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**RESEARCH ARTICLE**

# The Effect of an AI-Powered Application Visual2Go on English Vocabulary Acquisition Among Iraqi EFL Children with Autism Spectrum Disorder

**Ali AL-Zurfi [1*], Ruqayya Ayoub Kareem[2], & Jannat Mohammed Yaqoub[3]**

*[1]Department of English, Faculty of Education, University of Kufa, Najaf, Iraq*
*[2]Department of English, Faculty of Education, University of Kufa, Najaf, Iraq*
*[3]Department of English, Faculty of Education, University of Kufa, Najaf, Iraq*

*** Corresponding Author**: **Ali AL-Zurfi**, **E-mail**: alif.alzurfi@uokufa.edu.iq

**ABSTRACT**

This experimental study examines the impact of an AI-powered application, Visuals2Go, on English vocabulary acquisition among Iraqi EFL children with Autism Spectrum Disorder (ASD). Using a post-test-only control group design, 28 children (ages 6–8) were divided into an experimental group (n=13) using the AI application and a control group (n=15) receiving traditional instruction. After a six-week intervention, the Mann-Whitney U test showed a significant difference (U = 46.0, p = .023), with the experimental group (Mean Rank = 17.46) significantly outperforming the control group (Mean Rank = 11.93). The medium-to-large effect size (r = 0.43) suggests that AI-powered tools, when delivered in a peaceful, supportive environment, are highly effective for Vocabulary acquisition in autistic learners in the Iraqi context.

**Keywords**: AI-powered application, Autism Spectrum Disorder, EFL children, English vocabulary acquisition, Visuals2Go.

## 1. INTRODUCTION

Language development is essential for cognitive and social growth in early childhood. Children with language delays often face challenges in comprehension and communication, which can persist into adulthood (Tsai et al., 2025). Among these children, ASD represents a significant population characterized by deficits in social communication and language skills (American Psychiatric Association, 2013). Children with ASD commonly experience speech and language delays, learning difficulties, and challenges in social interaction (Santrock, 2007). The prevalence of autism has increased globally. In the United States, over 11% of children aged 6 to 17 have special needs, with autism affecting approximately 1% (Wirt et al., 2000). In Iraq, research on autism remains limited, though a case study revealed severe receptive language impairments in an Iraqi autistic child (Al-Hussein & Mulla Khassaf, 2023).

### 1.1. Teaching English to Children with ASD

Teaching English as a foreign language to children with ASD presents unique challenges (Olszak, 2025). Research in Dohuk, Iraq, found that EFL teachers face numerous difficulties when instructing autistic learners in inclusive classrooms (Ismael, 2022). These challenges include limited vocabulary generalization, difficulty maintaining engagement, and the need for customized teaching approaches (Andreou & Argatzopoulou, 2025). Additionally, children with ASD often exhibit atypical vocabulary organization requiring specialized instructional methods (Fowler et al., 2022).

### 1.2. Students with Autism

As Zigler (2002) stated, an increasing number of special needs students, particularly those with ASD, are enrolling in regular or inclusive schools. Due to certain dominant characteristics, such as low intelligence and difficulty

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understanding academic materials (Santrock, 2007), these students may be easily identified. Santrock (2007) noted that most students with autism experience speech and language delays, learning difficulties, or even hearing impairments. They also face challenges in adapting, communicating, and interacting with their peers and surroundings. These students may require an easily understood environment with minimal distractions and sensory stimuli to reduce anxiety. Regarding support systems, they may need learning and behavioral support, appropriate teaching approaches, and a "safe place" to regulate their emotions. These characteristics demonstrate that special needs students, specifically autistic children, require specialized interventions in their daily lives (Santrock, 2007).

The United Nations (2015) proposed a regulation requiring institutions to uphold respect for human rights, fair and non-discriminatory processes, and equal opportunities, ensuring that no individual is excluded or discriminated against. In response to this, many schools now accept students with autism, as addressing students with diverse learning needs and abilities has become a responsibility of general education teachers (Robertson et al., 2003). Additionally, some parents have expressed a preference for enrolling their autistic children in regular schools to ensure they receive the same quality of education as their typically developing peers (Padmadewi & Artini, 2017).

### 1.3. Technology-Enhanced Language Interventions

Recent advances in artificial intelligence offer promising tools for language intervention in ASD (Tsai et al., 2025). A pilot study using a generative AI-powered platform demonstrated significant language improvements in children with ASD, including increased vocabulary production and sentence length (Tsai et al., 2025). Systematic reviews confirm that technology-assisted interventions can effectively improve vocabulary skills in children with ASD (Solo et al., 2025). However, research in Iraq on such interventions remains scarce (Ismael, 2022).

Significant gaps exist in the literature. First, limited research has been conducted on ASD and language interventions in Iraq (Al-Hussein & Mulla Khassaf, 2023). Second, no studies have specifically examined AI-powered applications for English vocabulary acquisition among Iraqi EFL children with ASD (Andreou & Argatzopoulou, 2025; Solo et al., 2025).

### 1.4. Research Questions

This study attempts to answer the following questions:

1. Is there a significant difference in English vocabulary acquisition between Iraqi EFL children with ASD who use an AI-powered application and those who receive traditional instruction?
2. What is the effect size of the AI-powered application on English vocabulary acquisition among Iraqi EFL children with ASD?

## 2. LITERATURE REVIEW

### 2.1. Previous Studies

In a qualitative case study, Olszak (2025) investigated teaching English to primary students with ASD in Poland. The study involved an English teacher and a gifted ASD English learner participating in an individual teaching program. The findings revealed that teaching English to students with ASD is extremely multifaceted, with numerous critical tasks and challenges that teachers must navigate. The research emphasized that for students with special needs, teachers' roles become even more important and cannot be underestimated. Effective teaching practices identified included Universal Design for Learning principles, structured approaches such as the TEACCH method, visual supports, and the integration of technological tools.

According to Andreou and Argatzopoulou (2025), a systematic review following PRISMA guidelines examined foreign language learning interventions for students with neurodevelopmental disorders, including ASD, ADHD, and intellectual disabilities. The review included seven empirical studies, with four focusing specifically on ASD participants. The authors identified several effective intervention approaches, including the Picture Exchange Communication System, augmented reality, virtual reality, storytelling techniques, and gamification. These approaches demonstrated positive effects on vocabulary development, student engagement, and confidence. The review also identified significant research gaps, including limited generalization of findings, small sample sizes, and a scarcity of large-scale quantitative research. The authors noted that technological applications such as virtual reality, augmented reality, and artificial intelligence have transformed foreign language instruction by offering interactive and authentic contexts that maintain learner motivation and engagement.

A study by Sandra and Kurniawati (2020) examined the application of differentiated instruction strategies in teaching English to students with ASD through a case study approach. The findings demonstrated that differentiated instruction, which involves tailoring content, process, product, and learning environment to meet individual student needs, is essential for effectively teaching English to students with ASD. The study emphasized

that one-size-fits-all approaches are ineffective for this heterogeneous population, and individualized teaching strategies are necessary for successful language acquisition outcomes.

In their investigation of specialized reading modules for students with non-verbal autism, Toran and Mohamed (2020) demonstrated that structured reading modules incorporating visual supports and systematic instructional approaches can effectively support literacy and vocabulary development in non-verbal children with ASD. The findings supported the use of visually-based, structured interventions for vocabulary instruction with this population.

A study conducted by Fowler et al. (2022) examined language development patterns in children with ASD, focusing on the relationship between early language abilities and later outcomes. The research highlighted that lexical-semantic abilities in children with ASD are often relatively spared compared to syntax and pragmatics. However, the study revealed that the underlying organization of the lexicon may be atypical, with reduced integration and compartmentalized lexical entries. This finding has important implications for vocabulary instruction, suggesting that autistic children may require different approaches to building semantic networks.

As reported by Ong and Styles (2026), an ongoing systematic review is examining the effects of multilingual exposure on language and developmental outcomes in children with ASD across different geographic and linguistic contexts. This ongoing review (under embargo until April 2026) notes that existing studies on language interventions for children with ASD have largely focused on Western contexts with participants predominantly drawn from monolingual backgrounds, highlighting the need for research in Asian and other multilingual contexts. This study is particularly relevant for the Iraqi EFL context where children with ASD are learning English as a foreign language while maintaining their native Arabic language skills.

Evidence from Launay and colleagues (2025) comes from a systematic review examining written production skills across the lifespan in individuals with ASD. The review synthesized findings from studies investigating spelling, grammar, vocabulary use, and narrative abilities in written language. The findings indicated that while some individuals with ASD demonstrate strengths in spelling and decoding, difficulties often emerge in vocabulary selection, sentence structure, and narrative coherence. The review highlighted the importance of explicit instruction in vocabulary and organizational strategies for supporting written language development in ASD.

## 3. METHODOLOGY

### 3.1. Research Design

The researchers employed an experimental post-test only design. This was chosen to minimize "testing fatigue" and anxiety in the children, ensuring the final results reflected their actual learning gains over the six weeks rather than their familiarity with the test format.

### 3.2. Participants

The current study included (28) Iraqi children aged (6-8) years old diagnosed with ASD. Participants were selected purposively from a specialized private institute for children with ASD in Iraq. The sample was predominantly male (26 boys and 2 girls), which is consistent with international prevalence rates for the disorder. The language background of all participants was homogeneous, as they were all native Arabic speakers, with no previous experience with AI-powered language programs or applications.

To ensure strict group equivalence before the study, the 28 participants received extensive screening to establish baseline equivalence on key developmental and environmental factors. Clinical records of the private institute were first examined to ensure that all children fell in a similar range of mild-to-moderate ASD severity. Second, a preliminary demographic and administrative mapping confirmed that all children were within the same narrow age range (6–8 years) and had received comparable lengths of foundational traditional speech-language therapy at the institute. Finally, participants were randomly assigned into the experimental group (n=13) or the control group (n=15) to eliminate socioeconomic or environmental selection bias.

### 3.3. Instruments

#### *3.3.1. Post-test of Vocabulary Administration*

To understand the assessment process, the application of the research tool is mapped onto the following structural dimensions:

•What was used: A customized, visual Vocabulary Post test developed to measure acquisition and identification of explicit English nouns and verbs taught during the study.

• How it was applied: The test was administered individually using pictorial flashcards and visual prompts in hig hly controlled, identical environmental conditions.

•The children were asked to identify, point to, or verbally name the target English vocabulary items associated with the presented images.

• When was it applied: The assessment was conducted immediately following the 6-week instructional intervention period.
• Who administered it: The testing sessions were administered by the primary researchers, who were trained EFL educators from the University of Kufa.
• To whom it was applied: The test was applied to all 28 Iraqi EFL children involved in the study in the experimental group (n=13) and control group (n=15).
- Application setting: The evaluation was performed at the private institute for children with ASD, in a dedicated quiet low-stimulus testing room, to reduce sensory distractions and anxiety.

### 3.4. Intervention

#### *3.4.1. Experimental Group Intervention Protocol*

The experimental group (n=13) interacted dynamically with the Visuals2Go application for six weeks. Sessions were conducted on a high definition screen, with bright, high-contrast digital symbols, and integrated high-fidelity speakers, which provided clear, AI-generated English text-to-speech pronunciations. Researchers used an interactive teaching method, encouraging the children to verbally imitate and patiently repeat the vocabulary. Non-responsive or slow-to-engage learners received additional instructional time and gentle scaffolding to build confidence, but not pressure. Critically, an adaptive environment was used in which children were given complete freedom to move (e.g. change seats, pace, or have short play breaks). The atmosphere was fully supportive, intentionally excluding warnings, scoldings, or restricting commands to conform with the particular sensory profiles of children with ASD.

#### *3.4.2. Control Group Intervention Protocol*

The control group (n=15) was taught vocabulary in a traditional way for the same 6-week period. Instruction was delivered by a certified special education teacher using non-digital means such as physical flashcards, verbal repetition drills, and paper worksheets. The group received training in a traditional classroom setting with no digital screens, multi-sensory speakers or AI-based communication supports.

### 3.5. Validity and Reliability

Systematic validity and reliability measures were established to ensure the academic validation, psychometric rigor and robustness of the visual Vocabulary Post-test:

#### *3.5.1. Content and Face Validity*

The original form of the vocabulary test was given to a panel of five expert referees in the fields of Applied Linguistics, Methods of Teaching English as a Foreign Language (TEFL), and Special Education/Autism Studies. Experts rated the test items for appropriateness for children with ASD, clarity of the visual images, and linguistic match to the vocabulary taught. To ensure strong content validity, items with less than 80% agreement were revised or replaced based on feedback.

#### *3.5.2. Pilot Testing and Reliability*

Before the main study, a pilot study was completed with a small, independent sample of four autistic children that matched the target demographic (these children were excluded from the final sample). The pilot test showed that the visual layout was very accessible and did not cause testing fatigue. Cronbach's alpha was computed for internal consistency reliability on the pilot data, with a coefficient of 0.84. Furthermore, a test-retest reliability procedure was performed on the pilot group two weeks apart, which showed a high stability coefficient (r = 0.88), confirming the reliability and accuracy of the instrument for research verification.
AI-Powered Application (Visuals2Go): This AAC (Augmentative and Alternative Communication) tool served as the primary intervention. It utilizes an extensive library of symbols and images designed to support learners with communication difficulties. Key features include:

- **Customization:** The ability to record custom English audio to match local pedagogical needs.
- **Sentence Strip:** A specialized feature that allows children to transition from single-word recognition to building full sentences, thereby expanding their functional vocabulary.
- **Subscription Model:** The application offers a two-week free trial period, after which users can opt for either a monthly or annual subscription
- **Vocabulary Post-test:** A visually-based assessment was developed to measure the acquisition of the specific English nouns and verbs taught during the six weeks.

### 3.6. Procedures

The study followed a structured instructional protocol over a six-week treatment period. Ethical approval was formally obtained from the Faculty of Education at the University of Kufa (English Department) and the administration of the private institute for children with ASD. Informed consent was secured from all parents and legal guardians before the intervention began.

- **Experimental Group Intervention:** For six weeks, the experimental group engaged with the Visuals2Go application. To ensure maximum clarity and engagement, the researchers utilized a high-definition screen to display the application's vibrant images, while the integrated speakers of the screen provided the AI-generated English pronunciation.
- **Instructional Approach:** The researchers actively encouraged the children to pronounce and repeat the vocabulary along with the app. Special attention and extra patience were given to students who were initially non-responsive or slow to engage, using gentle encouragement to build their confidence without pressure.
- **Adaptive Environment:** A key feature of the intervention was the total freedom of movement allowed during sessions. The children were free to change their seating, walk around the room, or play at times. The researchers maintained a peaceful and interesting atmosphere, intentionally avoiding any warnings, rebukes, or restrictive commands. This created a high-interest, low-stress environment that respected the sensory and behavioral needs of children with ASD.
- **Control Group Intervention:** The control group received traditional instruction for the same six-week duration. Lessons were delivered by a teacher using conventional methods, such as physical flashcards, verbal repetition, and paper-based worksheets. This group was taught in a standard classroom setting without the use of the digital screen or the AI-powered application.
- **Assessment:** Following the six-week intervention, both groups were administered a vocabulary post-test under identical conditions. This test measured the children's ability to recognize and name the English vocabulary items covered during the study to compare the effectiveness of the two instructional methods.

## 4. RESULTS

### 4.1. Normality Testing

Before conducting the main analysis, the Shapiro-Wilk test was employed to assess the normality of post-test score distributions.

**Table 1.** Test of normality (Shapiro-Wilk)

| Group | Statistic (W) | df | p-value |
|---|---|---|---|
| Control | 0.849 | 15 | 0.0169 |
| Experimental | 0.863 | 13 | 0.0423 |

The Shapiro-Wilk test revealed that post-test scores were not normally distributed in either the control group ($W = 0.849$, $p = .017$) or the experimental group ($W = 0.863$, $p = .042$). Thus, a non-parametric approach (Mann-Whitney U) was employed as the primary analytical method.

### 4.2. Descriptive Statistics

**Table 2.** Descriptive statistics

| Group | N | | Mean | Std. Deviation |
|---|---|---|---|---|
| Control | 15 | | 12.73 | 8.05 |
| Experimental | 13 | | 20.00 | 4.08 |

The experimental group achieved a higher mean score (20.00) compared to the control group (12.73), with less variability (SD = 4.08 vs. 8.05).

### 4.3. Homogeneity of Variance

**Table 3.** Test of homogeneity of variance (Levene's test)

| F | df1 | df2 | p-value |
|---|---|---|---|
| 2.344 | 1 | 26 | 0.138 |

Levene's test confirmed that the assumption of homogeneity of variances was satisfied, $F(1, 26) = 2.344$, $p = 0.138$, as the p-value exceeded 0.05.

### 4.4. Independent Samples t-Test (Descriptive Purposes)

**Table 4.** Independent samples t-test

| Test Type | T | df | p-value (2-tailed) | Mean Difference | 95% CI Lower | 95% CI Upper |
|---|---|---|---|---|---|---|
| Student's t-test | -2.472 | 26 | 0.0203 | -7.27 | -13.31 | -1.23 |
| Welch's t-test | -2.450 | 23.63 | 0.0220 | -7.27 | -13.32 | -1.21 |

An independent samples t-test was conducted to compare post-test vocabulary scores between the control group (n = 15) and the experimental group (n = 13). The results showed a statistically significant difference between the two groups, t(26) = -2.472, p = .020, with the experimental group (M = 20.00, SD = 4.08) scoring significantly higher than the control group (M = 12.73, SD = 8.05). The mean difference was -7.27 (95% CI: -13.31 to -1.23), indicating that the experimental group outperformed the control group by approximately 7.27 points. The assumption of homogeneity of variances was met (Levene's test, p = .138); however, the assumption of normality was violated (Shapiro-Wilk, p < .05 for both groups). Therefore, while the t-test suggests a significant difference, these results should be interpreted with caution, and the non-parametric Mann-Whitney U test is considered more appropriate for this analysis.

### 4.5. Primary Analysis: Mann-Whitney U Test

**Table 5.** Rank-based descriptive statistics for post-test scores across groups

| Group | N | Mean Rank |
|---|---|---|
| Control | 15 | 11.93 |
| Experimental | 13 | 17.46 |

The experimental group demonstrated superior performance (Mean Rank = 17.46) compared to the control group (Mean Rank = 11.93), indicating that the AI-supported program was more effective for vocabulary acquisition.

**Table 6.** Comparison of post-test scores between control and experimental groups

| Variable | Control (n=15) | Experimental (n=13) | Test Statistic | p-value | Effect Size |
|---|---|---|---|---|---|
| Post-test Score (M ± SD) | 12.73 ± 8.05 | 20.00 ± 4.08 | U = 46.0 | 0.023 | r = 0.43 |
| Median (Range) | 15 (0–25) | 20 (15–25) | Z = -2.278 | | |

A Mann-Whitney U test was conducted to compare post-test vocabulary scores between the control group (n = 15) and the experimental group (n = 13). Results revealed a statistically significant difference, U = 46.0, Z = -2.278, p = .023, with the experimental group (Mean Rank = 17.46) scoring higher than the control group (Mean Rank = 11.93). The effect size was medium to large, r = 0.43, indicating that the AI-supported digital program was more effective than traditional instruction in enhancing vocabulary acquisition.

Although the data for one of the groups did not fully meet the assumption of normality, an independent samples t-test was conducted to provide traditional descriptive statistics, including the mean, standard deviation (Mean ± SD). The primary statistical analysis, however, was the Mann-Whitney U test, which is more suitable and reliable for non-normal distributions. Therefore, the t-test results are presented solely for descriptive purposes and should not be considered the basis for statistical inference.

## 5. DISCUSSION

The primary finding of this study is that the AI-powered electronic application significantly improved English vocabulary acquisition among Iraqi EFL children with ASD compared to traditional instruction. This result addresses both research questions: (1) there is a significant difference between the two instructional approaches, and (2) the effect size (r = 0.43) indicates a medium to large practical significance.

This finding aligns with previous research demonstrating the effectiveness of technology-assisted interventions for children with ASD. Tsai et al. (2025) reported significant language improvements in children with ASD using a generative AI-powered platform, including increased vocabulary production. Similarly, Solo et al. (2025) confirmed through systematic review that technology-assisted interventions effectively improve vocabulary skills in children with ASD. The present study extends these findings to the Iraqi EFL context, where such research has been notably absent.

The results also corroborate the findings of Andreou and Argatzopoulou (2025), who identified technological applications such as virtual reality, augmented reality, and artificial intelligence as transformative tools for foreign language instruction for students with neurodevelopmental disorders. The interactive and adaptive features of the AI-powered application in this study likely contributed to maintaining learner motivation and engagement, which are critical factors for successful language acquisition in children with ASD (Andreou & Argatzopoulou, 2025).

The effectiveness of the AI-powered application may be explained by several mechanisms. First, children with ASD often demonstrate atypical lexical organization with reduced integration and compartmentalized lexical entries (Fowler et al., 2022). AI-powered applications can provide repeated, structured exposure to vocabulary in varied contexts, potentially facilitating the development of more integrated semantic networks. Second, the visual supports and interactive features inherent in the application align with effective teaching practices identified by Olszak (2025), including visual supports and technological integration. Third, the adaptive nature of AI applications allows for individualized pacing, addressing the heterogeneous needs of children with ASD as emphasized by Sandra and Kurniawati (2020).

The finding that the experimental group showed less variability in scores (SD = 4.08) compared to the control group (SD = 8.05) is particularly noteworthy. This reduced variability suggests that the AI-powered application may have provided more consistent learning outcomes across participants, potentially by accommodating individual differences in learning styles and pacing. This consistency is valuable in educational settings where predictable outcomes are desired.

The significant difference between groups despite the small sample size (N = 28) highlights the practical significance of the intervention. The medium to large effect size (r = 0.43) indicates that the AI-powered application not only produced statistically significant results but also meaningful practical improvements in vocabulary acquisition.

## 6. CONCLUSION

This study investigated the effect of an AI-powered electronic application on English vocabulary acquisition among Iraqi EFL children with ASD. The findings demonstrate that the AI-powered application significantly outperformed traditional instruction, with a medium to large effect size. These results contribute to the limited body of research on technology-enhanced language interventions for children with ASD in Iraq and suggest that AI-powered applications represent a promising tool for vocabulary instruction in this population.

The implications for practice are significant. Educators and speech-language therapists working with children with ASD should consider integrating AI-powered applications into their instructional repertoires. Such applications can provide consistent, individualized, and engaging vocabulary instruction that addresses the unique learning characteristics of children with ASD. For the Iraqi context, where research on ASD interventions remains scarce, these findings offer initial evidence supporting the adoption of technology-enhanced approaches.

However, several limitations should be acknowledged. The sample size was relatively small, limiting generalizability. The study employed a post-test only design, which, while appropriate for this population, does not capture individual growth trajectories. Additionally, the study did not assess long-term retention of vocabulary gains. Future research should include larger samples, longitudinal follow-up assessments, and exploration of which specific features of AI applications are most effective for different subgroups of children with ASD.

Future research should examine the long-term effects of AI-powered vocabulary instruction, investigate the specific features that contribute to effectiveness, and explore the application of such technologies for other language skills beyond vocabulary. Additionally, research examining the integration of AI applications with other evidence-based practices for ASD would provide valuable insights for developing comprehensive intervention approaches.

While the findings yield positive evidence for AI-powered vocabulary acquisition, several inherent limitations must be addressed, which directly inform paths for future scientific inquiry. First, the sample size was relatively small (N=28), which inherently restricts the broad generalizability of the statistical outcomes to the wider population of EFL learners with ASD. To overcome this limitation, future research should utilize larger, multi-center samples across diverse geographic regions within Iraq to enhance external validity.

Second, the study strictly employed a post-test-only experimental design. While this framework was chosen strategically to minimize testing fatigue and anxiety in young children with autism, it does not capture individual baseline growth trajectories or longitudinal learning curves. Consequently, subsequent studies should implement longitudinal designs incorporating delayed retention post-tests to examine whether the vocabulary gains facilitated by the *Visuals2Go* app are structurally maintained over long-term periods.

Finally, this investigation evaluated the overall impact of the app without isolating individual system variables. Because autism is a highly heterogeneous spectrum, future investigations should explore which specific components of AI applications (e.g., customized voice recording, interactive sentence strips, or visual symbol density) are most effective for distinct behavioral and cognitive subgroups of children with ASD, and how these digital tools can be integrated with existing evidence-based behavioral practices.

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**Ethical Statement:** The study was conducted in accordance with academic ethical standards. Participation in the study was voluntary, and informed consent was obtained from all participants. Confidentiality and anonymity of the participants were maintained throughout the research process.

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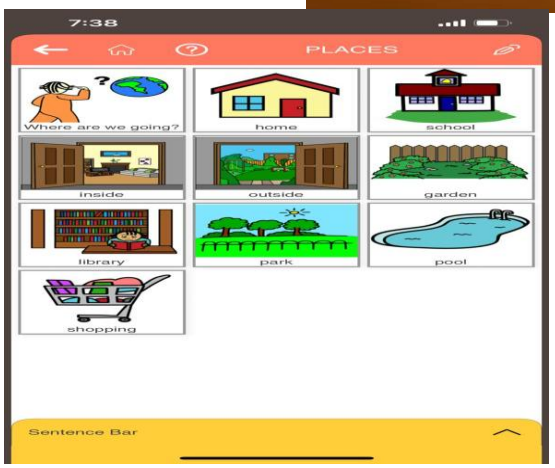
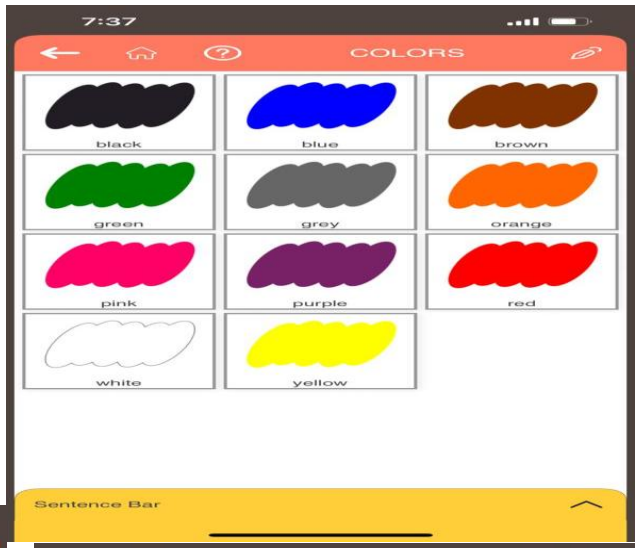
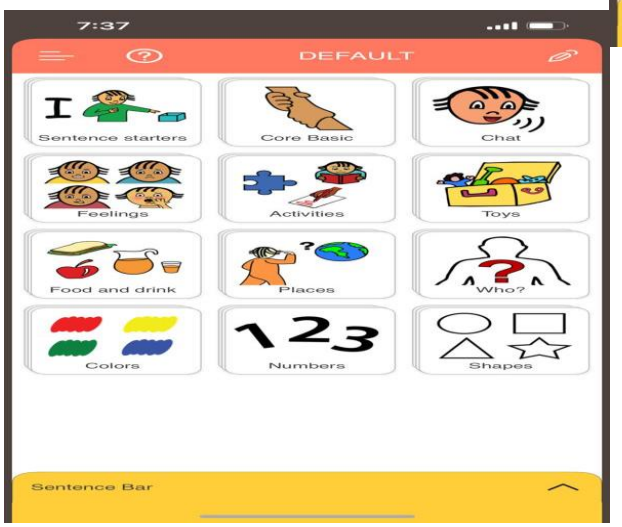
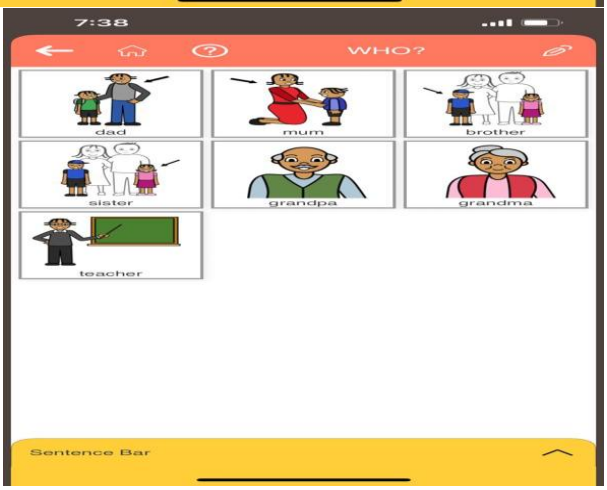
**Appendix (A):** The application (Visuals2Go)

**Appendix B:** Some pictures of the treatment period