UJI UNIVERSITAT JAUME I

Title: Aprende Jugando. A game for children with ASD.

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Abstract

Autism spectrum disorders (ASD) are a group of neurobiological developmental disorders that have no cure and have a serious impact on daily life from a psychosocial and family perspective. As a result, social discrimination occurs that is accentuated in later stages of life.

For these reasons, the main objective of this work is to create a tool capable of stimulating the main deficiencies of these children (social, academic and psychomotor skills) through playful activities. Likewise, it is intended to seek as a secondary purpose the inclusion in the school environment and ultimately in society.

For this, a video game made of different mini games whose target are children with ASD has been programmed. This minigames are made in order to help these children to improve their main deficiencies like empathy, social relationships, mental calculation …
All these mini-games have a very attractive cartoon art for children and easy-to-understand feedback through sounds and text boxes that allow the user's attention to be focused and make engagement on him.

As for the testing of the video game, it has been tested in relatives of approximately 5 years of age without associated disorders, obtaining good results. However, it would be convenient to test it with the public for whom it was designed and check its effectiveness.

Lastly, it should be noted that this work is an academic project carried out to obtain the final degree project (TFG) of the Degree in Video Game Design and Development at the Jaume I University.

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1. Introduction

Autism spectrum disorders (ASD) are a group of neurobiological developmental disorders that appear during the first years of life. Within this group different pathologies are included, such as Asperger's syndrome, Rett's syndrome, the social disintegrative syndrome or the most prevalent, autism. Nowadays, these disorders have no cure and their treatment focuses on psycho pedagogical therapies.

All these pathologies are characterized by presenting difficulties in social interaction, communication and language development. Because of this, these children present problems in the interactions of daily life: less interest in people, they prefer to play alone, they lack empathy, they do not correctly interpret facial expressions or understand emotions (acts that can lead to misinterpreting many situations or provoke immature behaviors in inappropriate situations) …

For this reason, keeping a conversation is so hard for them, because they don't know if the person they are talking with is happy, sad, angry…

Likewise, ASD is associated with other psychiatric disorders such as intellectual disability, attention deficit hyperactivity disorder (ADHD) or affective disorders (anxiety and depression). All this causes these children to have difficulties to relate and interact with other children of their age, which added to the problems in the academic field, create a discriminatory gap that marginalizes these children from society.

1.1 Work motivation

The main motivation of this game is to help the target, in this case the children with autistic syndrome or hyperactivity syndrome.

Another secondary motivation of this work is to show that videogames can also help and teach a lot of things to people and that they are not only for entertainment.

1.2 Objectives

The fundamental objective of the game is to become a useful tool for the learning stage for children with ASD, helping to improve the different skills that they lack of.

As secondary objectives, but also notable are:

- To encourage the integration of children with ASD with their social environment by making the gameplay broad so that other children can also play.
- To disseminate the academic properties of video games, showing that these are not only for entertainment.

1.3 Environment and initial state

The environment in which one the game has been developed is somewhat hard due to the actual spanish situation related to Covid19 and it has delayed and modified the stages of work.

Due to this environment I couldn't test the game with children and neither implement the robot that acts like interface.

1.4 Methodology

This game has been made through different steps, the first one is the research of information. In order to do this, I have searched and compiled various articles, studies and guidelines that address ASD from different perspectives, diagnostic criteria and possible therapeutic approaches. Also, I have contacted a specialist psychologist in these subjects who has helped me to focus the objectives of the project.

Secondly, the creation and search for the art and sound of the game, making it attractive, colorful and melodic for children. Thus, it allows them to focus their attention on the activity they are doing and not be distracted.

Finally, the programming and creation of the game, for this, the Unity graphic engine has been used and for the programming of the code the C# language has been used.

These last two steps have been evolving as the game progressed.

2. Planning and resources evaluation

2.1 Planning

The followed planning is the next one:

- Information compilation, talking with the teacher Rosa Garcia Castellar to identify the target deficiencies in order to focus the minigames on these deficiencies.
- Creation of minigames, both in terms of graphics and their programming.
- Robot programming that acts as an interface
- Creation of the differents reports and other necessary documents.
- Presentation preparations like videos, PowerPoints...

This planification has been affected by my internship that got me busy for 1 month.

Due to the exceptional circumstances of the covid19, the planning has been modified and the programming stage of the robot that acts as an interface has not been implemented.

2.2 Resource evaluation

For the resources, I have needed the help of Rosa Garcia Castellar, psychology teacher in UJI, for pointing out the deficiencies on children with autistic or hyperactivity syndrome.

On other hand, I have also needed some help from my relatives in order to test the minigames and also give me some feedback about them.

Finally, I have also needed help from my tutor Enric Cervera Mateu who helped me in the game and also in a robot implementation who acts like the game interface.

This last thing, unluckily. due to the spanish situation which I talked above, it has not been possible.

All guides, articles as well as web pages used are attached in the bibliography

3. System analysis and design

3.1 Requirement Analysis

Regarding the requirements, due to the closed target, the game needs to be very easy to understand and make engagement to the children.

In order to do this, the game inputs are buttons very easy to understand, the outputs through very visible texts.

In addition, the minigames are also so simple and easy to understand, the rewards and penalties provided to the player are also very evident.

Likewise, written information is given for an adult who helps the child throughout the learning process.

3.2 System Design

In this section we can see the different diagrams, use case diagrams, class diagrams and also activities diagrams.
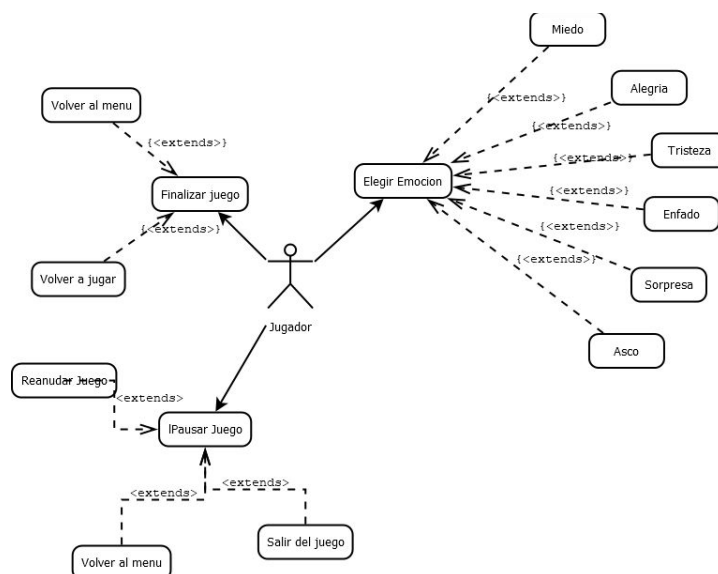
Figure 1. Use case diagram about game of emotions. In this diagram we can see what actions the player can do. For example he can choose between all the possible emotions, but he can also pause and finish the game.

Figure 2. Class diagram about the game of emotions. In this one we can see the different elements in the game, his attributes and his functions. For example the score, or the sprite of the emotions.

Figure 3. Activities diagram about the game of emotions. It describes the activity chain the player is going to do. In first place, the player chooses an emotion, then the game checks the answer, spawn particles and audio depending on the answer and then the player checks his answer thanks to that feedback.

Figure 4. Use case diagram about reflex game. In this diagram we can see what actions the player can do. For example, he can activate, stop or reset the car. He can also increase the difficult level or decrease it.

Figure 5. Class diagram about the reflex game. In this one we can see the different elements in the game, his attributes and his functions. For example the player, the car and the difficulty.
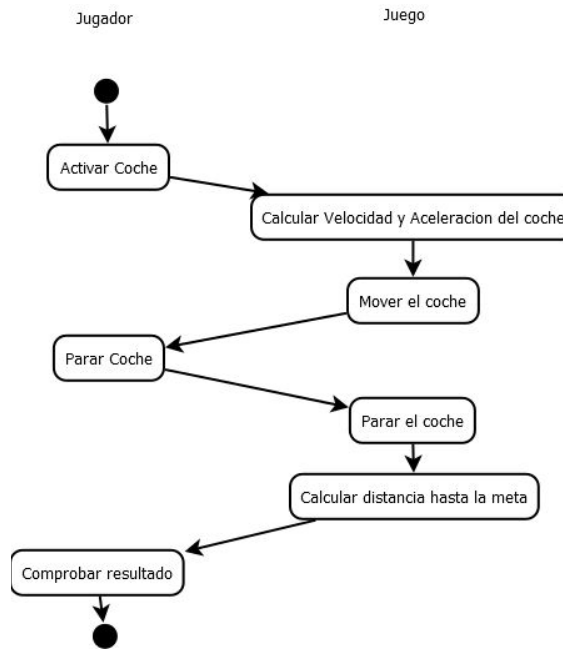
Figure 6. Activities diagram about the reflex game. It describes the activity chain the player is going to do. In first place, the player activates the car, then the game calculates the speed and acceleration and move the car. So the player stops the car, the game checks the distance between the car and the goal and informs the player about his outcome.
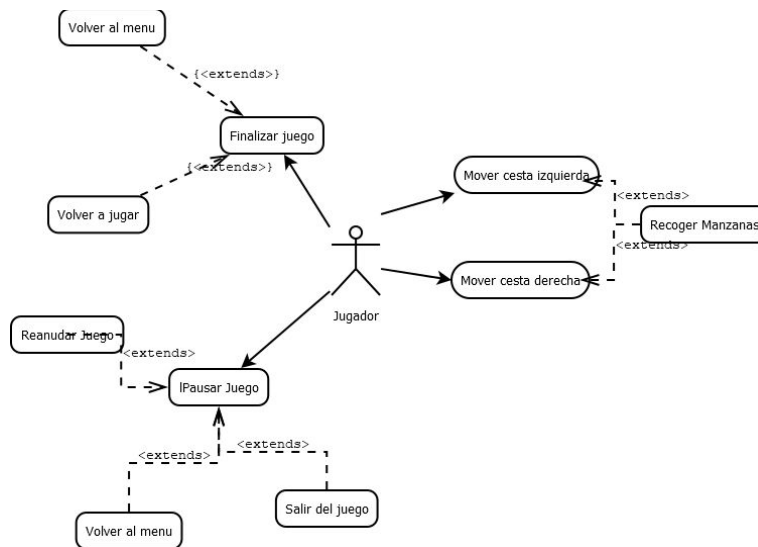
Figure 7. Use case diagram about apple game. In this diagram we can see what actions the player can do. For example, he can move the basket to the right or left in order to pick up the apples, he can also finish the game or pause it.
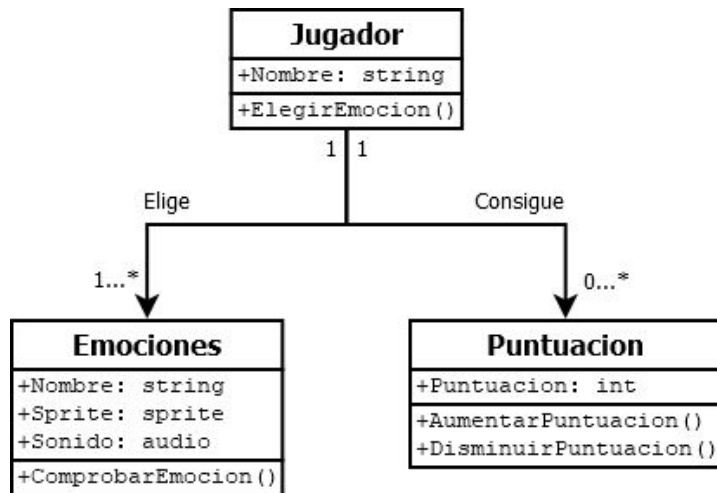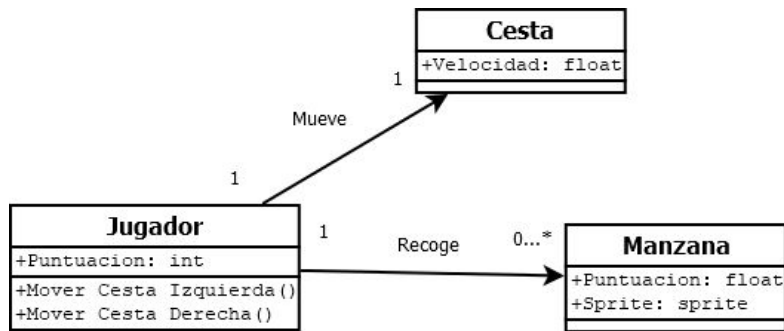
Figure 8. Class diagram about the apple game. In this one we can see the different elements in the game, his attributes and his functions. For example the player, the basket and the apples.
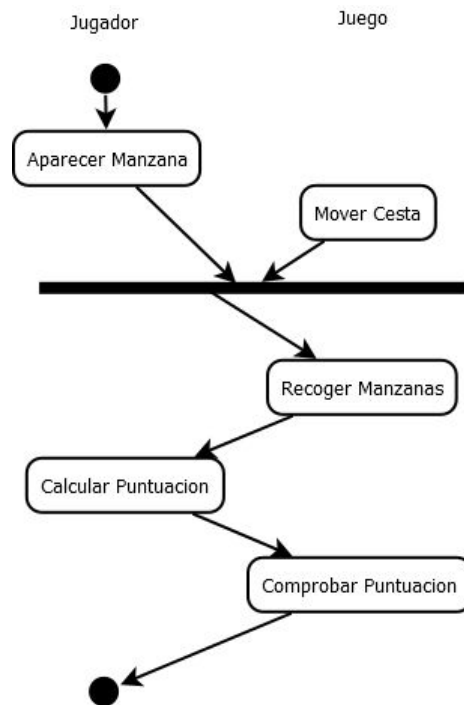
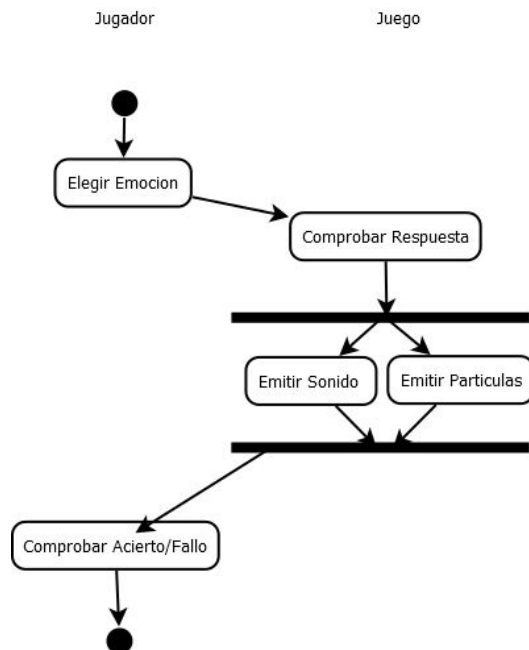**Figure 9**. Activities diagram about the apple game. It describes the activity chain the player is going to do. In first place, the game will spawn an apple, at the same time the player moves the basket. Then the player will pick up the apple and the game will compute the score depending on the apple's type and finally the player will check his score.
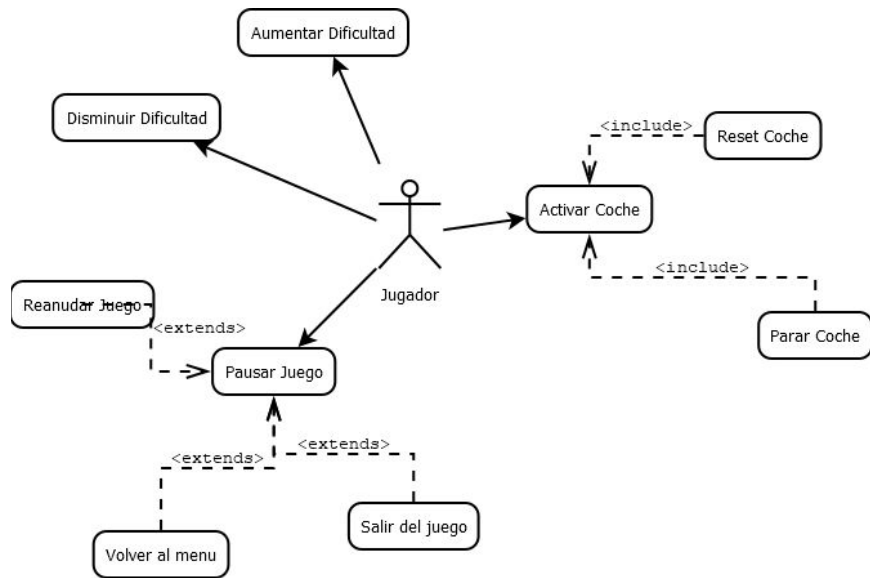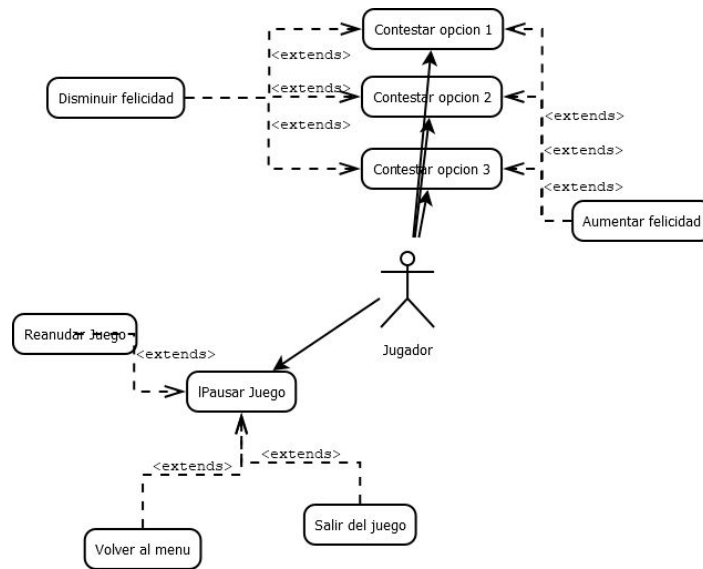
Figure 10. Use case diagram about conversation game. In this diagram we can see what actions the player can do. For example, he can choose between the different options with a different outcome on the other person happiness.
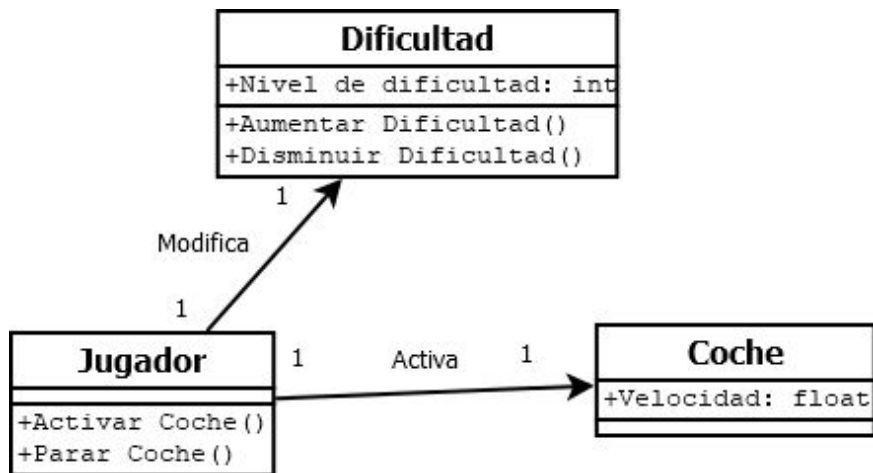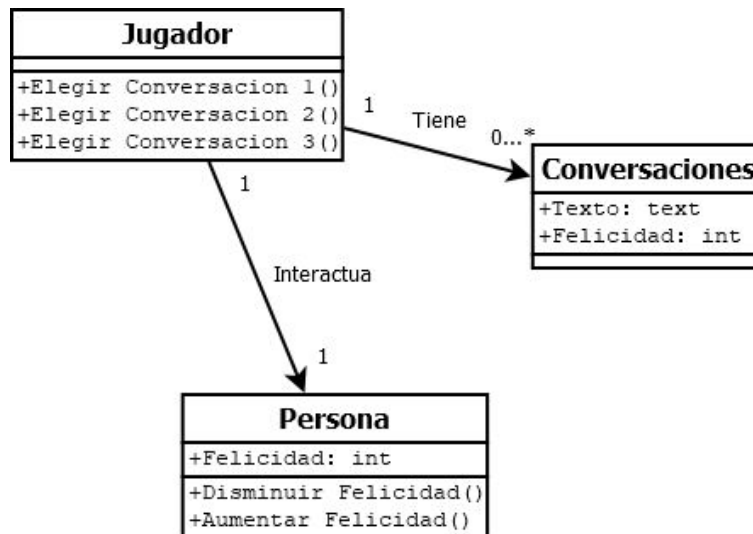

Figure 11. Class diagram about the conversation game. In this one we can see the different elements in the game, his attributes and his functions. For example the player, the basket and the apples.

Jugador   Juego   Persona

Genera Conversacion

Elige opcion de conversacion

Calcula felicidad dependiendo de la respuesta

Cambia Felicidad

Vuelve a generar conversacion
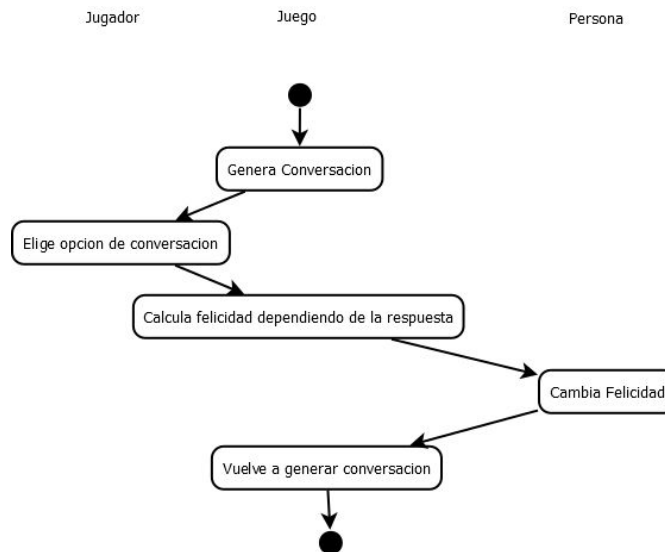
Figure 12. Activities diagram about the conversation game. It describes the activity chain the player is going to do. In first place, the game will generate a random conversation, then the player will choose between the different options to converse with the other person. Then the other person happiness will change depending on the user option and finally the user checks his outcome.

In addition, there are a few more games implemented, however, they have a similar structure that the diagrams above so, I don't think is necessary to put all the diagrams in here.

3.3 System Architecture

Since the target are children, the needed hardware and software are minimal. The idea is that any computer in the classrooms or in their own house is able to launch the game.

The only requirement is the resolution, fixed on 1920x1080.

About the robot that acts like the game interface, it could be possible to have the robot but the game is also playable without the robot with all their characteristics.

3.4 Interface Design

As mentioned before, due to the target, the interface is as friendly as possible.

It's so easy to interact with this interface with one or two clicks, and this interface is as clean as possible.

Figure 13. This image is from the main menu of the game and it has a cartoon esthetic and buttons easy to understand to make easier the children navigation on this menu.

Figure 14. This image is from the minigame selection. It has a horizontal scroll to navigate through this menu very easily. Inside the folders we will have the minigames icons to identify in them.

The user will be able to click on this folders in order to go inside them and proceed with the game selection.

Figure 15. This image is from the apple game showing a tutorial where the user can learn how to play the minigame.

In all the minigames there are these tutorials so the player can learn to play all the minigames.

Figure 16. This image is from the emotion game where we can see a pause menu.

The user can press "ESC" key in order to pause the game and he can also leave the game or go to the main menu.

Figure 17. After the games end, a panel like the image above is shown, telling the user his score and the option to replay or go to menu.

4. Work Development

This game is split in different mini games, that belong to three categories:

- **Social aptitudes:** In this category, we try to stimulate social communication and the management of expressions and feelings. In addition, we try to establish temporal sequences, some associated with daily and recreational activities since they are aspects that are difficult to internalize. As the greatest deficiencies occur in this area, the mini-games related to this category are the most important.

- **Psychomotor aptitudes**: Through these mini-games, the objective is to improve abilities such as: logic and memory. In addition to making focus on attention, an ability that is also frequently diminished in patients with ASD

- **Academic aptitudes:** In this section, attempts are made to speed up mental calculation, as well as figure recognition through arithmetic and geometric exercises, making these games a connecting link between children with and without ASD, as they can be used in schools.

Because of the game is about different set of mini games, the amount of mini games is not already defined so it can be increased. Similarly, you can choose which skills you want to enhance or which minigame is more suitable for the needs of the area in which you are.

In every minigame, the user receives feedback visually, either through text boxes or special effects, or audibly. This helps to understand if he is doing it correctly or incorrectly.

In addition, highlight all the menus are functional and all the mini games have their own final menu and pause menu and tutorial.

4.1 Social Mini-Games

4.1.1 Emotion game

The objective of this minigame is to stimulate the ability to recognize emotions using a playful activity. The user will see some faces of people with different emotions expressed, and the objective is to identify which emotion is shown.

To do this, the user has to press the buttons at the bottom of the image. In addition, the user will have a time limit, where they must find out the maximum possible emotions in the given time.

To ensure replayability, the order in which emotions are displayed is completely random. As the score is obtained by answering correctly, the images increase in difficulty (cartoon images or real photographs).
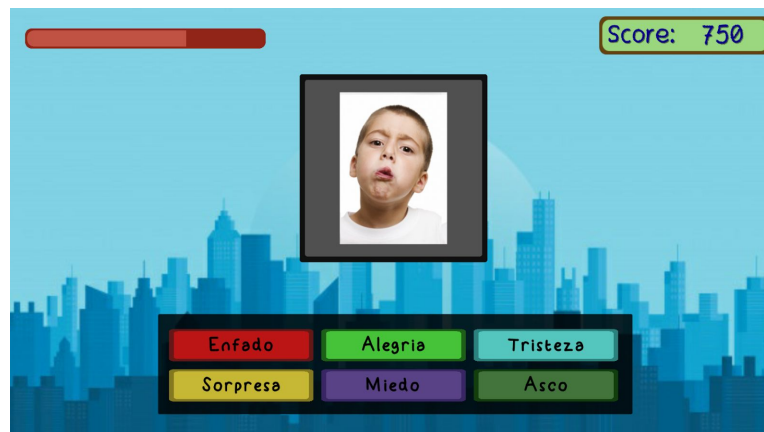
Figure 18.a
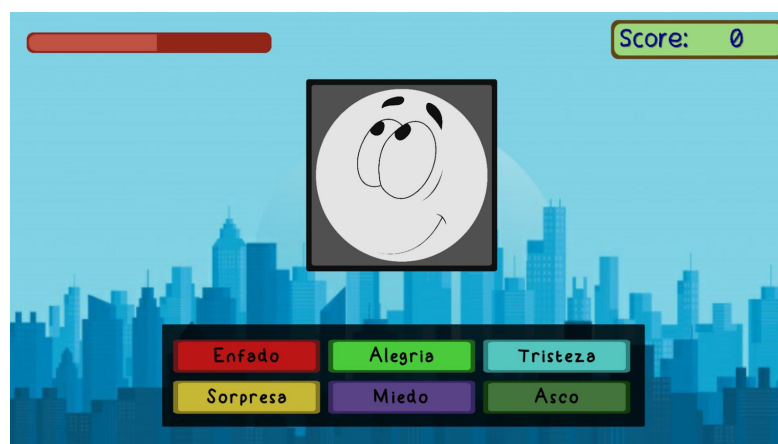
Figure 18.b

4.1.2 Conversation game

This game is a conversation simulator between the user and the system. The system will start a conversation and the user will have to choose between three options to reply. Depending on the chosen option, the other person's happiness will be increased or decreased. The objective is to have this happiness as high as possible.

There are 5 responses in total for the same phrase, but only 3 of them are shown at a time. In addition, the phrases are displayed randomly, so the same phrase can be repeated with different results.

At all times, you can see a happiness bar that is updated in size and color depending on the user's responses. The happiness bar is defined as a numerical parameter, where 0 is the minimum and 10 the maximum; the responses contain happiness modifiers of -3, -1, 0, +1, +3 depending on it's adequacy.

In this way, the child will understand the importance of answering appropriately and not hurt the other people feelings

Figure 19.a

Figure 19.b

4.1.3 Sorting Game

Different sequences of disordered activities are shown and the objective is to place them in order. These sequences deal with activities such as getting up, showering, eating breakfast... With this minigame, the children are intended to learn different routines to take.

Once the user has placed the images in the bullets, he will have to click on the check button to see if he has done it correctly, if so, the user will go to the next level, otherwise, the badly placed images will return to their position initial.

The order in which the sequences appear is always the same, with a difficulty curve from low to high. However, to avoid memorizing the position of the photos, it is calculated randomly each time the game starts

Figure 20.a

Figure 20.b

4.1.4 Empathy game

The user is presented with different situations from everyday life and has to put himself in the shoes of the characters to specify what they feel at the time.

There are 6 different images that are shown randomly and correspond to the basic emotions. If the user clicks on the correct option, he will go to the next scenario, otherwise, he will have to try again.

The objective of the game is to complete all the levels, but the importance of it lies in empathy. Through this activity, we try to improve this aptitude, making the child consider the feelings of the character and the attitude that he should face in the face of the problem that is presented to him.
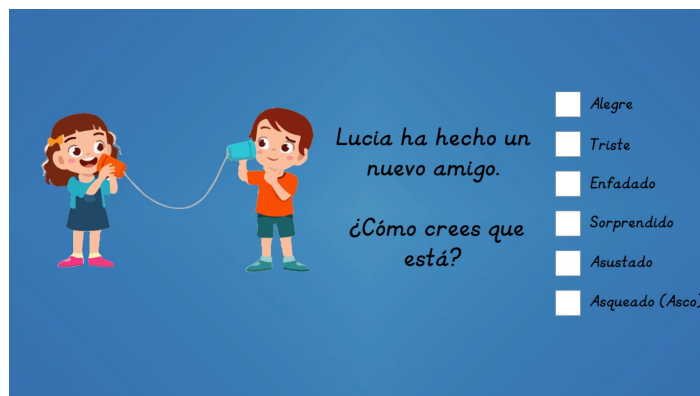
Figure 21.a

Figure 21.b

4.2 Academic Mini-Games

4.2.1 Operations game

The user will see a picture with different parts, each of this parts will have an addition or a subtraction, the outcome of this operation will be a number which can be translated to a color using a color code. The objective is to full paint the image. In this way, a very important mathematical activity such as mental calculation is disguised as an entertaining hobby.

Currently, the game has two drawings available.

For it. the user will have to drag the colors using the mouse to the part of the body they want to color, if the color number corresponds to the result of the associated operation, this part will be colored, otherwise nothing will happen.

Operations are calculated randomly, always providing a number between 0 and 5 to avoid memorizing these operations.
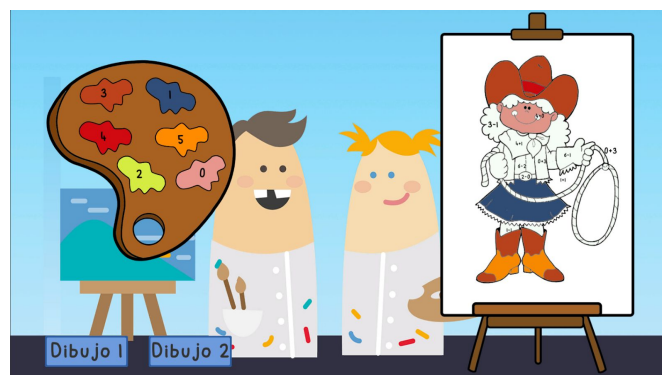
Figure 22.a
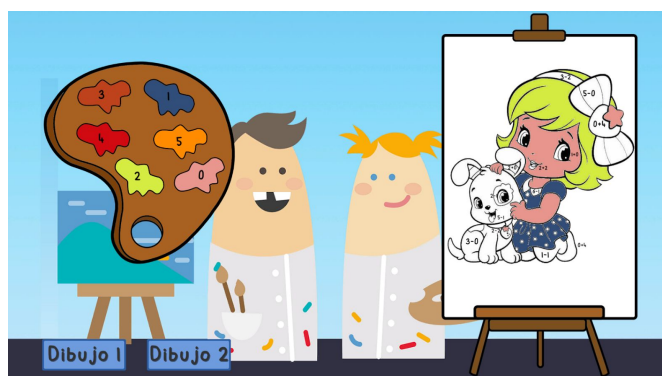
Figure 22.b

4.2.2 Maze game

Another minigame for developing mental calculation is the maze game. In this we can highlight the presence of the interactive character, the penguin, the fish, what the user has to collect and the igloo, the goal to be achieved. These fish will have an associated number between 0 and 9.

The user must lead the penguin using the "A", "S", "D" and "W" keys or the keyboard arrows to move the penguin to the left, down, right and up respectively.

The objective of the game is to take the penguin to the igloo catching fish whose numbers add up to a total of 10. The position of the fish is always the same, however, the number they contain is random.

There will always be a path through which 10 can be added, but due to the way in which the numbers are generated, the same result can be obtained through different paths.

Figure 23.a

Figure 23.b

4.2.3 Counting game

There are various groups of animals that the user must count to complete the minigame. To do this, you will have to click on the text boxes to the right of the groups and write the number of animals found.

The number of animals in each group will be a random number between 1 and 10. The objective of this minigame is for the user to learn to count by seeing different animals and counting them by looking at the screen. However, the number of groups to be hit is always fixed, 12, that is, four screens with three groups each.

It should be noted that there is no penalty for failing, the player is simply notified with a sound and he can try again with another amount.

Figure 24.a

Figure 24.b

4.2.4 Figure game

The objective of this game is for the user to learn which are the basic geometric figures and their shapes. For its development, different geometric figures will be shown that the user must enter in the corresponding spaces.

The user will have to drag the figures on the left side of the screen using click and drag and drop the figure in the corresponding hole. If you succeed, the figure will be embedded in the gap making it unable to move again. In case the user makes a mistake, the figure will return to the initial position.

The game has a total of 10 different geometric figures, among which 4 are selected in a totally random way each time the user starts the game.

Figure 25.a

Figure 25.b

4.3 Psychomotor Mini-Games

4.3.1 Object game

One of the skills to develop is logic, so this minigame aims for the child to associate in a logical way what is indicated in the text (the beach, the school ...) with the images shown (the objects that it would take).

The user is presented with a situation and some objects, and he, depending on the situation, must choose which objects that person should take. For example, in the first level, a person goes to the beach and the user must identify which objects should be carried among 6 possible objects. In this case, it would be a towel, an umbrella and a beach bucket.

Objects can be selected by clicking on them and select them in the same way. Once the user has decided what objects should be carried, they must click on the "check" button.

If the result is correct, you will go to the next level, otherwise you will have to select the necessary objects again.

Figure 26.a
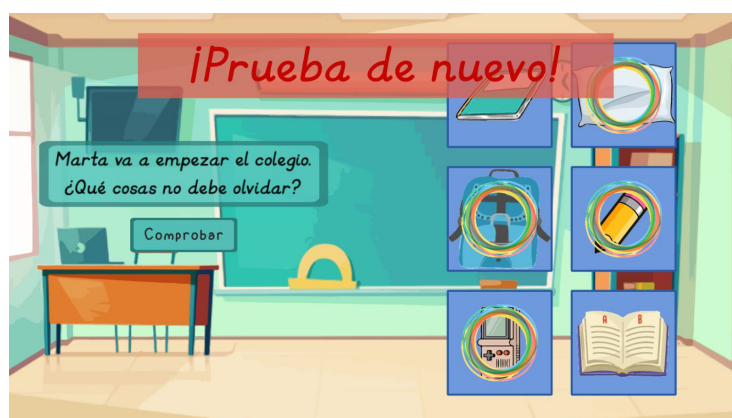
Figure 26.b

4.3.2 Apple game

As previously discussed, one of the disorders associated with ASD is ADHD. That is why this minigame aims to stimulate the ability to concentrate through a playful exercise.

So, the user has to train his coordination in order to pick up the apples falling in the sky with a basket that he can move.

Using the "A" and "D" keys or the "→" and "←" arrows, the user can move the basket horizontally to the left or right respectively.

The user has a time limit in which to collect the apples. There are two types of apples, some red and others green, the latter give higher scores than the first.
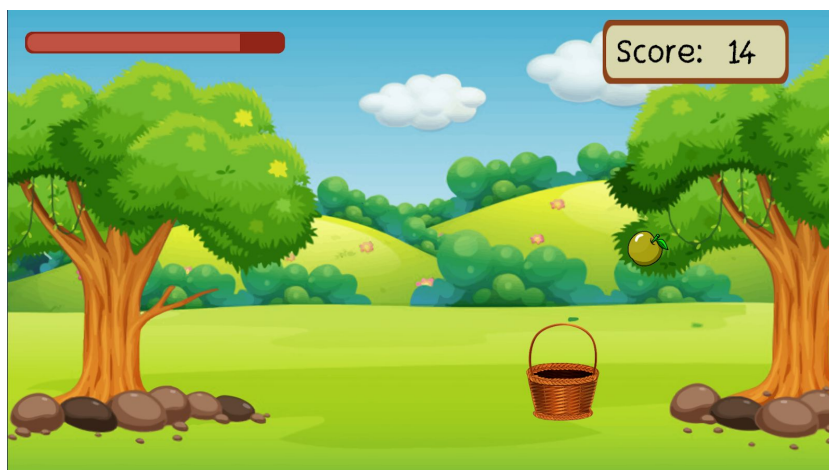
Figure 27.a
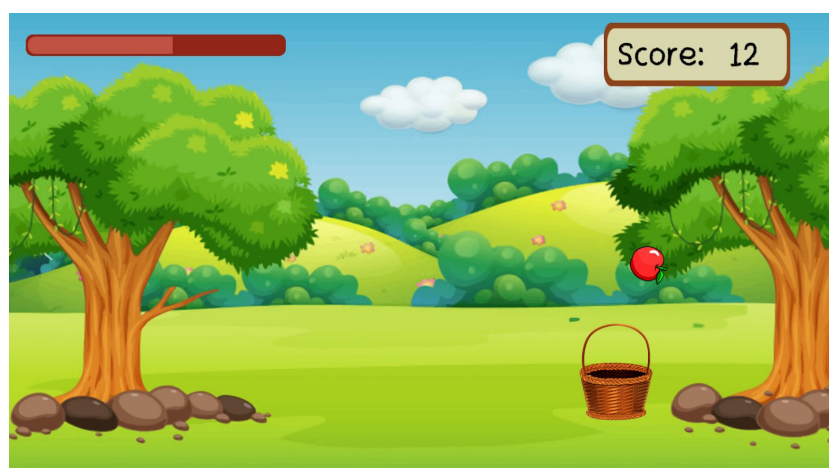
Figure 27.b

4.3.3 Memory game

Classically, the game of pairs has been used to improve memory capacity in children. This minigame is based on it: the user will flip the carts and find the two cards with the same image.

The user must click the cards to turn them over, when two cards are turned over, the system will check if they have the same image; if they are, they will be uncovered and cannot be clicked again, otherwise they will be flipped again.

As the user increases the difficulty, more pairs of cards will appear. There are 4 levels of difficulty, in each of them there are 2,3,4 and 5 pairs respectively.

The images that the cards contain are different in each level of difficulty, having among them animals, fruits, professions...

Figure 28.a

Figure 28.b

4.3.4 Puzzle game

An exercise that involves both concentration and logic is the completion of puzzles, so in this mini game the user will have to recompose a fragmented image in nine parts.

To complete the puzzle, the user will have to drag the images on the left to the grid on the right by clicking and drag. So when he drops a shape, it will move to the closest grid point.

In this case, unlike in the "Game of Figures", although the user correctly places a piece, it will still be able to move.

In total, there are 3 puzzles, with different images between which you can alternate randomly using the "Change puzzle" button.
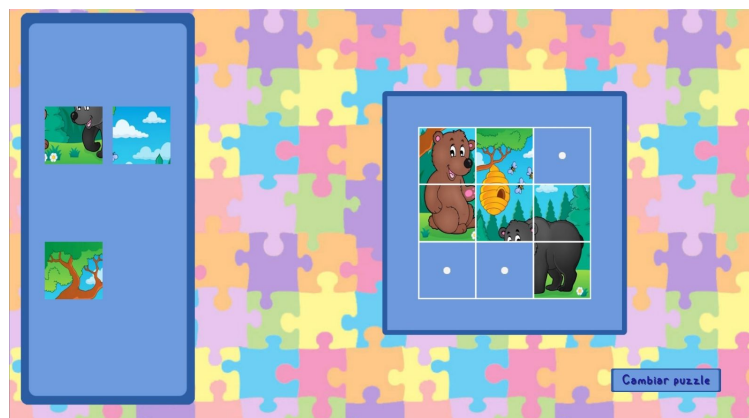

Figure 29.a

Figure 29.b

All this games have a score to tell how good or bad did the user play. The score could be shown as a number or also as a dialog text. In addition, in the game selection menu, the highest score will be saved and displayed to the user. So the player knows what score did he achieved in each mini game.

As mentioned before, all the games have a tutorial panel on the start of the game so the user can learn to play before starting. These minigames, and also the menus, have a cartoon esthetic, very childish in order to make the game attractive for the target.

On other hand, the volume of music and the effect sounds can be increased or decreased in the options menu. These music and sounds are also relaxing and not stressful.

Finally, I wanted to implement a robot that acts as interface, so it could say to the child what he has to do or tell him if he is doing good or bad.
However, despite being almost fully programmed, due to the spanish situation mentioned before, I couldn't implement the robot because I needed to meet my tutor in person to work properly with the robot.

This robot can connect to a Python server using sockets, so, when the player starts the game, and needs part of the interface, the game itselfs sends a socket to the Python server and tells the robot what it has to say. It can also do some body language, so for example, when it says "Hello" to the children, he can also wave his hand. In addition, the robot can also make sounds, so, it can do all the game sounds that indicate the player if he did it well or bad.

All this features are easy to implement so, with the actually programmed code, we just need to send a few lines of code to make it work.

4.4. Video Game Results and Testing

Although it is a theoretical project, it has been tested on various relatives between 4 and 6 years of age without associated disorders, although there has been no possibility of including the game in the scope for which it was designed.

Among the observations to highlight we find:

- **Social Mini-Games**: Since the children with whom the game was tested did not have any ASD disorder, these mini-games have been simple and monotonous.

- **Academic Mini-Games**: Since these mini games are based on school-based math exercises, they have been both familiar and entertaining for the children, for this reason these were their favorite games.

- **Psychomotor Mini-Games**: Finally, the games associated with this category have received positive reviews in terms of fun and entertainment.

In addition, thanks to these tests, a minigame that was intended to stimulate the user's reflexes has been ruled out, since unfortunately it has not worked as planned.

In this game, the user had to stop a car when it reached the goal, being able to increase and decrease the speed by putting tunnels that would make vision difficult on the road. Due to the imprecision and problems that the game generated to stop the car right at the goal, the game was not entertaining and the children ended up getting tired before reaching the objective.
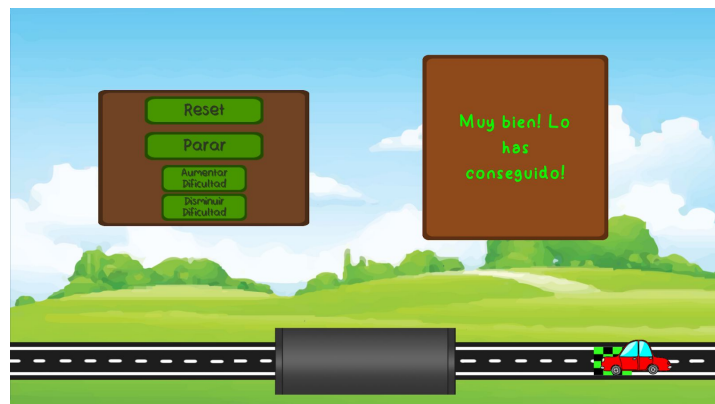

Figure 30

5. Conclusions and future work

5.1 Conclusions

As previously mentioned, the disorders included in ASD are problems without effective treatment, for this reason, the therapeutic approach must be multidisciplinary from a psychosocial perspective.

Playful exercises can be used to involve the child in cognitive therapies and make them more bearable, for her, one of the helpful tools that can be included is video games. In this case, specifically, it works in different areas that stimulate the deficiencies of children with ASD and its associated symptoms, such as ADHD, while enhancing that of children without them.

In addition, it has been tested in children without any disorder showing positive results; This indicates that it can be used as a support tool at school. For this reason, the use of the video game as part of the educational material can help children to interact and help each other and therefore, facilitating inclusion in the social sphere.

From all the aforementioned, we can extract that this tooling has not been conceived only for academic use but also aims to entertain and make these activities bearable.

5.2 Future work

Regarding future work, due to the type of this game, made on a set of mini games, it's totally expandable and a lot of them can be created without any problem. This is a really advantage of the game.

On other hand, to implement the robot mentioned before, is also a very good task. Having a robot that acts as an interface can help the child develop social skills more efficiently and also not see the game in a merely academic way but rather a playful activity.

In addition, it could be possible to contact with some school with children with ASD in order to test the game and see if the game can really help these children and also entertain them.

5.3 Personal Opinion

This work has been a great opportunity to put into practice everything learned in the Degree in Video Game Design and Development regarding programming.

In my opinion, it is a complete game since it has many fully playable and useful mini-games for both entertainment and learning.

However, the current Spanish situation has slowed down the project as well as limiting it, since one of the essential things that could not be done is testing the video game in a school with children with ASD. Along the same lines, the graphic section of the game has not turned out the way I would have liked, as there are some sprites and backgrounds that I would like to have changed, but due to lack of time and practice, it has not been possible.

Even so, I am satisfied with the work done and I wish I could continue with the project so that it could be implemented in real conditions.

5.4 Acknowledgments

I want to give tanks to my tutor Enric Cervera Mateu that helped me a lot by giving a very good ideas to develop the game, for example, the robot idea and also to Rosa Garcia Castellar, psychology teacher at UJI, that also gave me a lot of information about the deficiencies that children ASD have.

On the other hand, I also thank my sister who is a doctor and has also helped me both to understand the deficiencies that children with ASD have, as well as to correctly reflect them in video games and feedback on the different mini-games.

6. Bibliography

6.1. Used tools

The tools I've been using are:

- **Unity:** As game engine on the video game creation.

- **Photoshop:** To create and modificate sprites for the mini games and also for the menus.

- **Illustrator:** To also create different sprites mainly for menus.

- **Sony vegas:** Used for music and sound effect modification.

6.2 Links of interest

These are some links of interest from some websites used to differents things in the video game:

- **StackOverflow:** Used to check out some programming doubts that have been emerging along the game.
  https://stackoverflow.com/

- **Pinterest y Google Images:** Used to take some references and also download some images.
  https://www.pinterest.es/
  https://www.google.com/imghp?hl=en

- **FreePik:** A cartoon image web where you can free download a lot of images.
  https://www.freepik.com/

- **Unity documentation:** Documentation of Unity used to find some functions and game engine characteristics needed for the game.
  https://docs.unity3d.com/Manual/index.html

- **Robot documentation:** used to know how the robot works, and programming it.
  http://doc.aldebaran.com/2-1/naoqi/audio/alanimatedspeech.html

6.3 Project Links

- **Game Code links**: Since I haven't used GitHub because I used Unity Collabs there's only 2 commits. In addition, I also upload my code on Drive to ensure the sending.

  Drive:
  https://drive.google.com/file/d/1QCnVoJZ3dlsQ1apwu3e669gQvpJFsXSB/view?usp=sharing

  GitHub:
  https://github.com/Natxo58/AprendeJugando

- **Gameplay video:** Youtube link:
  https://youtu.be/CCSbUuo196U

- **Game build:**
  https://drive.google.com/file/d/1S-1hlHxDY2zNm_JdBZj42Chwf7yujuFM/view?usp=sharing

6.4 References

Some of the needed articles to get information about the deficiencies about the target. Most of them are found on Google Academic.

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