

## Research article

# Evaluation of the effectiveness of a serious game titled “Kookism” on the receptive lexicon in 4-9-year-old autistic children

Elham Hesami<sup>a,\*</sup>, Nour Mohammad Bakhshani<sup>b</sup>, Maryam Arabpour Dahouie<sup>c</sup>,  
Younes Zaheri<sup>d</sup>

<sup>a</sup> Zahedan University of Medical Sciences, Iran

<sup>b</sup> School of Medicine, Children and Adolescents Health Research Center, the Research Institute of Cellular and Molecular Sciences in Infectious Diseases, Zahedan University of Medical Sciences, Iran

<sup>c</sup> Department of Speech Therapy, School of Rehabilitation Sciences, Health Promotion Research Center, Zahedan University of Medical Sciences, Iran

<sup>d</sup> Department of Clinical Psychology, School of Behavioral Sciences and Mental Health (Tehran Institute of Psychiatry), Iran University of Mental Science, Tehran, Iran

## ARTICLE INFO

## Keywords:

Autism  
Receptive lexicon  
Semantic skills  
Serious game  
Speech therapy

## ABSTRACT

**Background:** Autistic children often face difficulties with semantic skills such as receptive lexicon. Games based on behavioral principles have been emphasized for treating autistic children. Serious Games are a new and effective way to alleviate deficits in autistic children.

**Objectives:** The present study aimed to design and investigate the efficiency of a Serious Game titled “Kookism” on the receptive lexicon of autistic children.

**Methods:** The empirical study with a pretest-posttest design, and a two-months follow-up, involved 30 children (aged 4–9) at Birjand and Zahedan, Iran. The participants were selected by convenience sampling and randomly divided into experimental and control groups (each 15 participants). The control group received the Applied Behavior Analysis (ABA), while the experimental group received a treatment consisting of the ABA plus the “Kookism” game. The 20-min sessions were held every other day for two months. Data were collected using MacArthur-Bates Communicative Development Inventories. After confirming the essential assumptions for the covariance analysis, ANCOVA was used to analyze the data.

**Results:** The findings showed a significant difference between the experimental and control groups in the increase in the participants’ receptive lexicon after eliminating the effects of the covariate ( $p < 0.05$ ). Two months later, there was no statistically significant difference. ( $P = 0.144$ ,  $F = 0.077$ ,  $p > 0.05$ ).

**Conclusions:** The findings of this study indicate that Serious Games significantly improved the receptive lexicon of autistic children. This result remained for up to two months.

## 1. Background

Autism, as a type of neurodevelopmental disorder, with a prevalence rate of 1 % [1], affects language skills [2], and one out of every three autistic children enters school with verbal language deficits [3]. Autistic children have problems in both receptive and expressive

\* Corresponding author.

E-mail addresses: [hesamielham1375@gmail.com](mailto:hesamielham1375@gmail.com) (E. Hesami), [nmb14@yahoo.com](mailto:nmb14@yahoo.com) (N.M. Bakhshani), [arabpour\\_m68@yahoo.com](mailto:arabpour_m68@yahoo.com) (M.A. Dahouie).

<https://doi.org/10.1016/j.heliyon.2024.e41036>

Received 9 June 2023; Received in revised form 22 November 2024; Accepted 5 December 2024

Available online 6 December 2024

2405-8440/© 2024 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

forms of language, but the receptive lexicon is more problematic [4]. One of the main language deficits of these children is the semantics deficit [5,6].

In semantic problems, autistic children show limited receptive lexicon in number and variety, word retrieval problems, use of scripts, and a narrow range of topics compared with their typical peers [5]. These language problems of autistic children affect their communication skills [4]. On the other hand, if autistic children up to the age of 5 acquire their linguistic skills through early behavioral interventions, they will have a better prognosis for social adjustment and communicative skills, and they will have linguistic development during later years [4,7]. Moreover, it has been shown that early concentrated behavioral interventions have positive effects on autistic children [1].

Applied behavior analysis (ABA) is a treatment approach that has gained attention recently for addressing the needs of autistic children [8,9]. Based on the principles of behaviorism, ABA is widely recognized as an effective method. In addition to traditional treatments, serious games are being used to train autistic children. These digital games have an educational purpose and are based on behavioral principles. They offer several benefits, including their appeal to children, potential to improve their sense of control in different situations, ability to reduce stress levels, simulation of real-life scenarios, cost-effectiveness, accessibility in underdeveloped areas, extension of training programs, and subsequent improvement in performance. Therefore, serious games can be a valuable addition to traditional therapies for autistic children [10–16].

However, Serious Games have been mostly used to enhance the communication skills of children [17], and their potential to teach

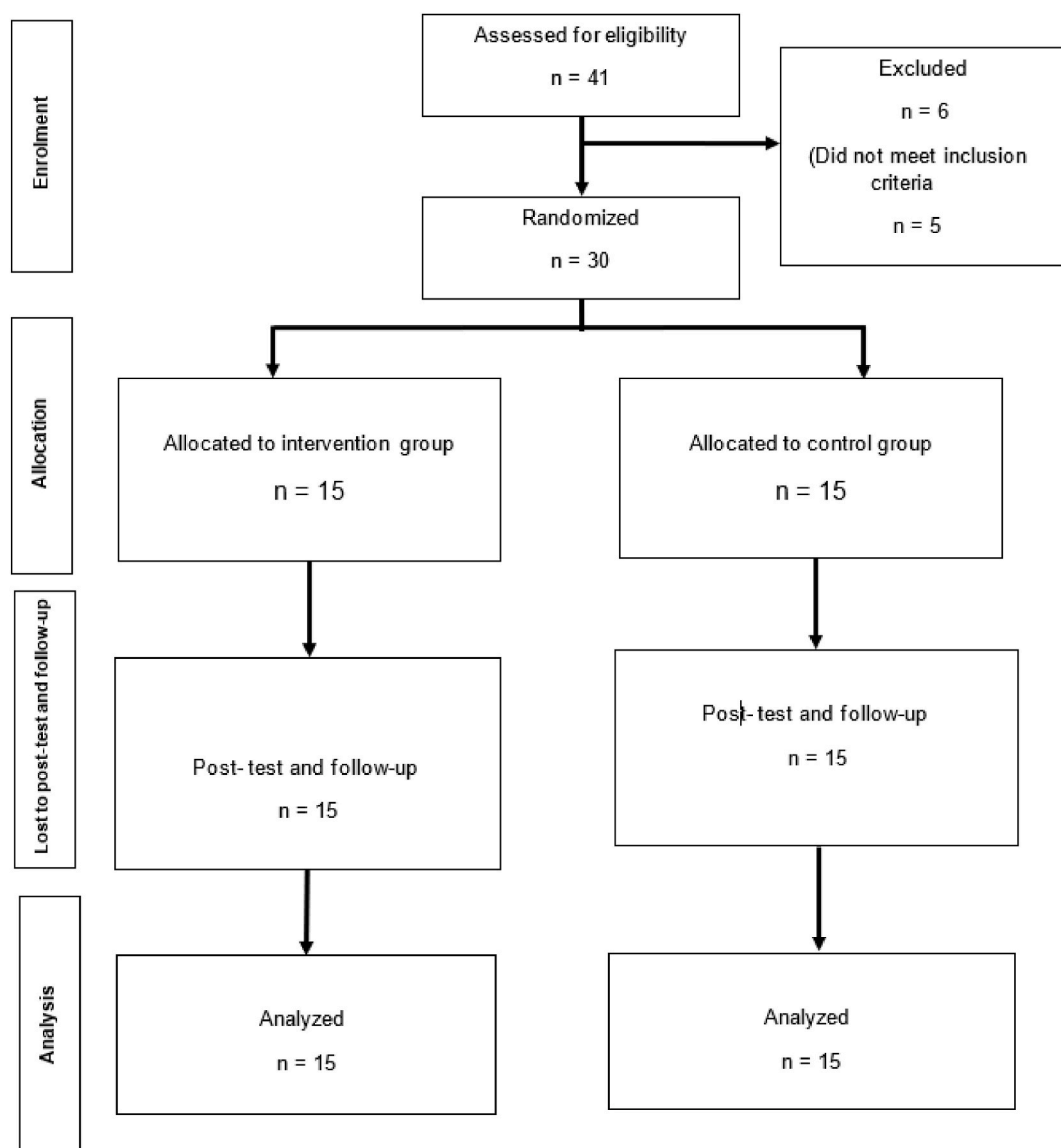


Fig. 1. Participant's flowchart.

vocabulary has been overlooked [18]. For instance, Khowaja and Salim (2019) conducted a study that demonstrated how Serious Games can help increase the number of words learned and decrease the time required for their recall [18]. In another study, Zhu (2016) successfully developed and evaluated a Serious Game called “Friendster” to train autistic children in social skills. However, the game lacked guidance for children, which was removed in the present study by introducing an additional character responsible for guiding them [19]. Similarly, Almeida et al. (2019) investigated the efficiency of a Serious Game titled “ALTRIRAS” and found it useful. However, the demo version of the game did not entirely adhere to psychological principles [20]. The results of a study on a game called ‘AL-QURAN’ revealed that the game significantly improved auditory skills [21].

Despite the benefits of use digital games for treating autistic children, there are some problems. One of the issues is the difficulty in combining the expertise of clinical mental health specialists, children’s interests, and game designers [14]. Additionally, most of the available games are in English [13]. Therefore, in this study, we aimed to enhance the game’s appeal to children and make the game easier by incorporating a guide character and fundamental psychological principles for autistic treatment. We also aimed to make the game environment more user-friendly and accessible to children. Furthermore, as all existing games for children are in English, we developed this game in the Farsi language, specifically for Iranian children.

### 1.1. Objectives

This study aimed to develop a serious game called “Kookism” and evaluate its effectiveness in teaching Persian vocabulary to autistic children (aged 4–9). The game was designed, keeping in mind the interests of children, clinical knowledge, and the expertise of game designers. The study aimed to answer the following hypotheses and questions:

1. Does using Kookism along with the ABA protocol result in better learning of more lexicon than using only the ABA protocol?
2. Does Kookism improve the learning of lexicons in autistic children?

## 2. Methods

### 2.1. Ethical considerations

The relevant ethics committee (the ethics committee of Zahedan University of Medical Sciences) has approved this study (IR.ZAUMS.REC.1399.449). We described the purpose and duration of the study to the participants and parent participants and assured them that their information would remain confidential. Written consent forms were also obtained from the parent participants.

### 2.2. Participants

30 autistic children (autism spectrum disorder according to the diagnosis of a psychiatrist) were selected using the convenience sampling technique in the Welfare Offices of Zahedan and Birjand. The inclusion criteria were: 1) Children aged 4–9 years old, and 2) Their verbal comprehension age is between 16 and 30 months as determined by their speech therapist. The exclusion criteria were: 1) had severe intelligence deficit, 2) psychological disorders according to the evaluations of the psychologist, and 3) lack of ability and interest in playing with mobile phones. The participants were randomly divided into two groups: the experimental group involved 15 participants (4 girls and 11 boys), and the control group involved 15 participants (3 girls and 12 boys). The flowchart illustrating the movement of subjects through the study (Figure 1).

### 2.3. Design

The empirical study with a pretest-posttest design and a two-month follow-up. After obtaining the code of ethics, a serious game called “Kookism” was designed by two clinical psychologists and a speech therapist. They designed a game to meet the special needs of autistic children, including issues with attention, concentration, verbal comprehension, and rapid data processing to learn 20 words. Then, a team developed the game. The game was tested in several stages (on two healthy children and two autistic children) to identify any defects or bugs and assess its level of attractiveness for children. As a result, the researchers improved the game, which increased its quality, attractiveness, and ease of communication with the game space. The researchers collected data at the pre-test, post-test (after two months), and follow-up (after two months) stages using MacArthur-Bates’ Communicative Development Inventories (CDI) administered with the assistance of parents to measure the children’s verbal perception.

### 2.4. Procedures

After the sample was selected, the Kookism game was installed on the phones of parents in the experimental group. The experimental group participated in 20-min sessions on the Serious Game every other day (for two months) while being monitored and followed up by the researcher every week to ensure that the game was played regularly and adequately. The procedure begins with the child choosing their favorite character. The game is performed step by step for the autistic child and each stage becomes more complicated than the previous stage.

Once some words are taught in the initial steps, they enter a testing stage. If they succeed in this step, they move on to a more complex instructional step. For instance, at the initial steps, the poem will be played simply by tapping, without any additional action.

However, in later steps, the child must solve a puzzle for the poem to be played. The stages are interconnected, and until the child completes the initial stages, they cannot move on to the subsequent stages, which will not be accessible until they complete the previous ones. The words in the game are repeated multiple times during gameplay, and characters are introduced through poetry. Each time a child gives a correct answer, they are immediately encouraged to continue. In each stage, a category of words is taught, for example, in the first stage, the words related to toys and animals are taught, while in the second stage, the words related to fruits are taught. In the fourth step, children are asked to select colors based on similarity and color names. In [Tables 1 and 2](#), you can find the game steps and word categories, respectively, for the Kookism game. Also, we have provided examples of the Kookism game space in [Figs. 2 and 3](#). During the two months, the experimental group received the ABA protocol with the game, while the control group only received the ABA protocol.

The ABA protocol, a common treatment method for autistic children in typical training, is rewarding when the correct answer is given. Also, The coach taught the game words to the children during therapy sessions, which were held three times a week.

2.5. Tools

The Communicative Development Inventory (CDI) designed by MacArthur-Bates is a questionnaire that provides information about children’s language development. CDI comes in two forms, one for children aged 8–18 months (form I) and another for children with a verbal age of 16–30 months (form II). In this research, form II was used. The validity of CDI was determined by consulting 2 linguists, 2 speech pathologists, and the parents of autistic children in the study by Kazemi et al. (2008). The highest reliability coefficient belonged to vocabulary comprehension (0.98), while the lowest coefficient (0.43) was observed in the case of general gestures. Cronbach’s alpha of the verbal comprehension part of this questionnaire is 0.98 [22].

2.6. Statistics

The data obtained from the study were analyzed by SPSS 26 software. Mean and Standard Deviation (SD) were used to summarize the data. The study employed the univariate Analysis of Covariance (ANCOVA) to report the results ANCOVA test was used to account for the influence of the Covariate variable, which refers to the ABA protocol that was applied to both groups in the study, to examine the efficacy of the Serious Game intervention. Results are reported as F-test (F) for group differences, P-value (p) for statistical significance, and Partial Eta Squared ( $\eta^2$ ) for the effect of the intervention. The significance level for all tests will be set at 0.05.

3. Results

In the present study, the average age of the participants was 7.27 (SD = 1.574) years. Also, the average age of the experimental and control groups was 7.27 (SD = 1.552) and 7.07 (SD = 1.624) years, respectively (p = 0.895). The substantial assumptions of the COVARIANCE test were confirmed (p > 0.05).

The results of the pretest, posttest, and follow-up stages for both the experimental and control groups are presented in [Table 3](#). Scores of receptive lexicon increased among children in the experimental group during the posttest and remained stable for two months. However, no changes were observed in the control group in either of the stages.

By eliminating the effects of the covariate variable (i.e., the ABA), a significant difference was noted between the experimental and control groups concerning the independent variable (F = 8.339, p < 0.05) ([Table 4](#)). Based on the increase in the mean of receptive lexicon during the pretest and posttest of the experimental group ([Table 3](#)), it can be concluded that the use of the Serious Game by autistic children enriched their receptive lexicon. Additionally, 23 % of the changes observed in the post-test scores are attributed to the effects of the game intervention ( $\eta^2 = 0.236$ ) ([Table 4](#)).

In the follow-up stage of the experimental group, no significant difference was detected between the mean scores in the post-test and follow-up phase and they could keep this change observed during the post-test was maintained until the follow-up (F = 0.077, p > 0.05) ([Table 5](#)).

**Table 1**  
Summary of the game stages.

Content	Aim	Stage
introduction of toys and animals by tapping each of them	Education	1
introduction of fruits by tapping each one	Education	2
character introduction by tapping on each of them (animals, fruits, body parts, colors, toys)	Education	3
Asking the child to choose a color based on the similarity and name of the color ( <a href="#">Figure 1</a> )	Evaluation	4
Asking the child to choose a fruit after presenting the name of the fruit	Evaluation	5
Education: Providing a model for teaching directions	Education and	6
Evaluation: (asking the child to choose the direction right after presenting the name of the direction)	Evaluation	
Completing the puzzle (animals, toys, fruit)	Education	7
Asking the child to choose a character after presenting the name of the character (color, toy, animal, fruit, body parts)	Evaluation	8
Asking the child to find the character after presenting the name of the character based on the name and similarity (animals, fruits, body parts, toys, colors) ( <a href="#">Figure 2</a> )	Evaluation	9
Asking the child to choose a character after presenting the name of the character (color, toy, animal, fruit, body parts)	Evaluation	10

**Table 2**  
Vocabulary items supported by the game.

Vocabulary items	Category
Car, doll, balloon, ball	Toy
Lemon, apple, pear, banana	Fruit
Green, blue, yellow, red	Color
Down, up	Direction
cat, dog, chick, hen	Animal
Bah, bib, jik jik, meow meow, hap hap, qodd qodd qodda	Sounds
Leg, hand, eye, mouth	body part
Well done, hit it, it was delicious, thank you, mom, baby, no	Other



Fig. 2. Screenshot of the fourth stage of the game.



Fig. 3. Screenshot of the ninth stage of the game.

**Table 3**

Descriptive statistics of receptive lexicon in the pretest, posttest, and follow-up stages in the experimental and control groups.

Variables	groups	Pretest		posrttest		Follow up	
		M <sup>a</sup>	SD <sup>a</sup>	M	SD	M	SD
receptive lexicon	Experimental (N = 15)	24.47	10.184	26.15	9.843	26.06	8.461
	Control (N = 15)	22.85	11.864	22.11	11.018	23.87	12.054

<sup>a</sup> M: mean, SD, Standard Deviation.**Table 4**

Results of univariate covariance analysis for evaluation of the effectiveness of a serious game on the receptive lexicon.

Source	SS <sup>a</sup>	Df <sup>a</sup>	MS <sup>a</sup>	F <sup>a</sup>	p <sup>a</sup>	η <sup>2a</sup>
pretest	2924.477	1	2924.477	599.199	0.000	0.957
group	40.699	1	40.699	8.339	0.008	0.236
error	131.777	27	4.881			
total	20498.434	30				

<sup>a</sup> SS: Sum of Squares. Df: Degrees of freedom. MS: mean square. F: F-test. p: Significance. η<sup>2</sup>: Partial Eta Squared.

#### 4. Discussion

The present study aimed to investigate the effectiveness of a serious game called “Kookism” on the receptive lexicon of autistic children aged 4–9 years old. The findings showed that performing serious games by autistic children significantly enriched their receptive lexicon, which is maintained until two months. The present study’s findings were in line with the findings of the previous studies.

Autistic children can remarkably interact with technologies despite their inability to communicate with external environments [23]. As a result, serious games are being used more and more to change their behavior patterns [24] and be effective in improving various skills in autistic children [18]. In a review study by Noor et al. (2012), it was shown that such games had significant effects on the treatment of autistic children [21]. Moreover, the review study by Zakeri et al. (2014) investigated 40 serious games designed for Autistic children, they concluded that performing the serious games had significant impacts on increasing the children’s social communication and enhancing their emotional deficits [23]. However, Serious Games have more potential to improve vocabulary skills in autistic children that have not been used yet [18]. It should be noted that some studies confirmed the positive effects of Serious Games on enhancing autistic children’s lexicon, and the effects were sustained two weeks later [18,25]. In addition, the findings of some studies showed that implementing Serious Games for teaching vocabulary was much more useful than using traditional methods and had a strong impact on learning words and increasing examinees’ abilities to recall words [26–28]. Moreover, the findings of Kalani et al. confirmed the significant effects of Serious Games on increasing the comprehension abilities of students with dyslexia [29]. Similar results were observed in the study by Schuurs (2011) where it was shown that Serious Games had significant impacts on children’s verbal development [30]. In addition, the significant effects of Serious Games on verbal skills have been observed in several studies. The study by Chen (2020) showed some findings in support of the significant effects of Serious Games on increasing children’s verbal lexicon [31]. findings of the present study were in line with the results of the above references. To explain these similarities, it can be argued that modern theories on effective learning state that learning can be more effective when carried out actively, empirically, and with immediate reinforcement, and computer games create such conditions for their audience [24]. Learning methods should activate the hippocampus, which is the region in the brain responsible for creating positive emotions, so that interest and positive emotions may emerge [32]. Serious Games are attractive methods for learning vocabulary by involving the emotional systems of their brains and lead to an increase in people’s motivation, participation, and effectiveness of treatment [24,26,33,34]. However, the meta-analysis by Girard et al. (2013) conducted to explain the effect of Serious Games on the rate of learning indicated that such games had no inherent effects on people’s learning rates, but it increased the time people were motivated to be exposed to learning by increasing their motivation and participation in the process of learning. Consequently, their learning rate would improve [35].

#### 5. Conclusion

Performing the serious game titled ‘kookism’ had a significant impact on increasing the receptive lexicon of autistic children aged 4–9 years, confirming the hypotheses of the study. The game explained 23 % of the progress in the post-test phase. The finding is maintained for two months.

#### 6. Limitations

First, the variation in autism severity levels among participants can potentially affect the generalizability of the results. It may lead to inconsistent performance across different words and make it difficult to draw conclusions about the overall effectiveness of the intervention. To address this, reserchers could consider analyzing the data separately for different severity levels or using statistical



**Table 5**

results of univariate covariance analysis for evaluation the maintenance of the effectiveness of a serious game on the receptive lexicon after one month.

Source	SS <sup>a</sup>	Df <sup>a</sup>	MS <sup>a</sup>	F <sup>a</sup>	Sig. <sup>a</sup>	$\eta^2$ <sup>a</sup>
Pos-test group	2766.083	1	2766.083	276.017	0.000	0.911
error	22.662	1	22.662	2.261	0.144	0.077
total	270.579	27	10.021			
	21544.633	30				

<sup>a</sup> SS: Sum of Squares. Df: Degrees of freedom. MS: mean square. F: F-test. Sig: Significance.  $\eta^2$ : Partial Eta Squared.

techniques to control for the variability in severity. Second, relying on families as a source of information may introduce subjective biases and inaccuracies in assessing children's progress. This could impact the reliability and validity of the results. To mitigate this limitation, researchers could consider incorporating objective measures of children's progress, such as standardized assessments or direct observations by trained professionals. Thirdly, some children showed echolalia, i.e. they repeated words without real understanding words, the presence of echolalia in some children may affect the accuracy of their performance during assessments. To address this, researchers could consider implementing additional measures to assess comprehension and ensure that the children are truly understanding and retaining the learned words. This could involve using different assessment methods or incorporating follow-up assessments over a longer period to evaluate the sustainability of word learning. Fourth, the short follow-up period may limit the ability to assess the long-term retention and generalization of word learning in autistic children. It may also underestimate the true impact of the intervention. To overcome this limitation, researchers could consider extending the follow-up period to evaluate the durability of word learning and assess whether the acquired vocabulary is being used in real-life contexts.

## 7. Suggestions

Future studies should extend the duration of the interventions to account for the slower learning speed of autistic children. In addition, the games should include options to adjust the speed and increase the number of word repetitions.

## CRediT authorship contribution statement

**Elham Hesami:** Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Nour Mohammad Bakhshani:** Writing – review & editing, Validation, Supervision, Resources, Methodology, Investigation, Conceptualization. **Maryam Arabpour Dahouie:** Writing – review & editing, Visualization, Software, Resources, Investigation, Data curation. **Younes Zaheri:** Writing – review & editing, Writing – original draft, Supervision, Software, Methodology, Formal analysis, Data curation, Conceptualization.

## Ethical considerations

The study was approved by the ethics committee with the ethics code. We explained the study aims, methods, benefits, and potential hazards to the participants' parents. Written informed consent was obtained from the participants. It is made completely and unambiguously clear to each participant that they are free to refuse to participate in the study, or that they can withdraw their consent at any time and for any reason, without incurring any penalty or withholding of treatment by the investigator.

## Data availability statement

The dataset utilized in the study can be obtained upon request from the corresponding author during submission or following publication. The data is not publicly accessible due to privacy and ethical considerations.

## Funding

This study had no support.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgment

All the parents and children who helped us in this research are thanked and appreciated.

## References

- [1] B.J. Sadock, Kaplan & Sadock's Synopsis of Psychiatry: Behavioral Sciences/clinical Psychiatry, Wolters Kluwer, Philadelphia, 2015.
- [2] S. Eikeseth, D.W. Hayward, The Discrimination of Object Names and Object Sounds in Children with Autism: A Procedure for Teaching Verbal Comprehension, Wiley Online Library, 2009.
- [3] D. Trembath, J. Paynter, R. Sutherland, H. Tager-Flusberg, Assessing communication in children with autism spectrum disorder who are minimally verbal, *Curr Dev Disord Reports* 6 (3) (2019) 103–110.
- [4] A.S. Chan, J. Cheung, W.W.M. Leung, R. Cheung, M. Cheung, Verbal expression and comprehension deficits in young children with autism, *Focus Autism Other Dev Disabl* 20 (2) (2005) 117–124.
- [5] S.L. Brook, D.M. Bowler, Autism by another name? Semantic and pragmatic impairments in children, *J. Autism Dev. Disord.* 22 (1) (1992) 61–81.
- [6] O. Tóth, O. Pesthy, K. Farkas, A. Guttengéber, E. Komoróczy, J.M. Réthelyi, et al., Intact fluency in autism? A comprehensive approach of verbal fluency task including word imageability and concreteness, *Autism Res.* 15 (4) (2022) 677–686.
- [7] J.A. Ungerer, M. Sigman, Symbolic play and language comprehension in autistic children, *J. Am. Acad. Child Psychiatr.* 20 (2) (1981) 318–337.
- [8] Q. Yu, E. Li, L. Li, W. Liang, Efficacy of interventions based on applied behavior analysis for autism spectrum disorder: a meta-analysis, *Psychiatry Investig* 17 (5) (2020) 432–443.
- [9] W.W. Fisher, K.C. Luczynski, A.P. Blowers, M.E. Vosters, M.D. Pisman, A.R. Craig, et al., A randomized clinical trial of a virtual-training program for teaching applied-behavior-analysis skills to parents of children with autism spectrum disorder, *J. Appl. Behav. Anal.* 53 (4) (2020) 1856–1875.
- [10] S.R. Dehkordi, M. Ismail, N.M. Diah, A preliminary study on design of rehabilitation game for children with autism spectrum disorder, *Indones J Electr Eng Comput Sci.* 16 (1) (2019) 524–529.
- [11] D.E. Hughes, E. Vasquez, E. Nicsinger, Improving perspective taking and empathy in children with autism spectrum disorder, in: 2016 IEEE International Conference on Serious Games and Applications for Health (SeGAH), IEEE, 2016, pp. 1–5.
- [12] C. Grossard, O. Grynspan, S. Serret, A.-L. Jouen, K. Bailly, D. Cohen, Serious Games to teach social interactions and emotions to individuals with autism spectrum disorders (ASD), *Comput. Educ.* 113 (2017) 195–211.
- [13] S. Fridenson-Hayo, S. Berggren, A. Lassalle, S. Tal, D. Pigat, N. Meir-Goren, et al., 'Emotiplay': a Serious Game for learning about emotions in children with autism: results of a cross-cultural evaluation, *Eur. Child Adolesc. Psychiatr.* 26 (8) (2017) 979–992.
- [14] L. Malinverni, J. Mora-Guiard, V. Padillo, L. Valero, A. Hervás, N. Pares, An inclusive design approach for developing video games for children with Autism Spectrum Disorder, *Comput. Hum. Behav.* 71 (2017) 535–549.
- [15] S. Tsikinas, S. Xinogalos, Studying the effects of computer Serious Games on people with intellectual disabilities or autism spectrum disorder: a systematic literature review, *J. Comput. Assist. Learn.* 35 (1) (2019) 61–73.
- [16] K. Corti, Games-based Learning: a serious business application, *Inf PoxelLearning* 34 (6) (2006) 1–20.
- [17] A.M. Ern, The Use of Gamification and Serious Games within Interventions for Children with Autism Spectrum Disorder, University of Twente, 2014.
- [18] K. Khowaja, S.S. Salim, Serious Game for children with autism to learn vocabulary: an experimental evaluation, *Int J human-computer Interact.* 35 (1) (2019) 1–26.
- [19] J. Zhu, C. Kerns, J.E. Connell, N. Lyon, Using interactive social story games to teach social skills to children with autism, in: DiGRA/FDG, 2016.
- [20] L.M. Almeida, DP da Silva, D.P. Theodório, W.W. Silva, S.C.M. Rodrigues, T.A. Scardovelli, et al., ALTRIRAS: a computer game for training children with autism spectrum disorder in the recognition of basic emotions, *Int J Comput Games Technol.* 2019 (2019).
- [21] H.A.M. Noor, F. Shahbodan, N.C. Pee, Serious Game for autism children: review of literature, *Int. J. Psychol. Behav. Sci.* 6 (4) (2012) 554–559.
- [22] Y. Kazemi, S. Nematzadeh, T. Hajian, M. Heidari, T. Daneshpajouh, A. Mirmoeini, The validity and reliability coefficient of Persian translated McArthur-Bates Communicative Development Inventory, *J Res Rehabil Sci.* 4 (1) (2008).
- [23] H.M. Zakari, M. Ma, D. Simmons, A review of Serious Games for children with autism spectrum disorders (ASD), in: *International Conference on Serious Games Development and Applications*, Springer, 2014, pp. 93–106.
- [24] T.M. Connolly, E.A. Boyle, E. MacArthur, T. Hainey, J.M. Boyle, A systematic literature review of empirical evidence on computer games and Serious Games, *Comput. Educ.* 59 (2) (2012) 661–686.
- [25] M.H. Emam, V.P. Roslin, Investigating the effect of serious games as an intervention on Iranian EFL learners' vocabulary learning and retention during COVID-19 pandemic, *SJIS* 3 (2) (2021) 1–8.
- [26] S. Vahdat, A.R. Behbahani, The effect of video games on Iranian EFL learners' vocabulary learning, *Reading* 13 (1) (2013) 61–71.
- [27] M. Ebrahimzadeh, Readers, players, and watchers: EFL students' vocabulary acquisition through digital video games, *Engl. Lang. Teach.* 10 (2) (2017) 1–18.
- [28] M. Taheri, The effect of using language games on vocabulary retention of Iranian elementary EFL learners, *J. Lang. Teach. Res.* 5 (3) (2014) 544.
- [29] S. Kalani, S.M. Asghari nekah, A. Ghanaei chamanabad, The effectiveness of linguistic play software package on reading accuracy and comprehension of students with reading disorder, *J. Learn. Disabil.* 4 (4) (2015) 66–84. Available from: <https://www.sid.ir/en/journal/ViewPaper.aspx?ID=521908>.
- [30] U. Schuurs, Serious gaming and vocabulary growth, in: *Joint Conference on Serious Games*, Springer, 2011, pp. 40–46.
- [31] H.-J.H. Chen, H.-L. Hsu, The impact of a Serious Game on vocabulary and content learning, *Comput. Assist. Lang. Learn.* 33 (7) (2020) 811–832.
- [32] H.W. Giessen, Serious Games effects: an overview, *Procedia-Social Behav Sci.* 174 (2015) 2240–2244.
- [33] W.S. Ravysse, A. Seugnet Bignaut, V. Leendertz, A. Woolner, Success factors for Serious Games to enhance learning: a systematic review, *Virtual Real.* 21 (1) (2017) 31–58.
- [34] Y. Zhonggen, Differences in Serious Game-aided and traditional English vocabulary acquisition, *Comput. Educ.* 127 (2018) 214–232.
- [35] C. Girard, J. Ecalle, A. Magnan, Serious Games as new educational tools: how effective are they? A meta-analysis of recent studies, *J. Comput. Assist. Learn.* 29 (3) (2013) 207–219.