

# Development of a Serious Games for Asperger Syndrome Based on a Bio-inspired Algorithm to Measure Empathy Performance

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**Abstract.** Currently, the development of a Serious Game, whose purpose is to assist cognitive behavioral therapy for patients with Asperger Syndrome, should provide valuable information always to the specialist providing the psychological therapy, to determine the degree of progress that the patient is achieving, and related to facial recognition and social disabilities exercises. Thus, we can improve the symptoms and achieve a better social interaction with other people. The use of specific knowledge from specialists about empathy can make simple videogame in a serious game, in which not only the fun factor is involved, this knowledge gives a support for a satisfactory progress achieved by the individual while playing. This paper, presents the progress in the development of a serious game that helps the socialization of children with Asperger syndrome, general aspects, and methodology that is being used.

**Keywords:** serious game, psychological therapy, algorithms, artificial intelligence, Asperger syndrome.

## 1 Introduction

The game is a fundamental activity for human development. Usually played to have fun, to entertain. However, there are those who claim that it is mainly played to learn [4]. Health video games are designed to entertain while attempting to modify some aspect of behavior [1]. With this premise is how you can summarize the main function of any therapeutic video game that is focused on health, and more in this case, in which we focus on people suffering from Asperger Syndrome.

In the field of research on autism spectrum disorders, computer-based interventions are being used to improve emotion and face recognition skills, as well as language and social skills [2], which have achieved be successful as the patient continues treatment. This approach has been inspired, in part, by the findings that children with this type of disorder often enjoy playing computer games in their free time [2].

Knowledge elicitation tactics has played a key role in the construction of serious games. The idea of constructing this Serious Game is to use specialized knowledge to support the progress that the patients with Asperger has, and that information obtained from mental health specialist can use the treatment of the patients. The game is a fundamental means for the structuring of language and thought, it acts systematically on the psychosomatic balance; enables learning of strong significance; reduces the feeling of gravity against errors and failures; invites participation by the player; develops

creativity, intellectual competence, emotional strength and personal stability. Finally, it can be affirmed that play constitutes a fundamental strategy to stimulate the integral development of the people in general [4]. The aim of this article is to show the progress of the project of developing a serious game to help the socialization of children with Asperger syndrome. In section 2, a brief explanation of flow theory, since has a significant impact when designing a video game. In section 3, the project structure is presented three mains items (psychological, technical and narrative of the video game). In section 4, is the proposed game with the narrative and how the therapy is including in the videogame. Section 5 presents the procedure of the project with the experimental activities, the location and time to test the serious game. In section 6, the statistical analysis shows the analysis of the existence of statistically significant differences in the pre-test and post-tests measurements of two groups.

## 2 Related Research

A theme related with videogame design is flow theory, because establish the fun of videogame.

### 2.1 Flow Theory

The flow theory also known as the zone is the operative state of mind in which a person is completely immersed in the activity executes. It is characterized by a feeling of focusing energy, of total involvement with the task, and of success in carrying out the activity. This feeling is experienced while the activity is in progress. The concept of flow was proposed by the psychologist Mihaly Csikszentmihalyi in 1975 [10]. This theory has been put into practice in different areas always with satisfactory results. In games, this practice results in having the player perform the activities in a way that is fun, and this is achieved by having a balance between the skills and the challenges that we face the player, we will achieve that the game is entertaining and motivating.

According to Csikszentmihalyi, the components of a flow experience are as follows [10]:

**Table 1.** The Components of a Flow Experience.

1	Clear objectives (Expectations and norms can be perceived, and goals are attainable appropriately with the set of skills and abilities).
2	Concentration and focus, a high degree of concentration in a limited field of attention (a person related to a single activity will have the opportunity to focus and delve into the matter).
3	Direct and immediate feedback (successes and failures in the course of the activity are obvious, so the behavior can be adjusted as needed).
4	Balance between skill level and challenge (The activity is neither too easy nor too complicated).
5	The activity is intrinsically rewarding, so no effort is noticeable when running.

### 3 Theoretical Framework

In every project work the area about theoretical framework is very essential. In this section we going to talk the structure of the project.

#### 3.1 Structure

In the structure section we divide the project in two areas (psychological category and technical category).

##### Psychological Category

According to the DSM 5 Manual of the American Psychiatric Association (a reference manual diagnosing neurological problems) [15], Asperger syndrome is already within autism spectrum disorder, with Asperger being the lowest level within of said disorder. As discussed earlier, this article is about the progress that is developing a serious game called also serious video game, which will help the socialization of children who have the diagnosis of Asperger Syndrome. To achieve such socialization, it is important to see empathy as one of the aspects to be addressed to achieve the objective. For the video game to have the therapeutic character and can be used in the therapies that the mental health specialists carry out, it is necessary that it fulfills a series of stages that in a conventional therapy would be carried out, the stages in question They are:

**Facial Recognition.** The deficit would be manifested through a marked difficulty in understanding the emotional load that faces present, being the inability to interpret emotions through the face. Abnormal processing of faces in people with autistic disorder may be because faces are not a stimulus important to them or in any case social content, not processed in a usual manner [12].

**Mind Theory.** Deficit Mind Theory mentions that people with Asperger show serious difficulties to take the place of the other and intuit their mental world. People with Asperger 's are unable to intuit the mental world of others, so that the consequences of this inability or difficulty very serious [12].

Some of the consequences of this limitation for understanding the mental world of others would be the following (Table 2) [12]:

**Table 2:** The limitations for understanding the mental world.

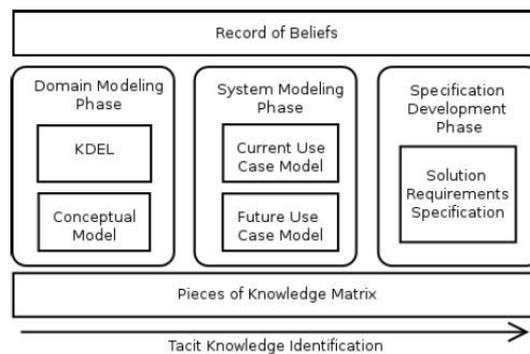
Difficulty predicting the behavior of others.
Difficulty in realizing the intentions of others and knowing the true reasons that guide their behavior
Difficulty understanding emotions, both own and others, which leads them to show few empathic reactions
Difficulty to consider the degree of interest of the interlocutor on the topic of conversation
Difficulty anticipating what others may think about their behavior
Difficulty to lie and to understand deceit

**Subtleties, Skills and Social Interaction.** In basic interaction skills, children with autistic disorder present difficulties since basic social conventions such as greeting, if they are not known, do not do it, as well as thank or ask permission, do not decode them because they are not explicit, many times they do not greet by the amount and forms of greetings that appear, that fail to capture the key and to be so changing it generates in the boys' and girls' confusion and finally they do not integrate it in their repertoire. By performing these stages within the video game, we can say that the patient is conducting a therapy as it would in the specialist's office, of course, adding the playful part that any video game has.

### 3.2 Knowledge Elicitation Tactic

The methodology that we use in this project is KMoS-RE. The KMoS-RE system is a tool that generate explicit knowledge from tacit knowledge and is based on the premise that, to develop a software, you must understand the requirements, and for that it is necessary to understand the domain [16]. The strategy consists of 3 phases:

- Domain Modeling: Formalizes the properties of the domain concepts, making explicit the concepts, attributes, relationships between concepts and basic integrity constraints. A lexicon is used to identify, classify and define domain terms [16].
- System Modeling: The information used to develop this model is derived from the lexicon and the conceptual model, and in this way the requirements are formalized [16].
- Development Specification: In this stage the requirements obtained are used to generate a formal document with the necessary information about the project in question [16].



**Fig. 1.** KMoS-RE Strategy Representation [16].

### Game Engine

The Game Engine refers to a series of routines that allow the execution of all elements of the game. It is where the control of each element of the game is represented and how it interacts with them. It is here that the AI (Artificial Intelligence), behavior,

personality and ability of the elements of the game are combined, the sounds associated with each element of the game in each moment and all the graphic aspects associated with them, including the kinematics of the game [11].

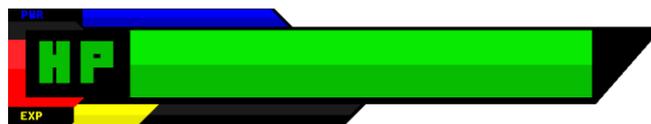
The game engine selected for the creation of the video game is Unity which is the tool of creation of videogames more used today. It has an excellent editor, with a multitude of options, is very friendly, and is completely multiplatform (PC, MAC, Linux, Web browsers, iOS, Android, Blackberry, Windows Phone, Xbox 360, PlayStation 3, Wii, Xbox ONE, PlayStation 4, PlayStation Vita and WiiU), allowing to export a project for any of these platforms in a straightforward way [9]. This video game aims to follow the theory of flow, but applied to people suffering from Asperger syndrome, therefore, is adjusted for these conditions of use.

## **4 Proposed Game**

In this section the narrative describes the therapy work together with the videogame to make the serious game.

### **4.1 Narrative Category**

As mentioned in the section of psychology, video game should contain the issues in question to be considered therapeutic, but without removing the playful game contains everything, and is represented as follows. The reward is a key factor in the game, because we keep the attention and motivation of the child and on the other hand will tell the progress that has been obtained. The reward system consists of stars that the child is gaining as he achieves the objectives and is advancing.

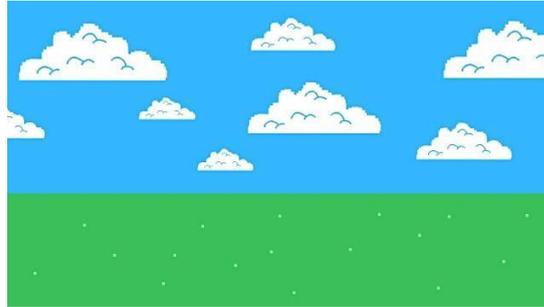


**Fig.2** Lives representation.

### **First Part**

In this section, and a scenario in 2D in which the game begins where a child with Asperger goes to sleep and dreams of an adventure that happens, which is immersed in a series of situations that must be resolved is contemplated being these situations the issues raised in the psychology category. First, there is the stage of face recognition, at this stage the child is in a village which is walled and has to leave but to get must be able to open the door of the wall with two keys which have them two people (Avatars) that have the face with the faction that we want the child to recognize in that case (happy, angry, sad, indifferent, etc.) and in case you ask the key to a different avatar will respond that he does not have The key that continues searching, it is necessary to remember that the main idea is that the boy recognizes the facial emotions. People

with Asperger's Syndrome do not recognize facial expressions as other people would, as a defect they must recognize emotions, and this is reflected in the social behavior of the person.



**Fig. 3** Dream and adventure begins.



**Fig.4** First level facial recognition

## Second Part

Once the patient manages to open the gate of the wall he will have passed the first level of the game, later he will go through some paths and some bridges as part of his adventure that will take him to the next stage. In this second part, the following item in question is theory of mind, which is taken as reference one of the most common tests in therapy, which is the Test of Anne and Sally, will become clear is set for release of video game.

Upon reaching the next stage, the child will find two characters in a forest where there is a hut where they live and observes how one of them leaves an object in a place near the hut and gets in, and the other Character takes the object and hides it in the forest. On leaving the first character of the hut there that help you find the object and should start where I left last time.

For a person who has Asperger disorder will result by other obviously should look at where you left off last time, but if you have Asperger someone who does not understand that there should look first. To find the object, began dating all the lost items that had hidden him the second character from long ago, and as a reward give you a canoe that had to cross a river to continue looking for the lost treasure. The concept of

mind theory refers to the ability to understand and predict the behavior of other people, their knowledge, their intentions and their beliefs [6].



**Fig.5** Second level theory of mind.

### **Third Part**

It is clear to determine that to establish an improvement in therapy it is convenient to see the patient have a better social interaction with the people in their environment, so we can say that the therapy is effectively giving the expected result. As part of the last level of the game, there are a series of situations in which the patient is interacting with other avatars simulating everyday situations of life. In this part, social subtleties, social skills and social interaction will be seen together as these 3 areas have much in common.



**Fig. 6** Village Representation.

Once the child has sailed the river reaches a village where is the lost treasure, but realizes that to get to the treasure, he must be kind, respectful and polite to the other characters there they are, for example, he should arrive greeting the characters to be told where the treasure is, and tell him across the bridge can get but to cross it must ask the guard to allow cross asking for a polite way. Reaches across a pyramid and tell him that there It is the treasure, but to open the pyramid deb and to have friends to help you and begins to befriend the characters of the village and together will open the pyramid and find the treasure.

At this point, the child wakes up at home and tells his mother that he dreamed of adventure.

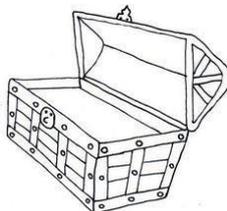


Fig 7. Treasure representation.

## 5 Procedure

The experimental activities were carried out at the Medical Center of Americas at El Paso, Texas. The study was carried out over the course of 3 months in sessions held once a week in which two groups of patients participated every hour. This study was carried out in accordance with the recommendations of American Psychology Association. The entire experiment was conducted in accordance with the Declaration of Helsinki. All participants gave also oral informed consent. Ethics approval was obtained from the Research Ethics Committee of the Health Research Unit. Tests were conducted in a sound-proofed room equipped with tables, chairs, and a computer connected to a projector. The groups consisted of between 10 and 15 patients, and the experiment lasted approximately 1 h. Participation was voluntarily. If any patient did not wish to take part, he or she could stop the activity at any time. The only criterion for exclusion was if the patient did not understand Spanish. The patients and were in- formed of these details prior to starting the experiment. None of the patients were excluded because of the language criterion, nor did anyone choose to leave during the sessions. The patients answered the Asperger's Standard Questionnaire [20] on patient's attitudes toward syndrome both before contact with serious game and after. In addition, once the test had ended, they were also asked to evaluate the usefulness and visual appeal of the program (on a scale from 0 to 10), whether they would recommend playing the game to a relative or friend or not, what they thought the game had taught them, and what improvements they would make on the game. In the control group, the patients participated in another video game not related to Asperger's with the same duration as Serious game. This group also answered the abovementioned questionnaire both before and after playing.

### 5.1 Statistical Analysis

To analyze the existence of statistically significant differences in the pre-test and post-tests measurements of the two groups, the patients was utilized for independent samples. This was complemented by an effect size with a statistic that corresponded, which in this case was Cohen's d. In a second analysis, the posttest and pre-test measurements of each group were compared using the Student's t for related samples. The third analysis involved the use of Cohen's d to assess the magnitude of the change produced during the experience. Finally, the descriptive statistics were utilized which were gathered from the participants' evaluations and answers. The analysis was carried out using the statistics program SPSS 11. As can be observed in Table 3, the av-

verage difference test between the pre-test measurements of the experimental group and the control group did not reveal the existence of statistically significant differences between the two with the variables analyzed. However, there were statistically significant differences between the two groups for all the variables evaluated following the intervention.

By using Cohen’s d, it was confirmed that the differences between the groups after the activity were moderate. The means and standard deviations of the variables in the study that correspond to the experimental and control groups for each study phase are displayed in Table 4. The analysis of the post-test–pre-test scores of the control group revealed no statistically significant differences with respect to any of the variables evaluated, as can be observed in Table 4.

However, significant differences were found in the same analysis for the scores of the experimental group, both in the total of the questionnaire score in relation to serious game and its two factors, namely, facial recognition and social disabilities. Consequently, it can be seen how the Asperger’s problems decreased among the people who participated in the serious game program.

About the scope of the effect, it was observed that the program had a strong impact on reducing Asperger problems in facial recognition but was weak in terms of affecting other social disabilities.

Regarding the assessment carried out by the participants, the program was given a high score for usefulness (7.2 average) and a slightly lower average score for interest (6.1). 75% of the participants said they would recommend playing serious game to a relative or friend. With regards to the characteristics of the different stories in the game, it can be observed that participants easily identified that said stories were not emotionally well.

**Table 3** Average difference test between the pre-test measurements of the experimental group and the control group.

	Pre-test			Post-test		
	t	p	d	t	p	d
<b>Facial Recognition</b>	0.833	0.405	0.127	-3.477	0.001	-0.481
<b>Social Disabilities</b>	-1.146	0.252	-0.280	-3.815	0.000	-0.533
<b>Total</b>	-1.069	0.286	-0.165	-3.894	0.000	-0.597

**Table 4** Means and standard deviations of the variables in the study that correspond to the experimental and control groups for each study phase.

	Experimental					Control				
	Pre-test		Post-test		Pre-post	Pre-test		Post-test		Pre-post
	M (SD)	M (SD)	t	p	d	M (SD)	M (SD)	t	p	d
<b>Facial Recognition</b>	5.11 (2.13)	3.55 (2.56)	16.899	0.000	0.662	4.86 (1.79)	4.66 (2.02)	1.244	0.220	0.104
<b>Social Disabilities</b>	4.41 (3.29)	3.96 (3.33)	3.301	0.001	0.136	5.48 (4.27)	6.00 (4.27)	-1.748	0.088	-0.121
<b>Total</b>	9.54 (4.78)	7.54 (5.24)	10.406	0.000	0.399	10.35 (5.03)	10.64(5.15)	-0.768	0.447	-0.056

## 6 Discussion

The results of the application of serious game with Asperger patients are presented. Firstly, it is worth highlighting that with regard to Asperger, evaluated using the Questionnaire [20] on patient's attitudes toward Asperger's, there was a considerable decrease among the participants who used the serious game. This was not the case of the participants who used other video games not related to Asperger's. As a result, the game's effectiveness in reducing misconceptions is clearly observed, particularly in relation to a friendly therapy. It must be taken into account that the preconceived notion of violence or danger associated with people with severe mental. The general assessment of serious game by the patients revealed interesting results as well. The participants scored close to eight points (7.2) for the game's usefulness and a slightly lower score for interest (average score of 6.1). Some of the patients' comments made about the game were the following: "everyday examples help to understand this disorder a little better," "it is fundamental to help and accept any individual, and to be patient," "people with Asperger as not necessarily an alien", and "I have learnt that I should treat people with same problems naturally." Additionally, 75% stated they would recommend trying this game to a relative or a friend. In light of the results obtained, serious game has proved to be an effective tool for raising awareness among people about Asperger's and for providing information about these disorder, which makes it possible to dispel myths.

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