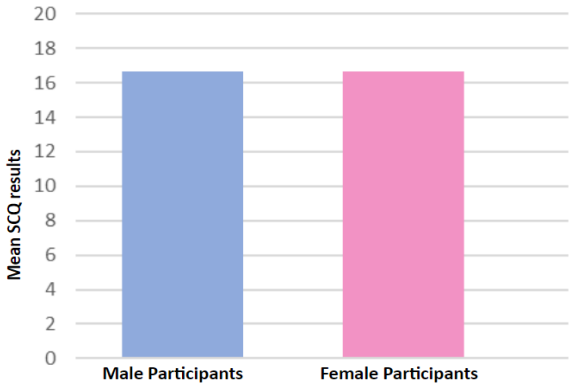
The mean SCQ results between the participants from Upper Egypt and Lower Egypt after using the application



- Unpaired t-test determined no significant difference between the elevation of social communication between male and female participants as shown in Fig.10.

Figure 10

The mean SCQ results between the participants from Upper Egypt and Lower Egypt after using the application



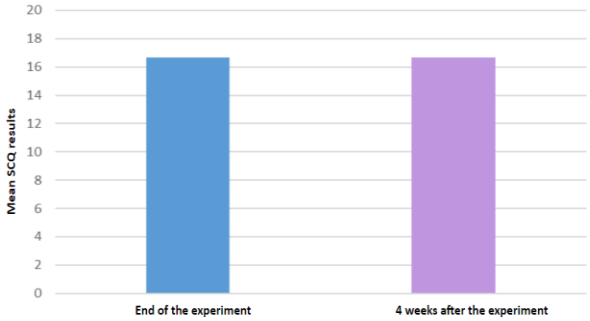
A follow-up was conducted 4 weeks after the end of the 12 weeks of using the application for the experimental group in order to detect any changes in the SCQ results after stopping the use of the application

- The mean of the SCQ results of the experimental group after 4 weeks from the end of the experimentation indicated no decrease in social communication in this duration as shown in Fig.11.

- Parents indicated no occurrence of abnormal behaviour that would affect the SCQ results

Figure 11

The meaning between the SCQ results for the Experimental Group immediately after using the application and after the follow-up



Qualitative analysis:

Positive Feedback from parents of:

Cases: 1,5,25,48,66,96&143
developed better eye contact (Week:2)

Cases: 23,24,70,89,93,200 & 235
responsive to their name called (Week:2)

Case: 23
initiated a conversation with his neighbor (Week:4)

Cases: 3,7,10,22,35,36,40,47&100
less repetition of words (Week:10)

Case: 297
played with her older brother for the first time (Week:12)

Negative Feedback from parents of:

Cases: 5,8,34,56,70,89,102,145,256
increase in screen time (Week:1)

However, using the application only requires 1 hour from the 2 hours provided by the parents to their children

9. Conclusions and project features

- First application to use video call to improve social communication for preschool mild autistic children to be prepared for primary education
- Has suitable UX and UI for autistic children
- Provides automated personalized positive reinforcement list for each child based on Paired Stimulus Preference Assessment
- Can be used by children from both genders with different socioeconomic backgrounds in rural and urban areas
- Virtual, so it Involves minimal parental interaction and saves time and effort for psychiatrist

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