

Recognition and Learning of Emotions by Primary School Children on the Autism Spectrum: A Study Using Tablets

Christine K. Syriopoulou- Delli¹, Paul Hatzigiannakoglou, Konstantina P. Liaratsika

Department of Educational and Social Policy, University of Macedonia

¹Correspondence: csyriop@uom.edu.gr

Abstract

Autism Spectrum Disorder is a neurodevelopmental disorder that affects, among other things, the emotional intelligence of children with autism. The purpose of this study is to investigate the recognition and acquisition of emotional knowledge by elementary school children with autism through the use of a tablet-based game. Additional objectives include assessing the difference in emotional recognition responses between children with autism and children with emotional difficulties, as well as evaluating the ability to associate each emotion with the corresponding facial expression. The study also aimed to examine the amount of time a student can remain focused without displaying stereotypical behaviors, and how long it takes for a student to respond to a command.

In this study, 22 students from Creative Activity Centers and speech therapy centers in mountainous northern part of the country, participated by playing a tablet game. Among them, 6 were children with autism, 6 had emotional difficulties, and 10 were typically developing children. Data were analyzed using the method of systematic observation and recording.

The results showed that children with autism exhibited stereotypical behaviors during the game up to 75%, responded more quickly than the children with emotional difficulties, sought visual contact with the supervisor and the Panda game, and had the lowest rate of correctly matching each emotion with the corresponding emoticon.

Keywords: Autism Spectrum Disorder; emotional intelligence; tablet; stereotypes; emoticon

1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder whose characteristics can vary greatly from person to person [1]. The disorder affects approximately 1% to 2% of the population and is 4.5 times more common in males than in females, while it is not linked to the socioeconomic background of the individual [2]. Specifically, it is estimated to affect one boy in every 54 births, while the number is significantly lower for girls, with a rate of one in every 252 girls [3].

Children with autism are fond of consistency and routine and strongly dislike changes that can disrupt their schedule, as these changes can cause them discomfort and anxiety [4]. Autistic children have been found to exhibit different patterns of cognitive and social development, particularly in social communication and interpersonal interactions [2]. For example, individuals on the autism spectrum may excel in music, mathematics, the arts, and visual perception [1].

However, impairments in social skills are one of the core features of the disorder and persist throughout the individual's life. These individuals often face challenges such as social isolation, difficulties initiating contact with peers and forming friendships, as well as problems with empathy and emotional support [5]. A key characteristic of autism is also difficulty in social communication and language use. They struggle to interpret and use figurative language, exaggerations, or idioms, as well as to engage in social interactions [2].

1.1. *Autism and Emotional Intelligence*

Research shows that individuals with autism often display lower levels of emotional intelligence, particularly in areas such as emotion perception, understanding emotional cues, and emotion regulation, which can hinder social interactions and academic success [6; 7].

People with autism may struggle to open up and express how they experience a situation or how they feel, resulting in alternative behaviors such as aggression or throwing objects, in an effort to communicate their emotions. Thus, managing their own emotions and interpreting the emotions of others can be a very difficult process for individuals with autism [8].

Although emotional intelligence deficits are significant and substantial, some argue that individuals with autism could develop their emotional skills by using specific emotional and social intelligence training programs [9].

1.2. *Modern Educational Approaches Aimed at Enhancing Emotional Intelligence*

Modern educational approaches play a crucial role in improving the emotional intelligence of children on the autism spectrum. Studies confirm that games that are more interactive, with calming environments supported by art, distinctive colors, and soothing music, can enhance children's social skills [10; 7].

Technology-based applications increasingly personalize emotional intelligence tasks for children with autism, utilizing advanced features such as facial expression recognition and user-generated content [11].

The use of emoticons has many positive effects on the socialization of individuals with autism and on improving emotional perception [12]. Emoticons that represent common emotions such as happiness, sadness, anger, and fear have been shown to help children with autism more easily recognize emotions and associate them with appropriate facial expressions [40].

Bright colors, especially warm ones, attract the attention of children with autism spectrum disorder [11]. Colorful images help children better understand concepts and connect them to real social situations [13].

1.3. *Use of Tablets and Autism in Primary School Children*

The use of tablets among individuals with autism spectrum disorder has been explored in various contexts, including education, social interaction, and daily living skills. Research

suggests that tablets can be beneficial for enhancing learning outcomes and skill acquisition in individuals with autism, although their impact on social interactions is less clear [14].

Regarding educational benefits, tablets—particularly iPads—have been shown to significantly improve learning outcomes for students with autism, as well as social skills, attention, and cognitive abilities [15]. Tablets have also been used to teach daily living skills to adolescents with autism and intellectual disabilities. iPad-based training allowed participants to access educational materials independently and apply these skills to perform new tasks, demonstrating the potential of tablets to promote independence [16].

1.4. *Purpose of the Study*

The purpose of the research is to investigate the recognition and acquisition of emotional knowledge by primary school children with autism through the use of a tablet-based game.

Additional objectives include:

1. To assess differences in emotion recognition responses between children with autism and children with emotional difficulties.
2. To evaluate the ability to match each emotion with the corresponding facial expression.
3. To investigate the length of time the student can stay focused without expressing stereotypical behaviors.
4. To explore the duration for which the student seeks visual contact with the supervisor and the panda character.
- 5.

1.5. *Research Questions*

The main research questions addressed by this study are:

- Is the use of vivid colors and animations a more effective learning method for children with autism?
- Can the use of tablets keep a child with autism focused without exhibiting stereotypical behaviors?
- Is tablet use an effective method for helping children with autism connect facial expressions with emotions?
- Do children with autism achieve higher accuracy and faster reaction times compared to children with emotional difficulties?

2. Methods

2.1. *Data Collection Procedure*

The tool used was a digital game featuring a three-dimensional panda as the main character. The duration of the game ranged from 7 to 8 minutes, depending on whether the child made any mistakes during the activity. The administration period of the game lasted from February to May 2025. Before the game was administered, the parents of each student provided their consent for their child to participate in the research by signing a consent form.

Regarding the procedure, an adaptation period was necessary to allow the child to feel comfortable and participate in the activity. Therefore, at the beginning, the child and the educator went to a room that the children were familiar with. A multi-purpose room was chosen for the children at the Creative Activity Center and a corresponding room was selected for children who participated in the game during their speech therapy or

occupational therapy sessions. The game was scheduled to be played after the child had completed both occupational and speech therapy sessions.

Once the child entered the room, they played their favorite game with the supervisor—either a game available at the Creative Activity Center or at the speech therapy center. Another relaxing activity might involve the child drawing themselves or their family and sharing some information about each family member. The goal was to allow the child time to become familiar and comfortable with the supervisor through a game they enjoyed and were used to.

Afterward, the supervisor placed a large panda teddy bear on the student's desk and placed the tablet—already running the emotions game—in the panda's arms. The supervisor explained to the student that they would play a short and fun game about emotions. The supervisor emphasized that if the child wanted to stop the game at any point because they were bored or wanted to return to the classroom with the other children, they could inform the supervisor to end the activity.

Before the game began, the supervisor asked the child which emotions they already knew and requested that the child name them. At the end of the game, the children were given printed versions of the emoticons exactly as they appeared in the game and were asked to stick the correct emoticon next to each corresponding emotion on a sheet of paper that the supervisor had prepared and placed on a wall within the facility.

2.2. Data collection tool

For the data collection in this research, a game was used that children played through a tablet. The specific game was designed by a member of teaching and laboratory staff of the University with specifications intended for children with autism and generally for individuals who struggle with the recognition and regulation of emotions. This particular tool includes emoticons representing eight basic emotions that a child is expected to learn and later recognize. These emotions are joy, sadness, anger, excitement, embarrassment, disgust, fear, and calmness.

Detailed description of the game: Upon opening the application, the child sees three rectangles with different bright colors and is asked to tap on one of them. The rectangles are labeled "Learning," "Practice," and "Exit," with the colors green, blue, and red respectively. While the child is looking at the screen, the Panda says: "If you want to learn about emotions, tap the green button; if you want to play a game about emotions, tap the blue button."

When the student taps on the "Learning" button, a 3D Panda—the main character of the game—appears on the screen. The Panda tells various stories, starting with phrases like "Joy is when...", "Sadness is when..." and at the end, the Panda says "Look at the picture," showing the appropriate emoticon on the screen. Each story narrated by the Panda corresponds to a different emotion. Each story is accompanied by a specific emoticon that matches the emotion described by the Panda. The goal is that by the end of the learning phase, the child will have associated the emotion with the corresponding emoticon and with the situation that causes that emotion.

At this stage, the student waits until all the stories for all the emotions have finished. Then, the application returns to the previous screen with the three rectangular buttons: Learning, Practice, and Exit.

The child is asked again to tap on one of the three buttons. By tapping the "Practice" button, the child is prompted to answer questions. The Panda appears on the screen, tells a short story to the student, and at the end asks: "Can you show me which picture is the correct one?" Based on the story heard, the student must select by touch the correct emoticon that corresponds to the specific situation. The emoticons that appear are the same ones the student practiced in the previous step. Additionally, the emoticons always appear in pairs to make it easier for the student—for example: joy vs. sadness, anger vs. excitement, embarrassment vs. disgust, fear vs. calmness.

When the participant gives a correct answer, the Panda says, "Bravo, you found the correct picture," and dances to the song "I Like to Move It" from the movie *Madagascar*. Then it continues to the next story. If the participant gives a wrong answer, the Panda says, "You made a mistake, that's okay, I'll leave for a bit but I'll come back." The Panda leaves the participant's field of vision and returns shortly after to ask the same question again. The Panda can repeat this process as many times as needed until a correct answer is given.

Once all stories have been told and their corresponding emoticons matched, the three rectangular buttons—Learning, Practice, and Exit—reappear. This time, the student is asked to tap the "Exit" button to complete the activity.

The emoticons are designed with clear facial expressions and exaggerated emotional cues for greater clarity and emphasis [14], using limited colors that resemble reality—for example, red cheeks on the emoticon representing embarrassment [17]. Finally, there must be a clear relationship between each emoticon and the emotion it represents [18; 19].

2.3. *Sampling*

The study involved 22 children. All children were between the ages of 6 and 11, meaning they were all enrolled in primary school classes. The sample consisted of 12 boys and 10 girls. Out of the 22 children, 6 had been diagnosed with Autism Spectrum Disorder (4 boys and 2 girls), 6 had emotional difficulties (3 boys and 3 girls), and 10 were typically developing children (5 boys and 5 girls). The children came from private institutions—Creative Activity Centers, and private speech and occupational therapy centers—where, with parental consent and a signed consent form, the child participated in the study.

The children participating in the study live and attend school in the region at the north area of the country. The sample was selected using random sampling [41] among children aged 6–11 who attended the Creative Activity Centers and therapy centers on Tuesdays, Wednesdays, and Thursdays.

2.4. *Profiles of Children with Autism Spectrum Disorder*

DA1: He is a 9-year-old boy attending the 4th grade of primary school. He receives occupational and speech therapy after school, and during school hours he has a shadow teacher who assists him with his lessons. His speech is clear. Academically, he holds the pencil correctly and writes independently. He has a rich vocabulary and clear handwriting. However, he consistently needs support from the teacher to complete each task. He struggles

significantly with mathematics, while his favorite subject is history, which he can memorize by heart. He is very eager to participate in all classroom activities, raises his hand, and makes an effort to engage. When the classroom becomes noisy, he tells the other children to be quiet so he can concentrate. Socially, he is well-liked by his classmates, although he doesn't have a specific group of friends. During recess, he moves between different groups or chooses to sit with his shadow teacher.

DA2: He is a 7-year-old boy in the 2nd grade. He attends speech and occupational therapy after school and is supported by a shadow teacher during school hours. His speech is unclear, and he often echoes the last words of a sentence he hears. He exhibits strong stereotypical movements with his hands and body, frequently smiling and maintaining intense eye contact with the person speaking to him. When asked a question, he mainly responds with single words and struggles to form sentences that include himself—for example, instead of saying "now I have to eat," he says "now [name] has to eat." Sudden changes in routine, such as a teacher's absence or change in schedule, lead to outbursts—he might tear paper or throw objects that seem out of place to him. Academically, he shows patience with exercises and reading, though he cannot read fluently but can syllabify. He struggles in math but can do basic addition and subtraction. Socially, he can join other children in play but tends to break the rules, either due to not knowing them well or losing interest. He enjoys playing tablet games and finds comfort in children's songs. He has learned to be independent, organizing his belongings and selecting the right books.

DA3: She is a 7-year-old girl in the 2nd grade. She does not have a shadow teacher and spends her afternoons at a local Creative Activity Center. She displays stereotypical hand movements and covers her ears when there is too much noise. In Physical Education (PE), where the room echoes, she prefers to wear earplugs. She has difficulty adjusting to changes in her routine—if a different teacher enters the classroom, she may have emotional outbursts, including crying and pushing the new teacher. She often repeats questions like "What time do we finish?" or "When is PE?" To help her adapt and attend all classes, her teacher rewards her with stickers and small gifts when she behaves calmly or attends PE without crying. Cognitively, she is at a high level—she reads and writes like her peers, is quick-witted and imaginative, and usually finishes her work first. She enjoys watching music videos that soothe her and often dances. She loves English and enjoys drawing emotions. During recess, she is always alone, talking to herself and inventing stories, showing no desire to play with other children. However, she never lashes out at classmates and is willing to join group activities.

DA4: He is a 7-year-old boy in the 2nd grade. He attends speech therapy in the afternoons and has a shadow teacher at school. He often flaps his hands, especially when happy, and likes to hold and shake a noisy sharpener near his ear. In the classroom, he does not engage, but he collaborates well with his shadow teacher. He completes exercises but needs encouragement. He struggles in math but enjoys language lessons. He does not take part in group work. He reacts by withdrawing when he feels he is doing something wrong and gives up easily. He performs best in individual tasks. Socially, he is isolated—he wanders alone during recess but always finds something to

engage with, such as toys or nature. He wishes to join groups but fears making mistakes. He often misinterprets comments or takes them personally. He experiences intense anxiety under pressure.

DA5: She is a 9-year-old girl in the 4th grade. She receives speech and occupational therapy and is supported by a shadow teacher at school. Her speech is understandable, but she uses simple, everyday vocabulary, often limited, making it hard for her to express herself or understand others fully. She needs time to process and react to information, so she doesn't finish tasks on time. She usually avoids eye contact and doesn't like participating in group games. She is generally serious, with limited facial expressions, and is deeply attached to her stuffed animal "Duckie," which she always carries with her. She needs very specific instructions to perform tasks and does not respond unless addressed clearly. If her routine is disrupted (e.g., if a different teacher is present), she may go silent or isolate herself. She exhibits stereotypical behavior like clapping her hands together rapidly. Socially, she is withdrawn and does not want to take part in group games. She spends a lot of time playing tablet games.

DA6: He is a 6-year-old boy in the 1st grade. He attends speech and occupational therapy. He displays stereotypical hand movements when he is focused or excited about a task or drawing. He often appears distracted, with his gaze fixed on objects. His handwriting and speech are at a very good level. He only participates in class when directly addressed by the teacher; otherwise, he does not raise his hand. He has a vivid imagination, which is evident in his drawings—he always uses dark colors and depicts imaginary situations. He gets angry when things do not go his way. During recess, he sometimes plays with classmates, but often prefers playing alone with sticks. When in front of a screen, watching or playing a game, he becomes completely absorbed and is not distracted by anything happening around him.

ED1: He is a 10-year-old boy in the fifth grade. He receives support from a special education teacher during school hours and attends the local Creative Activity Center in the afternoon. He is able to recognize basic emotions (e.g., happiness, sadness) but struggles to understand more complex ones (e.g., disappointment, jealousy). He often confuses "I'm tired" with "I'm angry." He becomes angry, especially when he feels treated unfairly, and has difficulty calming down. When he is anxious, he tends to withdraw or cry. In his attempts to join peer groups and interact with classmates, he makes rude comments without realizing it, excessively disturbs his peers, makes noise in class, and doesn't understand when to stop. He constantly wants to tease others but fears rejection. If he is ignored, he takes it personally and either isolates himself or hits himself. When he makes a mistake, he often gives up. He doesn't participate in class or do his homework. He shows anxiety when working in a group and, as a result, does not express his opinion.

ED2: She is a 9-year-old girl in the fourth grade. She has support from a special education teacher and attends a Creative Activity Centers in the afternoons. Emotionally, although she seems to understand situations when speaking, in reality, she doesn't fully grasp them. She says "I know how you feel," but often does not show it. When anxious, she experiences physical symptoms such as headaches and stomachaches—she somatizes stress. She wants to help others but can't recognize when someone truly needs support. She doesn't understand sarcasm or innuendos. Her intense reactions often cause classmates to distance

themselves, labeling her as “overreacting.” She frequently changes friends due to misunderstandings. She performs well in calm environments. She needs time to adjust after a conflict. When she feels “judged,” she avoids participating in activities and group work.

ED3: He is an 8-year-old boy in the third grade. In the afternoons, he attends speech and occupational therapy. He has a special education teacher in class. He has a limited vocabulary and language skills but speaks and writes clearly. He prefers drawing. He rarely participates in class, even when given the opportunity. When stressed, he often withdraws and stays still for a long time until he realizes no one is paying attention to him. He needs to feel comfortable with someone to speak more openly and to open up emotionally. He doesn’t socialize with typically developing peers, except for one classmate who also struggles with social interaction. He doesn’t show facial expressions and always appears serious. He cannot understand figurative language, and if he feels mocked, he responds harshly and abruptly. He does not have outbursts but becomes distant and indifferent when feeling pressured or like he failed. Later, he may react to unrelated situations.

ED4: She is an 11-year-old girl in the sixth grade. She attends a in the afternoons. She is extremely sensitive to others’ emotions but cannot distinguish her own feelings from those of others. She absorbs others’ emotions very easily. If she senses someone is angry, she panics. She reacts strongly to yelling or arguments between children, even when not involved herself. She wants to help all her classmates, and if she doesn’t succeed, she becomes anxious; if she does succeed, she feels exhausted. She is known as the “good child.” She feels responsible for what happens to others and how others feel, which causes her a lot of anxiety, and she sometimes stutters. She seeks validation mainly from her teacher and becomes easily confused during lessons. She is very giving and can fit into many peer groups. Finally, if she sees someone else crying, she may cry as well. She calms down by listening to her favorite song or watching brightly colored videos on her tablet.

ED5: He is an 8-year-old boy in the third grade. He attends a Creative Activity Center in the afternoons. He denies his emotions (“I’m not sad”) because he believes expressing emotions is a sign of weakness. He does not have emotional outbursts, but when he feels anxious or defeated, he becomes distant and apathetic. Later, he may have an outburst in an unrelated situation. Although he is affectionate, he shows little sympathy for his classmates—or at least gives that impression. He believes “everyone should solve their own problems,” so he neither seeks nor offers help. He often uses sarcasm or irony toward classmates, but in reality, he seeks recognition and approval from them. He avoids collaboration, usually using humor or pretending not to care. If given personal responsibility or a role such as the teacher’s helper, he performs very well. During breaks, he is usually alone and enjoys thinking.

ED6: She is a 9-year-old girl in the fourth grade. She attends a Creative Activity Center in the afternoons. She understands only external expressions of emotion—for example, if she sees someone laughing, she assumes they are happy and cannot consider that they might be laughing out of nervousness or sarcasm. She appears to be in control, but even if she doesn’t show it, she gets very angry. She rarely expresses her emotions directly and has unexpected outbursts. She often says she understands how others feel and wants to help but doesn’t know how. If someone cries, she freezes and walks away. She follows rules but has difficulty with spontaneous interactions, which she cannot manage. If she doesn’t feel safe,

she shuts down. She is very consistent and quiet but does not participate in social activities. She shows no reaction to insults, but remembers them vividly.

Here are the profiles of typically developing children:

TD1: She is a girl, 8 years old, attending third grade. In the afternoons, she goes to a structured leisure program. Regarding her education, she really likes mathematics but struggles with language. She rarely asks to speak on her own and when the teacher calls on her, she answers hesitantly. She is quite shy and reserved, not very social, and finds it difficult to trust friends enough to open up. She is very quiet and often sits alone during breaks or timidly approaches a group of girls. She struggles to express what she feels and fears making mistakes when speaking.

TD2: She is a girl, 8 years old, attending third grade. She goes to a structured leisure program in the afternoons. Educationally, although she is quite smart, she lacks motivation for studying and often forgets her books and homework at home. She is lively and often gets involved in classroom happenings. She participates in lessons but often interrupts to say something unrelated to the lesson content. She cries easily when she feels wronged. In games, she tries to have a leadership role and dislikes losing. When this happens, she reacts strongly with harsh words and intense expressions. She befriends girls in her class but often has quarrels with them.

TD3: He is a boy, 10 years old, attending fifth grade. He goes to structured leisure program in the afternoons. His favorite activity is video games, which he talks about constantly, even during lessons. He is quite accustomed to screens for his age. In class, he does not participate much and rarely answers teacher questions correctly. He often stands in front of his desk and finds it hard to sit still in class. He likes to draw attention and make classmates laugh, which he often succeeds in. He is social and has many friends, but has also quarreled with many of them without resolving the conflicts.

TD4: She is a girl, 9 years old, attending fourth grade. She goes to structured leisure program in the afternoons. Educationally, she is a very active and quite obedient student. She participates in class and tries to help her classmates. Socially, she is rather reserved, preferring to be friends with younger children and feels the need to care for them if they get hurt or argue during recess. She finds it harder to integrate into groups of children her own age. She rarely gets angry, but when she does, she can express how she feels and her opinion in front of the whole class, especially with the teacher present, believing an older person will understand her.

TD5: She is a girl, 6 years old, attending first grade. She goes to structured leisure program in the afternoons. She is quite good at writing and reading and quick in math calculations. She is competitive with her classmates about who solves exercises faster, but is willing to cooperate when needed. In individual tasks, she is competitive and often reports mistakes of others to the teacher. When insulted or teased, she can become abrupt and may hit another child. She struggles to manage her anger.

TD6: She is a girl, 7 years old, attending second grade. She goes to structured leisure program in the afternoons. She consistently participates in lessons and likes learning new things. She can easily insult a classmate or embarrass them and often does not apologize. She is quite lively and often laughs or reacts when the teacher reprimands her in class. She is

integrated into groups and gets angry easily when another classmate tries to gain attention from the teacher or the group. She compares herself to other children.

TD7: He is a boy, 10 years old, attending fifth grade. He goes to structured leisure program in the afternoons. He is a consistent student who is always prepared. He has a rich vocabulary and good speech. He is polite and clever. However, he often makes noise in class by teasing other classmates. Sometimes he mocks others for their weaknesses, leading to teacher reprimands and apologies to classmates. He is very interested in computers and video games. His favorite subject is Informatics.

TD8: He is a boy, 6 years old, attending first grade. He receives speech therapy. He struggles with reading and writing. Although he writes clearly, he often omits vowels in words. He tries to participate in class and is brave enough to express his thoughts and opinions. He is quiet and cooperative, enjoys group activities, and eagerly anticipates Informatics classes, where they work collaboratively. He is a social child with team spirit and cooperation, and does not react negatively when losing in games.

TD9: He is a boy, 7 years old, attending second grade. He receives speech and occupational therapy. He has mild instability from birth that makes him slower in running and less skilled in games like soccer. He avoids basketball because he struggles with jumping. He gets upset easily if he fails and withdraws from play. Academically, he participates actively, enjoys reading and writing, and reads many books at home. He is cooperative and cheerful. He almost never gets involved in fights and avoids conflicts.

TD10: He is a boy, 6 years old, attending first grade. He receives speech therapy because he cannot pronounce the letter "R" clearly and often stutters, pausing between words while speaking. When he feels unsuccessful, he causes disturbances in class and does not listen to the teacher. He exhibits sudden behaviors when something he dislikes happens. If the teacher gives homework, he might tear it up or refuse to do an exercise in class, reacting with shouting. Though cooperative in play, he dislikes losing and when his team loses, he gets angry at teammates. He is, however, well-liked by classmates. His favorite subject is Informatics, where he feels calm.

Data Analysis: The data analysis was conducted using systematic observation and recording methods. Specifically, an observation chart was created for each child, documenting their behaviors, and a chart was made for all 22 children to record specific behaviors for comparison. Finally, for children on the autism spectrum, a chart was used to record the occurrence of stereotypical reactions every 30 seconds.

3. Results

3.1. Development of Stereotypical Reactions

For the children on the autism spectrum, a chart was used to record the occurrence of stereotypical reactions every 30 seconds. All the children completed the game in 8 minutes.

Observation period: 8 minutes — 30-second intervals

Table 1. Intervals of stereotypical movements occurrence per student with Autism Spectrum Disorder

Stud.	1 st minute	2 nd minute	3 rd minute	4 th minute	5 th minute	6 th minute	7 th minute	8 th minute	Intervals of behavior occurrence	Percentage of intervals
AD1			✓	✓	✓	✓	✓	✓	6/16	37,5%
AD2	✓		✓	✓	✓	✓	✓	✓	12/16	75%
AD3	✓			✓			✓		3/16	18,75%
AD4			✓			✓			2/16	12,5%
AD5		✓	✓		✓	✓		✓	6/16	37,5%
AD6							✓		1/16	6,2%

From the observation results, it appears that stereotypical reactions continue to occur during the game for students with autism. For some students, the stereotypical reactions persist during most of the game time, as one student exhibited stereotypical movements during 75% of the observation period, while others showed a lower frequency, such as 6.2% of the game time. The average occurrence of stereotypical reactions is 31.24%, meaning that almost one-third of the observation time the child with autism displayed stereotypes.

More specifically, based on the observation of students' behavior, the stereotypical reactions were more intense in the following situations: at the beginning when the participants were excited seeing the Panda, each time they answered positively to questions, and when the reward song was played. After incorrect answers, when the panda returned to the game, the child showed more intense stereotypical reactions than before.

They exhibited fewer stereotypical reactions during the process of learning emotions and matching them with the appropriate emoticons. Also, during the learning part, children with autism often repeated the emotions they heard or made gestures or facial expressions with their hands in an attempt to imitate the emoticon, or commented on specific features of each emotion as depicted in the emoticons, such as a green face or red cheeks.

3.2. Response Speed and Accuracy of Answers

Children with autism were compared to children with emotional difficulties in terms of their response speed and accuracy of their answers. The results show that children with autism on average need 1.5 seconds to respond, children with emotional difficulties need 2.6 seconds, and typically developing children need 1.15 seconds (Table 2).

Therefore, children with autism respond faster than children with emotional difficulties but slower than typically developing children. Overall, the children with autism who participated in the study were alert. Both the colors of the game and the interaction with the 3D panda that speaks to them in the game created a positive impression and heightened their attention to listen to what the panda would say. Overall, they were quite engaged with the game and the task assigned to them.

Regarding the accuracy of the total 8 questions, children with autism gave on average 7.33 correct answers, while children with emotional difficulties gave 7.66 correct answers. From this comparison, it appears that children with emotional difficulties answered more questions correctly than children with autism. This result may be influenced by the fact that children with autism answered very quickly, resulting in insufficient time to think about the correct answer. Additionally, some children on the autism spectrum intentionally gave wrong answers to observe what the panda would do each time a wrong answer was given.

3.3. Matching Emotions with Emoticons

Despite their answers in the game, many times the matching of emotions with emoticons is not successful. Therefore, based on the matching task that the children were asked to perform after the game to reflect the degree to which they have managed to connect the emotion with the facial expression, the results shown in Table 2, in the column "emotion matching," were obtained.

Specifically, children on the autism spectrum have learned to match emotions with emoticons at a rate of 91.4% (out of the 8 emoticons they were asked to match, they correctly matched an average of 7.33). Similarly, children with emotional difficulties have learned to match emotions with emoticons at a rate of 93.7% (on average, they correctly matched 7.5 out of 8 emoticons). Meanwhile, typically developing children showed 100% success in matching emotions with emoticons.

A small but significant difference is observed between children with autism, children with emotional difficulties, and typically developing children. Children with autism have greater difficulty than the other groups in matching emotions to facial expressions, even among those who can easily name emotions. This difficulty is more visibly reflected in children's social adaptation. Following them are children with emotional difficulties, who show some difficulty but to a lesser extent than children with autism, and lastly, typically developing children, who according to this study, can match emotions to facial expressions with 100% accuracy.

The emotions that caused the most difficulty for the children in matching with emoticons were calmness, excitement, and embarrassment. Better responses were seen for happiness, sadness, anger, disgust, and fear.

Table 2. Observation Table of Specific Behaviors

Child	Stereotypical Reactions (Yes/No)	Contact with Panda (Yes/No)	Emotion Matching (out of 8)	Response Time (sec)	Correct Answers (out of 8)	Contact with Supervisor (Yes/No)
DA1	Yes	Yes	7/8	2	7	Yes
DA2	Yes	Yes	6/8	0.5	6	Yes
DA3	Yes	Yes	8/8	0.5	8	Yes
DA4	Yes	Yes	8/8	3	7	Yes
DA5	Yes	Yes	8/8	3	8	Yes
DA6	Yes	Yes	7/8	0.5	8	Yes

Child	Stereotypical Reactions (Yes/No)	Contact with Panda (Yes/No)	Emotion Matching (out of 8)	Response Time (sec)	Correct Answers (out of 8)	Contact with Supervisor (Yes/No)
ED1	No	No	8/8	5	8	Yes
ED2	No	Yes	7/8	3	8	Yes
ED3	No	No	7/8	3	7	Yes
ED4	No	No	8/8	1	8	No
ED5	No	No	8/8	2	8	No
ED6	No	Yes	7/8	2	7	Yes
TD1	No	No	8/8	1	8	No
TD2	No	Yes	8/8	1	8	No
TD3	No	No	8/8	1	8	No
TD4	No	Yes	8/8	2	8	Yes
TD5	No	No	8/8	2	8	No
TD6	No	No	8/8	2	8	No
TD7	No	No	8/8	0.5	8	No
TD8	No	Yes	8/8	0.5	8	No
TD9	No	Yes	8/8	0.5	8	No
TD10	No	No	8/8	1	8	No

3.4. Interaction with the Supervisor and the 3D Panda

As shown in Table 2, regarding the students' need to interact with the supervisor, all children with autism looked at their supervisor mainly during the task to seek confirmation before selecting each emoticon or to proceed to the next question. They also sought the supervisor's gaze to tell them the emotion they heard from the panda during the learning process. Additionally, some children with autism wanted to see the supervisor's reaction when the panda described the stories in order to understand how the supervisor would respond and then react similarly.

Regarding children with emotional difficulties, as shown in Table 2, two-thirds of the sample sought the supervisor's gaze to answer, asking for confirmation that the emoticon they were about to select was correct. One-third of children with emotional difficulties asked the supervisor, "Is this correct?" before answering the game.

In contrast, typically developing children did not seek the supervisor or make eye contact with them. They played the game independently until the end without asking for help or confirmation on any questions before responding.

Concerning visual contact with the Panda, according to Table 2, all children with autism had contact with the Panda. This contact was either visual or involved holding the Panda's hands and feet and dancing along. At the end of the session, one child from the autism group asked to give the Panda a tight hug. Children with emotional difficulties had a

lower need to interact with the Panda. Specifically, 67% had contact with the Panda during the game. From the typically developing children, 40% had contact with the Panda. Mostly, this contact was visual or involved touching the Panda's feet, which were at the tablet's height.

Overall, children with autism sought interaction with the Panda and the supervisor more than the other two groups. They were more expressive with the Panda and showed more enthusiasm than most participants from the other two groups. Also, 50% of the children with autism asked to play the game again once it ended, while the same percentage played with the Panda before the study began. In contrast, typically developing children were quite reserved and showed minimal expressiveness with the Panda in front of the supervisor, especially the older children, who were shy to show affection towards the Panda in front of the supervisor

3.5. Recording Participants' Behavior

As shown in Table 3, during the game administration, the children who participated commented on the game or made nonverbal reactions such as facial expressions matching the emotion they heard each time, grimaces during some of the stories told by the Panda, and smiled when they gave correct answers and the song played.

Specifically, Table 3 presents data per child based on observations. Overall, children with autism and children with emotional difficulties commented or participated more actively in the game compared to typically developing students, who appeared to complete the game more passively.

Table 3. Students' Verbal Reactions and Behavioral Observations by the Supervisor During the Game Session

Child	Verbal Reactions	Observations
DA1	"Oh, this is a difficult game", "It's funny to see the Panda"	At the start of the game, hears the phrase "touch me if you want to play", imitates the emoticons, looks at the Panda only during the learning part, touched the Panda to start the game the second time the phrase was heard
DA2	Repeats the emotion during learning, asks "Will we play with the Panda afterwards?"	Strong stereotypes, plays with the Panda, stands up to dance after each correct answer, wants to play again, looks at the supervisor for confirmation
DA3	Repeats the emotion during learning, asks "When does it end?", "Will we play again afterwards?" reacts to the stories told by the Panda with exclamations	Chews hands throughout, makes intense facial expressions for each emotion described, dances and sings with the Panda, stands up, mimics the faces, wanted to play again
DA4	Repeats the emotion heard	Looks at the supervisor for confirmation, holds the Panda's hands and feet, strong stereotypes
DA5	Repeats the emotion heard	Smiles intensely after giving a correct answer, plays with the Panda, wants to play again

Child	Verbal Reactions	Observations
DA6	"Yuck", "This face looks like my grandfather", "I want to play again"	Stereotypical movements, mimics facial expressions, plays with the Panda from the moment he saw it, asked to hug it before starting the game
ED1	Comments on emotions: "Oh, you want to vomit?" (disgust), "You relax a bit when you have a friend" (emoticon for calmness)	Looks at the Panda during the description of the emotion, smiles and looks at the supervisor when answering correctly
ED2	Repeats the emotions heard	At the command "touch me if you want to play" touched the entire screen instead of the Panda, during learning looks at the floor and walls, asks the supervisor which emoticon to select
ED3	Repeats the emotions heard	Fixed gaze on the tablet, tries to express the emotion heard through body language (e.g. put hands on hips for anger, touched stomach for disgust)
ED4	Before starting the game asks when they will play again, repeats Panda's words during learning	Imitates the emoticons
ED5	Does not speak	Looks at the screen from the corner of the eye, ties and unties shoelaces during the session
ED6	Makes exclamations: "ooo", "aaaa", "mmmm"	Bites her lips during practice, imitates the emoticons
TD1	Does not speak	Laughs after each answer, does not look at the Panda but plays with it
TD2	Comments on what he sees, e.g. "The Panda is very nice, did you make it?", "Oh, miss, it's moving"	Seeks confirmation from the supervisor for his answers
TD3	Does not speak	Shows no interest, does not interact with the Panda
TD4	Adds emotions beyond those learned in the game	Moves the Panda's arms, sings the song and laughs
TD5	Does not speak	Looks at his hands while the Panda is talking, lowered gaze
TD6	Does not speak	Plays with her hair, although she doesn't look at the Panda, plays with the Panda's two feet near the tablet
TD7	Does not speak	Plays very seriously and restrains a smile when giving correct answers
TD8	Does not speak	Nervously shakes his leg while watching the Panda and during the learning part

Child	Verbal Reactions	Observations
TD9	Does not speak	Ready to answer quickly, finger right in front of the screen, only looks but does not touch the Panda
TD10	Said during learning "These are very easy"	Looks at his watch, yawns, wants to laugh when the song plays but restrains himself

4. Discussion

Other studies related to the use of tablets in teaching children with autism confirm that the use of bright colors and animations is a more effective learning method. According to the study by Aspiranti et al. (2020) [20], the use of tablets can significantly improve academic performance in children with autism.

It is also noted that the effectiveness of tablets can vary depending on the number of sessions and the duration of the intervention. When the sessions are more frequent and the interventions longer, tablet use leads to better outcomes in the performance of children with autism [20].

In general, it is widely accepted that there are several advantages to using mobile devices (e.g., tablets) as assistive tools because they are intuitive, and the user can operate programs and play games simply by touching the screen—making them easily accessible to children with autism. Modern digital devices help children with autism gain more independence. Tablets are portable, and the student with autism can access the information or content on the device whenever it suits them [21].

Another study reports that many games for children with autism that focus on behavior contribute to the improvement of their social skills [21] and assist with certain daily habits such as hand–eye coordination, balance, as well as language, imitation, communication, and daily living skills [22].

Tablet use can help an individual recognize and express emotions through facial expressions. Studies have shown that connecting facial expressions with emotions in children with autism contributes to generalization and real-life adaptation so that they can understand the thoughts and behaviors of others [23]. However, learning to recognize emotions through facial expressions alone is not sufficient for improving social skills in everyday social interaction [24; 25]. It would be more beneficial to use real human faces instead of emoticons—perhaps of different ages and ethnicities—so that children with autism become familiar with recognizing the same emotion based on the facial expressions of various individuals. Additionally, it would help to place more emphasis on the eyes, as eye contact and gaze are essential for interaction [26].

A differing perspective is expressed in a study that examines how a game can help a child with autism perceive and understand emotions and connect them with facial expressions [3]. This study concludes that technology helps the child with autism learn the vocabulary of different emotions, their expression, and the variations of these emotions in different real-life situations—not just in a static format. The research refers specifically to a role-playing game

that trains the recognition of facial expressions such as happiness, sadness, anger, and surprise [3].

Regarding whether a child with autism will perform better and have a faster reaction time than a child with emotional difficulties, it appears that the child with autism responds more directly and accurately. Children with autism tend to react faster to motor and visual stimuli due to increased sensitivity, but have slower responses to tactile and complex stimuli [42]. In contrast, children with emotional difficulties often struggle with concentration, attention, and self-control, which may result in slower and less accurate responses in tasks requiring emotional processing and focus [27].

In conclusion, when instructions are clear, repetitive, and do not require social interpretation, children with autism tend to have faster reaction times and a higher likelihood of selecting the correct answer. Conversely, if the instruction involves emotional processing or requires flexibility, the child with autism may respond more slowly. Children with emotional difficulties may react more quickly, but are more likely to choose incorrect answers.

In relation to prior tablet use, studies show that children who are already familiar with using tablets perform better in tablet-based games, show more interest, and adapt more quickly compared to children with no prior experience—who need to both adjust to the game and learn how to handle an unfamiliar device [28]. Children with prior tablet use feel more comfortable, which may enhance the duration and quality of their engagement in the activity [29]. Additionally, experienced children can respond faster, use more creative strategies, or even apply prior knowledge from similar applications during the game—unlike those with no such experience [30].

4.1. Comparison of Results with Studies Using Robots

Other educational methods, especially the use of robots with children with autism, appear to yield significantly better results in their social skills and their understanding of the emotions of the people they interact with [31].

More specifically, robots are considered a very effective way of learning and acquiring new knowledge for students with autism, as their interaction with robots is more predictable than with humans. This predictability makes children with autism feel more at ease and helps them more easily engage with a robot than with a person [32; 25].

Various studies have shown that the use of robots improves the social skills of children with autism, particularly joint attention, which increases dramatically. Regarding communication skills, eye contact steadily increases during the use of the robot by the child with autism, as does emotional expression. Generally, it has been demonstrated that when a child with autism interacts with a robot, they do not feel embarrassed or afraid [32]. Other studies also confirm that the use of robots in education encourages children with autism to communicate more willingly with their peers and educators and to justify their actions [33; 34].

It is noteworthy that children with autism display higher levels of eye contact with robots than with humans. Ultimately, they feel a sense of familiarity with robots, as they express emotions in a very simple manner that children with autism can easily recognize [35].

Through structured activities, robots help children with autism develop specific skills such as imitation, turn-taking, and joint attention [25; 37]. Robots offer consistency, specific patterns, and predictability, which helps children with autism concentrate better, supports their learning process, and reduces challenging behaviors [37; 38]. As a result, outbursts, aggressive behaviors, and non-compliance are significantly limited.

Regarding stereotypical behaviors, research findings are conflicting. In some studies, these behaviors persist throughout the use of robots [32]. In other studies, however, there is a general decrease in undesirable behaviors such as excessive reactions, attempts to flee the classroom, yelling, lack of interest, and even a reduction in stereotypical movements [36].

When using robotics as part of education for children with autism—compared to children with emotional difficulties—it seems that the former respond more effectively and promptly to robots. Children with emotional difficulties do not necessarily need something so predictable and consistent, and therefore may not respond as positively to robots. They might prefer interacting with people. Consequently, it is not certain that the use of robots would improve their social and emotional skills in the same way it does for children with autism.

4.2. Conclusions

From the research results, it appears that children with autism, although they have faster response times to questions, give more incorrect answers, while their stereotypical reactions do not cease during the research process. The various colors in the game maintain the interest and concentration of children with autism; the children remain alert. The use of the tablet itself helps children with autism actively participate in the emotion recognition game.

Children with autism struggle more than children with emotional difficulties and typically developing children in recognizing emotions. Although their deviation from the other groups is not large, this measurement reflects the overall difficulty these individuals have in perceiving their own and others' emotions and in interacting with others.

4.3. Research limitations

There are limitations in the study that need to be mentioned and examined. Although the sample size is larger than in other studies, it is still relatively small to help generalize the results and to design an intervention for children with autism based on enhancing their emotional intelligence. Additionally, the four-month period during which the research was conducted, while helpful in deriving useful conclusions, is short to effectively monitor the progress of the students, if any, and to implement an intervention. Prior experience with tablets may have influenced the research results, as some children had previous contact with tablets, while others did not.

Furthermore, the ages of children within each group differ. The group of children on the autism spectrum consists of younger children compared to the other two groups. On average, the age of children with autism spectrum disorder is 7.5 years, those with emotional difficulties are 9.1 years old, and typically developing children are 7.7 years old. Therefore, children in the other two groups have a more developed cognitive and social level, making it easier for them to adapt to social contexts or respond to questions about emotions.

Finally, the presence of the supervisor in the room where the game was conducted may have caused the students not to be as spontaneous and relaxed, which could affect the examination of every movement and expression. Having students participate one by one in the room helped focus the participants; however, it was not studied how students react in the presence of their classmates in a classroom setting when asked to interact with Panda and the tablet. It is possible that their presence in the school classroom would show different results regarding reaction time and interaction with the Panda bear.

The positive results measured may not be solely due to the children understanding the emoticons and their association with emotions but rather the fact that a different game than usual was used, and the use of appropriate colors, voice, sounds, and music helped them stay focused and achieve correct answers in a short reaction time.

4.4. Suggestions for Future Research

More research needs to be conducted in Greece, within the school context, which differs from that of many other countries abroad. A similar study should be carried out in a school classroom setting in the future. The research sample could be larger and include more children with autism and typically developing children. Children with Attention Deficit Hyperactivity Disorder (ADHD) could also participate, and the study could last longer to allow for re-evaluation of behavior and adaptation of what they learn from the game in their social life.

Author Contributions: Conceptualization, project administration, supervision, review and editing CS; software PH; Data collection, original draft KL. All authors have read and agreed to the published version of the manuscript

Funding: This research has not been funded

Data Availability Statement: The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

Conflict of Interest: The authors declare no conflicts of interest

References

- [1] Andreou, M.; Skrimpa, V. Theory of mind deficits and neurophysiological operations in autism spectrum disorders: A review. *Brain Sciences*, 2020; 10(6), 1–12. <https://doi.org/10.3390/brainsci10060393>
- [2] Duvall, L.; May, K. E.; Waltz, A.; Kana, R. K. The neurobiological map of theory of mind and pragmatic communication in autism. *Social Neuroscience*, 2023; 18(4), 191–204. <https://doi.org/10.1080/17470919.2023.2242095>
- [3] Almeida, L. M.; Silva, D. P. D.; Theodório, D. P.; Silva, W. W.; Rodrigues, S. C. M.; Scardovelli, T. A.; Silva, A. P. D.; Bissaco, M. A. S.; ALTRIRAS: A Computer Game for Training Children with Autism Spectrum Disorder in the Recognition of Basic Emotions. *International Journal of Computer Games Technology*, 2019; <https://doi.org/10.1155/2019/4384896>

- [4] Madsen, M.; Goodwin, M. S.; El Kaliouby, R.; Picard, R.; Eckhardt, M.; Hoque, M. E. Lessons from participatory design with adolescents on the autism spectrum. *Conference on Human Factors in Computing Systems - Proceedings*, 2009; 3835–3840. <https://doi.org/10.1145/1520340.1520580>
- [5] Peterson, C. Theory of mind understanding and empathic behavior in children with autism spectrum disorders. *International Journal of Developmental Neuroscience*, 2014; 39(C), 16–21. <https://doi.org/10.1016/j.ijdevneu.2014.05.002>
- [6] Trevisan, D. A.; Abel, E. A.; Brackett, M. A.; McPartland, J. C. Considerations About How Emotional Intelligence can be Enhanced in Children With Autism Spectrum Disorder. *Frontiers in Education*, 2021; 6(April), 1–9. <https://doi.org/10.3389/educ.2021.639736>
- [7] Chaidi, I.; Drigas, A. Emotional intelligence and autism spectrum disorder. *Technium Social Sciences Journal*, 35(September), 2022; 126–151. <https://doi.org/10.47577/tssj.v35i1.7271>
- [8] Howes, S. S. Emotional Intelligence in Autistic Adults: A Review with Considerations for Employers. *Sustainability (Switzerland)*, 2023; 15(9). <https://doi.org/10.3390/su15097252>
- [9] Klin, A. Autism an Asperger syndrome:an overview. *Rev Bras Psiquiatr*, 2006; 28(1), 3–11.
- [10] Rahmawati, I.; Rahmatullah, A. S. *Jurnal Pendidikan Progresif How Are Emotional Intelligence Development Efforts in Improving Social Skill in Autistic Children ?2024; 14(02)*. <https://doi.org/10.23960/jpp.v14.i2.20249>
- [11] Wardani, N. K.; Mustikasari, B. F. Colour preference on Picture Therapy Cards in Children With ASD. *KnE Social Sciences*, 2023; 244–251. <https://doi.org/10.18502/kss.v8i15.13938>
- [12] Fridenson-Hayo, S.; Berggren, S.; Lassalle, A.; Tal, S.; Pigat, D.; Meir-Goren, N.; O'Reilly, H.; Ben-Zur, S.; Bölte, S.; Baron-Cohen, S.; Golan, O. 'Emotiplay': a serious game for learning about emotions in children with autism: results of a cross-cultural evaluation. *European Child and Adolescent Psychiatry*, 2017; 26(8), 979–992. <https://doi.org/10.1007/s00787-017-0968-0>
- [13] Deng, L.; Li, L.; Mao, Y. *Rehabilitation Environmental System Design of children with autism from the analysis of visual perception. Etmhs*, 2016; 670–674. <https://doi.org/10.2991/etmhs-16.2016.148>
- [14] Fage, C.; Consel, C. Y.; Balland, E.; Etchegoyhen, K.; Amestoy, A.; Bouvard, M.; Sauzéon, H. Tablet apps to support first school inclusion of children with autism spectrum disorders (ASD) in mainstream classrooms: A pilot study. *Frontiers in Psychology*, 2018; 9(OCT), 1–16. <https://doi.org/10.3389/fpsyg.2018.02020>
- [15] Esposito, M.; Sloan, J.; Tancredi, A.; Gerardi, G.; Postiglione, P.; Fotia, F.; Napoli, E.; Mazzone, L.; Valeri, G.; Vicari, S. Using Tablet Applications for Children With Autism to Increase Their Cognitive and Social Skills. *Journal of Special Education Technology*, 2017; 32(4), 199–209. <https://doi.org/10.1177/0162643417719751>

- [16] Alhajeri, O.; Anderson, J. A.; Alant, E. Effectiveness of the Use of iPads to Enhance Communication and Learning for Students with Autism: A Systematic Review. *International Journal of Technology and Inclusive Education*, 2017; 6(1). <https://doi.org/10.20533/ijtie.2047.0533.2017.0132>
- [17] Olmedo-Vizueta, D.; Hernandez-Ambato, J.; Ávila-Pesantez, D.; Bilotta, E.; Pantano, P. VALE-Emotions: Aplicación móvil de enseñanza para individuos con Desordenes del Espectro Autista. *Enfoque UTE*, 2017; 8(1), 358–373. <https://doi.org/10.29019/enfoqueute.v8n1.145>
- [18] Lyu, C.; Chen, H.; Peng, X.; Xu, T.; Wang, H. DailyConnect: A Mobile Aid that Assists the Understanding of Situation-based Emotions for Children with ASDs. *Conference on Human Factors in Computing Systems - Proceedings*. 2021; <https://doi.org/10.1145/3411763.3451578>
- [19] Al-Saadi, A. M.; Al-Thani, D. Mobile Application to identify and recognize emotions for children with autism: A systematic review. *Frontiers in Child and Adolescent Psychiatry*, 2(March), 2023; 1–10. <https://doi.org/10.3389/frcha.2023.1118665>
- [20] Aspiranti, K. B.; Larwin, K. H.; Schade, B. P. iPads/tablets and students with autism: A meta-analysis of academic effects. *Assistive Technology*, 2020; 32(1), 23–30. <https://doi.org/10.1080/10400435.2018.1463575>
- [21] Stathopoulou, A.; Loukeris, D.; Karabatzaki, Z.; Politi, E.; Salapata, Y.; Drigas, A. Evaluation of Mobile Apps Effectiveness in Children with Autism Social Training via Digital Social Stories. *International Journal of Interactive Mobile Technologies (IJIM)*, 2020; 14(03), 4. <https://doi.org/10.3991/ijim.v14i03.10281>
- [22] Reisi Dehkordi, S.; Mohd Rias, R.; Reisi Dehkordi, S. *Computer Game Approach for Children with Autism Spectrum Disorder: A Pilot Study Motion Interaction Games For Rehabilitation of Children With Developmental Disability View project Computer Game Approach for Children with Autism Spectrum Disorder: A Pilot . September 2013*; <https://doi.org/10.13140/2.1.4411.1682>
- [23] Kardas, N. T.; Sadik, R. An Analysis of the Effect of Educational Game Training on Some Physical Parameters and Social Skills of the Children with Autism Spectrum Disorders. *Asian Journal of Education and Training*, 2018; 4(4), 319–325. <https://doi.org/10.20448/journal.522.2018.44.319.325>
- [24] Papoutsi, C.; Drigas, A.; Skianis, C. Mobile applications to improve emotional intelligence in Autism - A review. *International Journal of Interactive Mobile Technologies*, 2018; 12(6), 47–61. <https://doi.org/10.3991/ijim.v12i6.9073>
- [25] Onaolapo, A. Y.; Onaolapo, O. J. Global Data on Autism Spectrum Disorders Prevalence: A Review of Facts, Fallacies and Limitations. *Universal Journal of Clinical Medicine*, 2017; 5(2), 14–23. <https://doi.org/10.13189/ujcm.2017.050202>
- [26] Sartorato, F.; Przybylowski, L.; Sarko, D. K. Improving therapeutic outcomes in autism spectrum disorders: Enhancing social communication and sensory processing through the use of interactive robots. *Journal of Psychiatric Research*, 2017; 90, 1–11. <https://doi.org/10.1016/j.jpsychires.2017.02.004>

- [27] Tanaka, J.; Bai, A.; Bowen, J.; Xu, B.; Bartlett, L.; Sanchez, J.; Chin, M.; Poirier, L.; Blinkhorn, M.; Campbell, A.; Sung, A. From the small screen to the big world: mobile apps for teaching real-world face recognition to children with autism. *Advanced Health Care Technologies*, 2015; 37. <https://doi.org/10.2147/ahct.s64483>
- [28] Van Der Meere, J.; Van Der Meer, D. J.; Börger, N.; Pirila, S. Attention and impulse control in children with borderline intelligence with or without conduct disorder. *Perceptual and Motor Skills*, 2008; 107(3), 676–682. <https://doi.org/10.2466/PMS.107.3.676-682>
- [29] Hourcade, J. P.; Bullock-Rest, N. E.; Hansen, T. E. Multitouch tablet applications and activities to enhance the social skills of children with autism spectrum disorders. *Personal and Ubiquitous Computing*, 2012; 16(2), 157–168. <https://doi.org/10.1007/s00779-011-0383-3>
- [30] Fletcher-Watson, S.; Pain, H.; Hammond, S.; Humphry, A.; McConachie, H. Designing for young children with autism spectrum disorder: A case study of an iPad app. *International Journal of Child-Computer Interaction*, 2016; 7, 1–14. <https://doi.org/10.1016/j.ijcci.2016.03.002>
- [31] Neely, L.; Rispoli, M.; Camargo, S.; Davis, H.; Boles, M. (The effect of instructional use of an iPad® on challenging behavior and academic engagement for two students with autism. *Research in Autism Spectrum Disorders*, 2013; 7(4), 509–516. <https://doi.org/10.1016/j.rasd.2012.12.004>
- [32] Gkiolnta, E.; Zygopoulou, M.; Syriopoulou-Delli, C. K. Robot programming for a child with autism spectrum disorder: a pilot study. *International Journal of Developmental Disabilities*, 2013; 69(3), 424–431. <https://doi.org/10.1080/20473869.2023.2194568>
- [33] Irani, A.; Moradi, H.; Vahid, L. K. Autism Screening Using a Video Game Based on Emotions. *2018 2nd National and 1st International Digital Games Research Conference: Trends, Technologies, and Applications, DGRC 2018*; 40–45. <https://doi.org/10.1109/DGRC.2018.8712053>
- [34] Yun, S. S.; Kim, H.; Choi, J.; Park, S. K. A robot-assisted behavioral intervention system for children with autism spectrum disorders. *Robotics and Autonomous Systems*, 2016; 76, 58–67. <https://doi.org/10.1016/j.robot.2015.11.004>
- [35] Scassellati, B.; Henny Admoni; Matarić, M. Robots for use in autism research. *Annual Review of Biomedical Engineering*, 2012; 14(February), 275–294. <https://doi.org/10.1146/annurev-bioeng-071811-150036>
- [36] Ricks, D. J.; Colton, M. B. Trends and considerations in robot-assisted autism therapy. *Proceedings - IEEE International Conference on Robotics and Automation*, 2010; 4354–4359. <https://doi.org/10.1109/ROBOT.2010.5509327>
- [37] Kim, E. S.; Berkovits, L. D.; Bernier, E. P.; Leyzberg, D.; Shic, F.; Paul, R.; Scassellati, B. Social robots as embedded reinforcers of social behavior in children with autism. *Journal of Autism and Developmental Disorders*, 2013; 43(5), 1038–1049. <https://doi.org/10.1007/s10803-012-1645-2>
- [38] Costa, A. P.; Charpiot, L.; Lera, F. R.; Ziafati, P.; Nazarihorram, A.; Van Der Torre, L.;

- Steffgen, G.; Van Der Torre, L.; Steffgen, G. A comparison between a person and a robot in the attention, imitation, and repetitive and stereotypical behaviors of children with Autism Spectrum Disorder. *Proceedings Workshop on Social Human-Robot Interaction of Human-Care Service Robots at HRI2018*, 4(September), 2018. http://robotics.auckland.ac.nz/wp-content/uploads/2017/10/UoLuxembourg-Final.pdf%0Ahttps://www.researchgate.net/publication/327915762_A_comparison_between_a_person_and_a_robot_in_the_attention_imitation_and_repetitive_and_stereotypical_behaviors_of_childr
- [39] Ismail, L. I.; Shamsudin, S.; Yussof, H.; Hanapiah, F. A.; Zahari, N. I. Estimation of concentration by eye contact measurement in Robot-based Intervention Program with autistic children. *Procedia Engineering*, 2012; 41(Iris), 1548–1552. <https://doi.org/10.1016/j.proeng.2012.07.348>
- [40] Neo, H. F., Teo, C. C., & Yeo, Q. F. (2021). Augmented reality emotion recognition for autism spectrum disorder children. *F1000Research*, 10, 1217. <https://doi.org/10.12688/f1000research.73522.1>
- [41] Lemeshow, S., & Ferketich, A. (2020). Simple Random Sampling. *Polling America: An Encyclopedia of Public Opinion, Second Edition: Volumes 1-2, December*, 661–664. <https://doi.org/10.4324/9780203128640-6>
- [42] Puts, N. A. J., Wodka, E. L., Tommerdahl, M., Mostofsky, S. H., & Edden, R. A. E. (2014). Impaired tactile processing in children with autism spectrum disorder. *Journal of Neurophysiology*, 111(9), 1803–1811. <https://doi.org/10.1152/jn.00890.2013>

APPENDIX

STUDENT TARGET BEHAVIOR RECORDING SHEET

Student Names: DA1, DA2, DA3, DA4, DA5, DA6

Target Behavior: Stereotypical movements

Observation Duration: 8 minutes

Observation Period: 8 minutes – 30-second intervals

Table. Intervals of Occurrence of Stereotypical Movements per Student with Autism Spectrum Disorder (ASD)

	1st minut e	2nd minut e	3rd minut e	4th minut e	5th minut e	6th minut e	7th minut e	8th minut e	Intervals of behavior occurrenc e	Percentag e of Intervals
DA 1										
DA 2										
DA 3										
DA 4										
DA 5										
DA 6										

Student Behavior Observation Sheet during Gameplay
Child's Code Name: _____

Date: _____

Observation Time: _____

Type of Development (TD/ESN/ASD): _____

Target Behaviors	Description	Yes	No	Sometimes	Comments
Stereotypical Reactions	Appearance of repetitive movements/phrases	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Contact with the Supervisor	Eye contact with the supervisor / need for reassurance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Emotion-Situation Matching	Association of emotion with an everyday situation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Response Time to Questions	Speed of answering (e.g., <5")	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Correct Answers	Number of correct answers out of total	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Eye Contact with Panda	Frequency of eye contact with Panda	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Verbal Comments	Utterances related to the content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Additional Comments:

GAMEPLAY SNAPSHOTS



Start of the game



PRACTICE:
Joy - Sadness



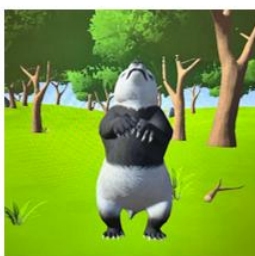
PRACTICE:
Disgust - Embarrassment



PRACTICE
Calmness - Fear



PRACTICE:
Anger - Excitement



Correct answer: The panda is dancing.



Wrong answer: The panda moves away and then returns after a while.