

A Case Study on the Creative Process of Making a Game for Cognitively Impaired Children

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Abstract

Computer games are today a common source for learning and entertainment for people of all ages and genders. Although games are released in great numbers, few games are suitable for children with cognitive impairments. The main problem with most games is that they are too complex in different aspects and don't have the ability to be adapted after individual needs. This report will demonstrate the creative process of making a game for children with cognitive impairments. Ideas like using an animation of a photographic hand and making the same button respond to different events depending on game context will be presented in this thesis. The ideas will be implemented and an experiment will be performed where children with cognitive impairments tests the prototypes. The experiences gained will be discussed.

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1. Introduction

This project was started by the electronics company Motion Control that partly focuses on developing electronic equipment for people with impairments. One of Motion Controls products is an electronic unit that is able to substitute buttons on the keyboard and mouse for buttons that is connected to the unit. This means that special types of buttons can be used to control the computer. These types of buttons are used by children with physical or cognitive impairments to control different types of specialized software. To market this product, Motion Control request to create a computer game to be sold together with their product. This computer game would be created for children with cognitive impairments and would be made for usage with Motion Controls unit. This idea came from Motion Controls observation that there might be room for a new type of game on the current market for children with cognitive impairments.

The requests on the product are based on the company's knowledge of the target audience and of similar products they've encountered on the market. The requests are also a consequence of the aim of the product which is to sell their electronic unit.

The company expects the game to be of a very simple nature and have the ability to be controlled by one button only. The game should also be able to be adapted after individual needs. This means that there should be a wide range of difficulty levels and settings for anything that might be relevant to ensure that the game is accessible for children of all kinds. The settings should be very easy to understand and should mainly be used by a teacher, parent or personal assistant. Because the game is to be used with Motion Controls unit, the game should be compatible with this unit and possibly other units that Motion Control has developed. The product should be able to be released for the platforms; Windows, Linux and Mac. The concept of the game is to be developed with the cognitively impaired children's conditions and needs along with the above requests in mind. Therefore the company requests that a research of the target audience is made to ensure the quality of the game concept and design.

The main problem with the games that has been released for children with cognitive impairments is that they often have a low level of creativity. This was confirmed at the interview made with a special education teacher and a speech therapist that focuses on games for people with impairments. These simple games may demand less of the programming part of the game but even more than common games in the creative part. To make a game fun and exciting with just one button to press is a challenge. Around 1% of the population have the diagnosis of cognitive impairment [1] and a fraction of these are children. These children and their parents may not be aware of the games available on the market. This is likely to result in low economical benefits in the field and is probably the reason why the games on the market do not have a high quality. This means that the development time on these kinds of games most likely is extremely limited and that the staff probably does not have the creative and pedagogic background that is needed. Some games on the market have the appearance of standard games for children converted for use with one button (see Existing games on the market: Nallelek). This result in games that isn't made from the target audience perspective and most games do not suit for conversion to one button. Also a lot of the games have exercises that are constructed to teach the user something specific which can lead to a lower entertainment value (see Existing games on the market: Hipp). This thesis is built on the belief that even though the games do not have an explicit exercise, the games can educate children on another level as Irv Bialer suggests in a book review in *American journal of mental deficiency* [2]. This could be socially or even intellectually.

If this game would be successful in this field Motion Control would grow as a company and have the opportunity to expand their area of expertise to include game development for people with impairments. The benefits for the schools and health care would be enormous due to the helping hand this game would be to learning and familiarization with computers. The game would help to entertain a group that is very under stimulated and games can contribute to these children's development. The game industry would grow and this field would be improved and hopefully recognized as an area with economical possibilities. Because with economical possibilities comes recourse and a will for further improvement. This field would hopefully expand to include more fun and pedagogical games for children with all kinds of impairments. If this game would be successful Sweden would be able to compete with developers of these kinds of games all over the world.

2. Aim and scope

The main aim of this thesis is to study a creative process to develop a successful game for children with cognitive impairments. This means using a creative model to achieve something new that has the target audience interests in focus. The creation of the final product will not be in focus in this BA thesis. This thesis will analyze a new perspective than the games on the current market and will test some creative ideas in practice. These tests will not give a scientific result but rather ideas that can be developed and further researched.

In this thesis, creative scenarios for a game will be created along with prototypes to experiment the ideas. This experience will be to get some kind of feedback from the actual users to see if the ideas could be of interest. The experience will not give a complete picture of the user's opinion of the ideas. When the concept prototypes are experimented, output will be discussed for the final game by the company and me. The final part of this thesis will be to create a platform for the actual game. Creating a final product is not within the scope of this thesis.

The hypothesis for making a successful game scenario for children with cognitive impairments before the research was that the game had to have limited number of controls and that the abstraction level had to be low. The game should also encourage this specific user to interact with the game and have a limited amount of graphical elements. I believed that a game with the possibility to be played by two users could be stimulating for the child. I also believed that the emotional and social factors of the game should be maximized.

3. Cognitive impairment

3.1. Background

The development of game ideas for children with cognitive impairments is dependent of knowledge about their condition. A short description of the impairment is presented below.

Cognitive impairment is an impairment related to people's intellectual development and factors affected during the developmental age, hence before 18 years of age. Cognitive impairment is recognized by a significantly limited intellectual functioning and adaptive behaviour. Cognitive impairment is different for different people but everyone needs support and aids. The impairment does not however affect the emotional factors, the creativity and the development of the body. To set the diagnosis, three criteria's have to be fulfilled:

- IQ (Intelligence Quotient) result of approximately 70 or less.
- Impairments in adaptive functioning in at least two important areas of life. (difficulties of adapting to normal requirements in everyday life)
- Shown signs of cognitive impairment before 18 years of age.

People with cognitive impairment are further categorized into four levels based on their IQ results. Mild cognitive impairment is categorized by an IQ between 50-55 to 70; Moderate cognitive impairment between 35-40 to 50-55; severe cognitive impairment between 20-25 to 35-40; and profound cognitive impairment with an IQ below 25 [3].

The concrete implication of the impairment can be the following [4]:

- Difficulty to generalize
- Difficulty of performing long sequence of events
- Difficulty of seeing connection between cause and effect
- Difficulty of doing several things at once
- Poor short term memory
- Difficulty of treating objects with sensibility
- Impaired perception of time

3.2. Gaming with cognitive impairment

To meet the needs of people with cognitive impairment and severely physically impaired, a simple and flexible electronic unit is often used to control computers. This unit is called a contact box and is plugged into the computer. Switches of different kinds can then be plugged into the unit. Examples of different switches are push, squeeze and puff.



Figure 1: A contact box with switches

Switches are often used by people with cognitive impairments when playing games. The games often use a special type of behaviour called scanning when one button is used. Scanning is a method of iterating through a set of selection items with some kind of marking. When the user presses the button the marked item is selected. This method can give the user the opportunity to choose between options with a single button [5]. Because cognitive impairment comes in many different forms, the contact box and specialized games may not be required for everyone with cognitive impairments.

3.3. Creating game scenarios for cognitively impaired children

A wide range of difficulty levels and different ways of controlling the game should be provided in the game. A simple and brief language and a limited number of graphical objects should be used [6] [7] [8]. There should be a clear connection between cause and effect, and the game should not require long sequences of events. The game should also avoid forcing the user to remember too much information [4].

The following statements are from an interview with special education teacher, Eva-Karin Alm and speech therapist, Maria Nolemo.

When creating a game for cognitively impaired it is important to be consequent and use visual and auditory rewards. It is often positive to let the person make their own choices in the game. This can create a feeling of independence. It is important that the person knows what the alternatives are, but knowing the exact outcome of interaction with the game is not necessary. People with cognitive impairments often enjoy games that contain things that are related to the reality, like simple car games. Car games in general have been appreciated by children with cognitive impairments at Datateket in Västerås. It's commonly not good when games are cluttered but strangely some games of this type works anyway. (From interview with Alm and Nolemo)

4. Overview of previous work

4.1. Existing games for cognitively impaired children

One switch games are used by a variety of people, from users with severe physical impairments to users with different cognitive impairments. Numerous games of this type has been developed both non profit and commercial. Over 100 non profit one switch games are available for the general public at the one switch website [9]. There are also some mainstream games that have settings that can make the game controllable with one button, for example Microsoft Motocross Madness 2 [10]. Although the great number of games, there are relatively few that is created specifically for children with cognitive impairments. The main difference between standard one switch games and games specially adapted for children with cognitive impairments is that games for children with cognitive impairments need a low abstraction level and easy control of the single button (the button can be used in many ways, for example: held down, double clicked etc).

Here follows an overview of games developed for children with cognitive impairments that can be controlled by a single button.

Easy Games is a game that contains six mini games [11]. The game has settings for play with both one and two buttons. The main idea of this game is to simplify existing classical games and make them controllable with one button. Among the mini games, there are simplified versions of Tetris, Asteroids and Pacman which are described below.

Tetris is a game where the user is supposed to create a horizontal line of blocks to make the blocks go away and to generate points. In Tetris different types of objects built up by blocks are falling down from the top of the screen. The user is supposed to rotate these objects and place them in an appropriate position to make a whole row of blocks. If the blocks reaches all the way from the bottom of the screen to the top, the game is over. In Easy Games Tetris the objects have been simplified and the ability to rotate the objects has been removed. The object is moving back and forth horizontally and will go straight down if the user presses the button.

Asteroids is a game where the user's supposed to shoot down asteroids that are flying around on the screen. The user controls a spaceship and if the spaceship is hit by an asteroid a game life is lost. In Easy Games Asteroids the spaceship is constantly rotating and if the user presses the button the spaceship shoots in the direction the spaceship is in.

Pacman is a game where the user controls a character called Pacman that eats small blobs on the screen. The character is in a mazelike environment and is chased by a ghost. If the ghost collides with the character a game life is lost. In Easy Games Pacman the Pacman character rotates 90 degrees clockwise periodically. When the user presses the button the Pacman character moves one step in the direction he is facing.

Most of the mini games are likely hard to control for children in general because the game uses automated input and time-dependent game concepts. Because the games are time-dependent and the control methods are time consuming, the games can become stressful. The problem is probably because the game concept is basically the same as the original games but the input is more limited.



Figure 2: Easy games, main menu

Nallelek (Teddyplay in english) is a game that can be controlled with both mouse and a single button [11]. In this game the main menu is in form of a room where different objects in the room can be clicked on. The room contains objects like; toys, paintings and teddy bears. When this game is controlled by a single button, a scanning method is used where a marker moves periodically between the selectable objects on the screen which is the objects in the room, settings button, stop button and a special teddy bear outside of the room. If the marker is on the teddy bear and the button is pressed an explanation of what the user is supposed to do is spoken by a voice. If the user chooses an object in the room, a mini game starts. There are twelve different mini games that each contains an exercise. Examples of mini games are Connect Trains and Present.

In Connect Trains the user is supposed to pick out a railway wagon and connect it to the last railway wagon that is connected to the train. To know which wagon to choose there is a picture on the last wagon that is the same as one of the selectable wagons. When the user presses the button when the marker is over the right wagon, the wagon will be connected to the train and then this procedure continues.

In Present mini game a big present is located on the middle of the screen. If the user presses the button when the marker is on the present, something will pop out of the present, like a clown or a monster.

Nallelek has the same structure as a lot of standard games for children; press on an object and a mini game will start. As an example of a similar standard game, the web based game choochoo can be given [12]. The main menu in this game is cluttered and a lot of mini games have exercises that intend to teach the user something specific which can lead to school associations. The settings can also be accessed by mistake in this game.



Figure 3: Nallelek, main menu

Happenings is an extremely simple game that has the exact same concept as numerous other games for children with cognitive impairments [11]. The main idea is to build up a scene/picture by pressing the button. Each time the button is pressed something in the scene appears. When the entire scene is displayed a video sequence is played. In the main menu, the user gets to choose category of the scenes by using scanning.

This game will probably be too simple and not stimulating enough for a large amount of children with cognitive impairments.



Figure 4: Happenings, main menu



Figure 5: Happenings, a scene

Ooops! is a game containing four mini games [11]. All the mini games have the same concept. The main objective of these mini games is to catch as many diamonds as possible without colliding with an object. The four mini games consist of the user controlling a submarine, a rocket, a car and an air balloon. An example of a mini game is the Car game.

In the Car game the user drives a car on a road with two lanes. When the user presses the button the car switches lanes. Occasionally the user will have to avoid crashing into cars that appear on the road. The more diamonds the user catches the more points is rewarded.

Some of the mini games demands that the button is held down which can make the game hard to control for some children.



Figure 6: Ooops!, main menu



Figure 7: Ooops!, Car game

PlayWithMe is the only game for children with cognitive impairments that can be played by two users [13]. This game consists of six mini games. The mini games consist of both player versus player (computer) mini games and cooperative mini games. An example of a player versus player mini game is the Snake game and an example of a cooperative mini game is the Falling eggs game.

In the Snake game two snakes are trying to throw watermelons on the other snake. One snake at the time begins with the watermelon on their tale. When the user that controls this snake presses the button the watermelon is thrown. The other user then has to duck from the watermelon at the right time by pressing the button. If the Snake is hit, the user that threw the watermelon gets a point. When the watermelon is out of the screen the roles are switched. This means that turns are taken to throw and to duck.

The Falling eggs mini game is about controlling two rats that's supposed to catch eggs in a basket that are falling from Hens above. The rats have two positions, left and right. When one button is pressed, the rats move right and when the other button is pressed, the rats move left.

PlayWithMe uses turn-taking in some mini games which may result in one user having to wait for the other.



Figure 8: PlayWithMe, main menu



Figure 9: PlayWithMe, Snake game

Tigerlek (Tigerplay in English) is a game where the user plays hide and seek with a tiger [14]. The user gets a hint on where the tiger hides in text and speech and is supposed to choose the right object the tiger is hiding behind. There are options on how to control the game. If the one button option has been set, scanning is used. When the tiger has been found a number of times a reward is given in form of an object in the game.

This game is very cluttered and monotonous. The rewards in this game do not seem to be from the target audience perspective. For example one reward is an MP3 player. A child with a cognitive impairments might not know what it is.



Figure 10: Tigerlek, reward



Figure 11: Tigerlek, main game

Hipp is an extremely simple game that consists of six mini games [11]. Examples of mini games are Patterns and Match object.

Patterns is a simple game that spawns primitives (circles, squares, triangles) in different colours along with a sound when the user presses the button. When primitives of a certain kind cover the screen, the screen is cleared and new primitives are spawned when the button is pressed.

Match is a game where the user is supposed to match a picture half that's located in the middle of the screen with it's other half. The user gets to choose between three picture halves and the method of choosing is scanning if the one switch option has been set.

This game is most likely too simple for a large amount of children with cognitive impairments and the exercises intend to teach something specific as in Nallelek.

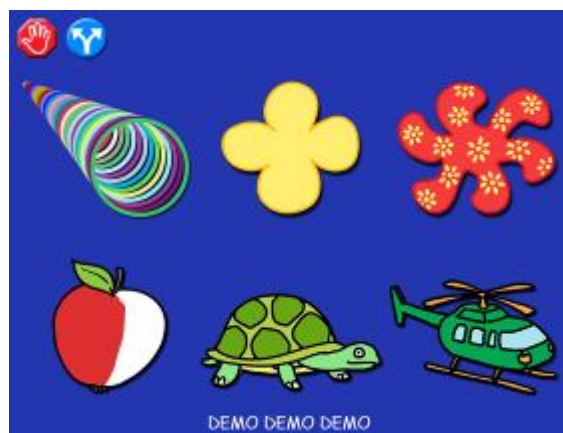


Figure 12: Hipp, main menu

Switch Skills 3 is one of several games in the Switch skills series [15]. These games are mainly for learning to use switches. This game contains several mini games that encourage the user to press the button at the right time. Examples of mini games are Sports and Jungle Adventure.

In the Sports mini game the user is supposed to press the button when the running avatar is in front of an obstacle.

In the Jungle Adventure an avatar is facing a small waterhole that contains a crocodile. To be able to jump over the user must wait until the crocodile closes it's mouth, otherwise the avatar will be eaten and the user will repeat this stage. So trial and error can be used to solve this problem.



Figure 13: Switch Skills 3, Sports



Figure 14: Switch Skills 3, Jungle Adventure

4.2. Game structure for one switch games

Games controlled by one button often have automated parts and scanning is often used to give the user more options.

Game Concept

There are mainly two types of game concepts used in the games:

- Concept 1: The main structure of this concept is that a task is given, either explicitly or implicitly. The task can either be completely solved and result in that the task was completed or the task can be performed differently well. The input to the game can cause behaviour in the game that solves the task or performs the task well.
- Concept 2: The concept has no task and relies on the user's intent on entertaining themselves in an exciting game environment.

Controls:

One switch games have a basic structure that is a result of the single input. This structure is based on the fact that a button is either pressed or not pressed. Excluding the possibility of holding a button down and just taking button down events into consideration, different types of structures can be obtained. The reason for excluding the holding button down function is that it may not be intuitive because trial-and-error is the usual approach of children in general [16] and this might not work because the user might never try to hold the button down.

The following four control structures have been recognized in this thesis:

- Control Structure 1: A special type of event is bound to the button click.
- Control Structure 2: Control Structure 1 is often related to applying the event in a special time interval depending on the game context. This often includes the scanning behaviour (not if the scanning maps to different events though).
- Control Structure 3: Button click responds to different events depending on game context. This behaviour is widely used in mainstream games. It's not unusual that mainstream games have an event button that runs different events depending on the context (for example opening a door or talking to a person).
- Control Structure 4: Button click responds to different events depending on the time between clicks. A common example of this type of control structure is the double click widely used in computer software. This control structure is not used in any of the games. This is probably not very intuitive because trial-and-error might not work.

4.3. Experts about existing games: Interview

The following opinions were expressed by special education teacher Eva-Karin Alm and speech therapist Maria Nolemo.

There is a gap in difficulty in the games on the current market. A lot of games are really simple and can be too simple for some children, while games on the next difficulty level can be too hard. The simple games can also be too childish. This can be a problem for the older children. There are too few games containing photographs on the current market.

Games that have the ability of being used by two players are too few, PlayWithMe is the only game with this feature and the turn-taking in this game is not good. Turn-taking can force one player to wait for the other.

4.4. Deficiencies with existing games

A problem with the existing games is that even though children with cognitive impairments are a relatively small part of the population and are grouped together as one special group they have very different conditions and needs. The difference between mild and profound cognitive impairment can be extremely high. This means that a very flexible and generally fun game is needed to satisfy this entire group. Looking at the games on the current market, attempts of flexible games have been made. Although the setting available in these games rarely makes the games include the entire target audience because the games don't have a flexible game concept. Some of the games on the market don't aim on making a game for all children with cognitive impairments. Games like Happenings and Hipp may fill their purpose, but are maybe not entertaining enough for everyone in the target audience. Games like Easy Games, which are games converted from standard games to games for children with cognitive impairments often result in bad controls and may fit for a small group of the target audience. The game Nallelek falls under this category because it's very similar to a standard children game. PlayWithMe takes a step towards something new by creating a two user game. The game falls short on the fact that most of these mini games are very predictable and in the player versus player mini games, the users have to take turns for the rolls in the mini games. A lot of the mini games in the games on the current market are conceptually the same. A lot of them also contain exercises that can lead to school associations which likely decrease the entertainment value. For example Match in Hipp which explicitly is for learning to recognize patterns, connect and see relations. The research of the games currently available shows that there is room for a game that is both exciting and flexible.

4.5. Thesis contribution

In this thesis several unique ideas in this field will be presented, mainly:

1. Apply Control Structure 3 in a game for children with cognitive impairments in a way that hasn't been done.
2. Use a generally familiar object in creative ways to reach out to the child's imagination and curiosity.
3. Use photographs and photographic animations in the game.
4. Make a game that has the ability of using own photographs of the child or the child's relatives.
5. Use photographic environments to use in pedagogical practise in a game.
6. Use a combination of Game Concept 1 and 2 in the same game to broaden the usability of the game.

5. Working methodology

5.1. Overview of creative process

The figure below (Figure 15) shows the different steps taken to create the ideas for the product.

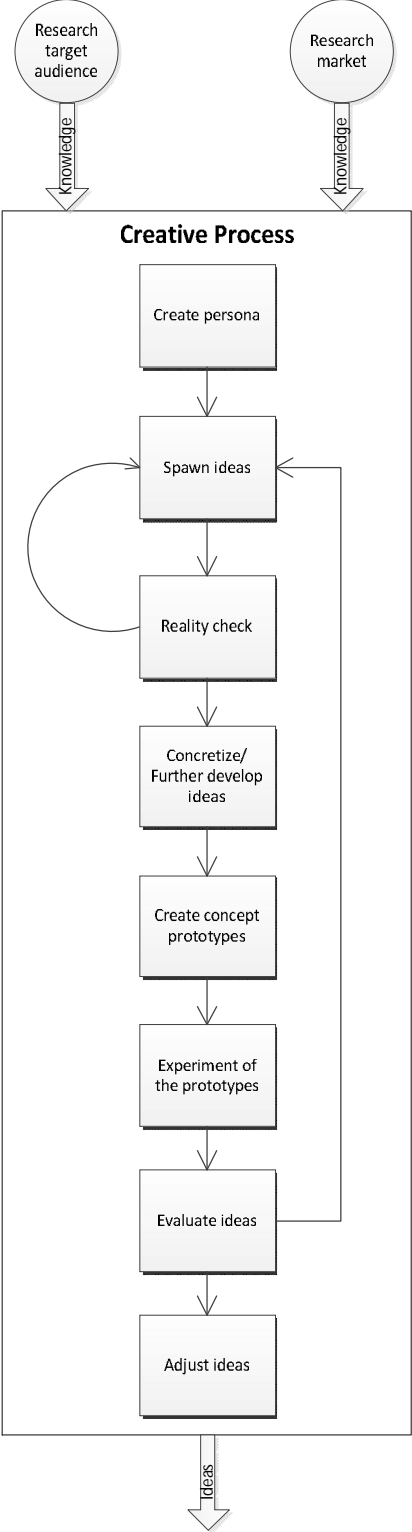


Figure 15. Overview of workflow

5.2. Process description

Research target audience

In this step a research of the target audience is made to ensure that an understanding of the special conditions and needs of children with cognitive impairments is accomplished. The main target audience is below 14 years of age and has cognitive impairment. This does not mean that everyone with cognitive impairment has to play specialized games, but the goal is to make a generally fun game that could be exciting for the entire group. The game should hopefully include children without cognitive impairments as well. Both boys and girls are within the target audience.

Research the market

In this step a research of the market of existing games for children with cognitive impairments is made. This step will provide knowledge of what kind of games exists and the pros and cons of these games.

Create persona

This step is foundation on which the ideas are spawned from. The persona is a fictional person which has the characteristics of the users of the game. The persona is set into a scenario.

Spawn ideas

In this step ideas are spawned with minimum amount of demands. Trying to create ideas that are supposed to fulfil all the demands is hard and can lead to stiff thinking. The ideas are spawned when trying to think from the personas perspective.

Reality check

At this stage a large amount of rough ideas have been created and the ideas have to be evaluated. A reality check is made by examining if the ideas are feasible, innovative, fun and within the frames of the demands from the users and the company. Ideas that don't fit are discarded. If the ideas are discarded or questionable, a step back in the process is made to the Spawn ideas stage.

Concretize/Further develop ideas

At this stage the ideas have been recognized as something that might be good. The ideas might need to be concretized or further developed.

Create concept prototypes

When this step is reached concept prototypes can be produced from the existing ideas. This will include getting sound effects, producing pictures/photographs and implementing the game.

Experiment of the prototypes

At this stage, users within the target audience test the created prototypes and do some kind of evaluation.

Evaluate ideas

After meeting the target audience and seeing them test the game, an evaluation of the ideas are made. If the ideas are discarded or questionable, go back to stage Spawn ideas.

Adjust ideas after results

After evaluating the ideas, adjust or further develop the ideas if needed.

5.3. The role of the company

The company's role in the creative process is partly giving feedback on the ideas from their perspective. The company also provide information and contacts to experts. The company have also given demands on the product and some suggestions on what the game concept could be.

6. Argument

6.1. Creative process

6.1.1. Research target audience

An overview of the target audience conditions and needs were established by searching through papers and books. To get a better picture of the target audience, an interview was made with experts that have had much contact with children with cognitive impairments. The interview was made at Datateket at Lasarettet in Västerås with a special education teacher, Eva-Karin Alm, and a speech therapist, Maria Nolemo. Both the target audience and games for them were discussed.

6.1.2. Research market

The research of the market was made by searching through the internet. Games of interest were tested at Datateket and the tests were documented.

6.1.3. Create persona

When a picture of the market and the target audience had been established, a simple persona was created and set into a scenario. This is an attempt to fully understand the target audience and see the scenario in which the game is played. A scenario was set up where the user is playing the game with the help of a specially designed button. The game has this button as only input. An assistant in form of a special education teacher is present when the child is playing the game. The special education teacher's role is talking to the child about what happens on the screen while the child is playing. The location is a computer room at the hospital where games are used for learning and entertainment for children with special needs. The child is a 9 year old boy with moderate cognitive impairment and without any physical impairments.

6.1.4. Spawn ideas

Attempt 1: The first attempt on creating a game for children with cognitive impairments resulted in the following ideas:

DriveThere



Figure 16: DriveThere, choose car



Figure 17: DriveThere, navigation

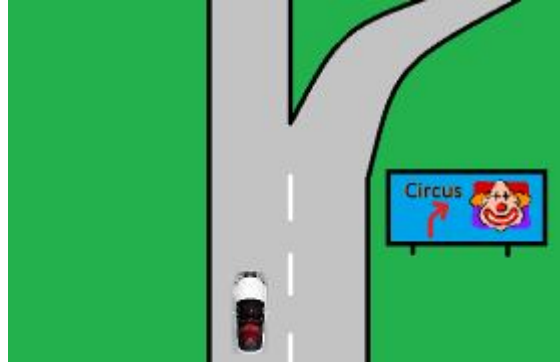


Figure 18: DriveThere, extended idea

In this game, the user would start off by choosing the car to be used in the game. This feature was added because of what had been said in the interview about the advantages of giving the user choices in the game. The next step would be choosing one car mini game. One of the car mini games would be navigating a car to the right destination by following the arrows on top of the screen as shown in Figure 17. The game would therefore be about being in the right lane. If the user would press the button, the car would change lanes. An extension of this idea was to have the car game lead to different mini games as shown in Figure 18. The road would have the same structure as a highway with different exits described by billboards. If the user would be interested in a mini game they would just switch lanes and the car would turn to the destination.

The Circus



Figure 19: The Circus, menu

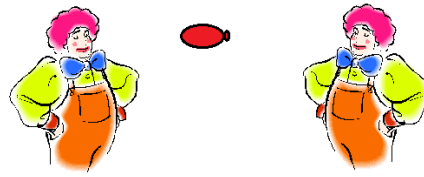


Figure 20: The Circus, Clown game

The circus game was also a result of giving choices to the user. Figure 19 illustrates the start menu of the game. The user would get to choose which circus tent to enter by the use of scanning. Pictures on top of each tent would give clues about what would be inside. One of the mini games would be two clowns throwing water balloons at each other. This mini game was an idea from the company and was not a concrete idea of how it would be done.

Attempt 2: After a reality check of the previous ideas, a second attempt was made which resulted in an enormous amount of ideas. These are some of the ideas produced with some revision from my supervisor. The following ideas were created when trying to think into the persona. These are simple ideas that are supposed to make the child feel comfortable by seeing something familiar. All the ideas below are to be used with real photographs:

Walking hand



Figure 21: Walking hand

This game is about a hand walking like a human. When the user presses the button the hand jumps. When it lands it keeps walking. Some positive aspects of this game are that the hand is familiar to everyone and it is very close and interesting. This will hopefully encourage the user to think creatively and awaken their imagination. They can even practice this in real life.

Hand hello

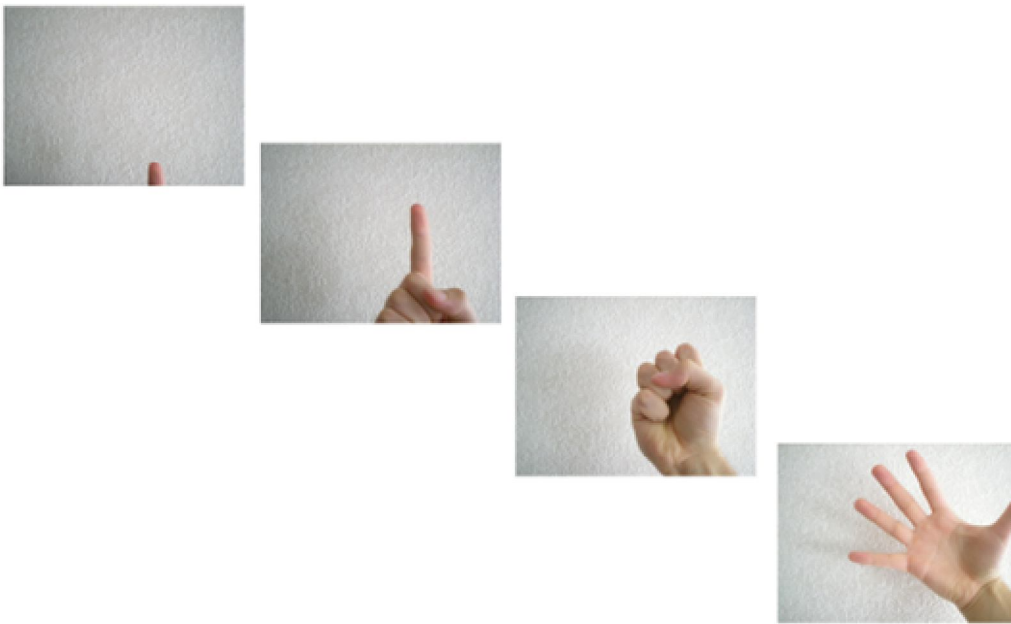


Figure 22: Hand hello

This simple game has the same base idea as the Walking hand. The game starts with a little part of the finger sticking up at the bottom of the screen. This is to make the user curious of what it is and what it is doing there. When the user presses the button the finger goes up and a hand waves at the user.

Reflection



Figure 23: Reflection

This game is called the reflection game because the person on the screen reflects what the user does. So if the user presses the left button the person on the screen will wave with their left hand. If the user presses the right button the person on the screen will wave with their right hand (from the user's perspective). In this game parents or assistants could put in own pictures of relatives or things that the child like.

Pick an item



Figure 24: Pick an item

This game lets the user choose an item by using scanning. When the user clicks on an item the item does something.

Catch



Figure 25: Catch

In this game a ball fly through the air towards the position of the hand to the right in Figure 25. When the user presses the button the hand goes up, ready to catch the ball. If the ball isn't there the hand goes down, and misses the ball if it flies by.

Swing board



Figure 26: Swing board

This game is supposed to be played by two users. In this game two primitives of some kind lay beside a swing board. When a user presses the button their primitive jumps on the swing board. The objective is to jump on the swing board to make the other players primitive fly away.

6.1.5. Reality check

The reality check of Attempt 1 revealed that the *The Circus* and *DriveThere* might be developed to decent games but they aren't really something new in the field. My supervisor urged me to think more freely and don't think of all the demands on the game. The reality check made the process regress back to the Spawn Ideas stage with Attempt 2.

In the reality check of Attempt 2 most of the ideas (not shown in this report) were discarded. These ideas weren't that fun or innovative.

The ideas created were presented to the company to get their opinion about the ideas. The company explained that the ideas of Attempt 2 certainly were innovative but that they were neutral to these ideas. They liked the idea of putting in own pictures in the game however, like in *Reflection*. They were interested in the extended version of *DriveThere* in Attempt 1. The Swing board idea was discarded because the company thought it would be too complicated.

The ideas were further evaluated by asking the special education teacher, Eva-Karin Alm, and speech therapist, Maria Nolemo, what they thought about the ideas created. They were actually very interested in the new ideas and gave me tips on how to further develop the ideas. They were also interested in the extended version of *DriveThere*. Alm and Nolemo thought *The Circus* idea was a little bit plain and the idea was discarded. Alm and Nolemo really liked the idea of being able to put in own pictures in the game and suggested a game where the user could put in a picture of themselves and add things like a moustache, clown hair and things like that.

6.1.6. Concretize/Further develop ideas

At this stage some ideas had been discarded and feedback on the existing ideas had been given. Some ideas were still abstract and needed to be concretized.

The changes made are described in the description of the different prototypes in the next topic.

6.1.7. Create concept prototypes

To implement the ideas pictures/photographs and sound effects were needed for the different games. This was accomplished by taking pictures, doing drawings in paint, collecting appropriate sound effects and creating sound effects.

The game was implemented in C++ with Allegro [17]. The games only purpose was to test the concept of the games which meant quality code was not required. The only important factor was time so the prototypes were made as fast as possible.

When the prototypes were done, another visit was made at Datateket with Alm and Nolemo to ensure that the prototypes were made in a good way. They liked the prototypes and gave me some suggestions on last minute changes that could be made, like add more sounds.

The results were the following prototypes:

Car game

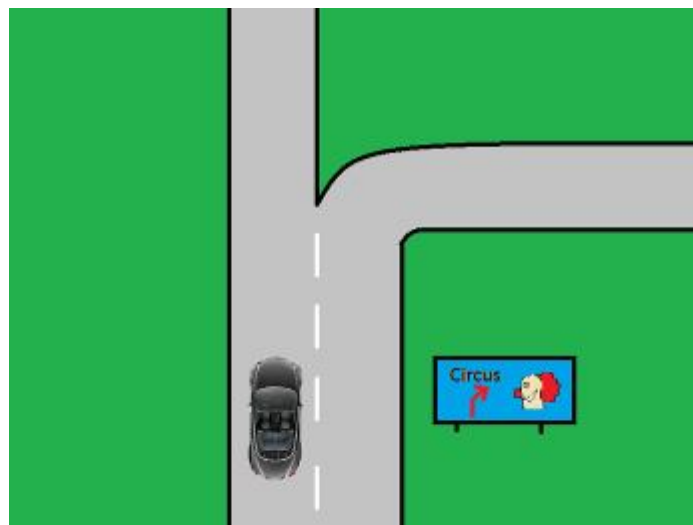


Figure 27: Car game

This prototype was made exactly as the original idea. The car moves forward by itself and changes lanes if the user pushes the button. If the car is in the lane of the road turning off to the circus the car will turn and stop in front of the circus tent and the clown mini game would start. The only mini game in this prototype was the clown game.

Clown game

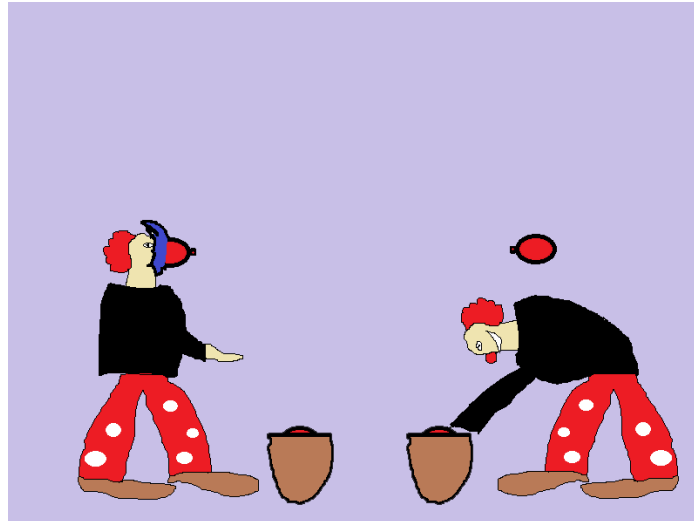


Figure 28: Clown game

The clown game is a game that uses Control Structure 3 where the event that responds to button events is based on the context of the game. This game is to be played by two users where each user controls one clown. If a clown doesn't have a balloon in his hand the clown ducks down and picks up a balloon if the button is pressed. When the clown has a balloon in his hand the balloon is thrown if the user presses the button. Further, the action of picking up a balloon also functions as a duck from balloons thrown from the other clown. This means that no user has to wait for the other to do something as in PlayWithMe. If a clown doesn't duck when a balloon come flying, the balloon splashes in the clowns face. As mainstreaming is an important factor for children with cognitive impairments [18], the game is supposed to be enjoyable by children without cognitive impairments as well.

Hand hello

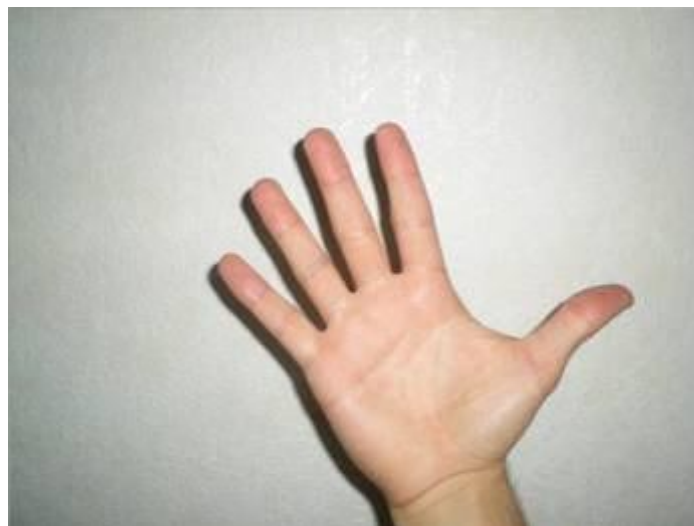


Figure 29: Hand hello

The original idea of this game is extremely short so the idea was extended. A sequence of events was added to follow the button press. This game was developed to doing different things with the hand when the button was pressed. For example waving at the user or one more hand comes in and the hands are shaken if the button is pressed at the right time.

Walking hand



Figure 30: Walking hand

The walking hand idea was developed to include objects that would block the way for the walking hand. When the user would press the button, the hand would jump over the object and keep walking. In this prototype the only objects were pairs of glasses that repeatedly appeared.

Catch

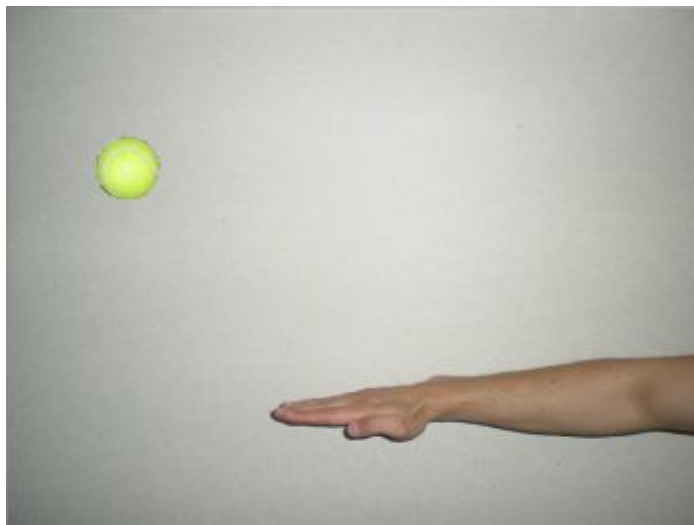


Figure 31: Catch

This prototype was made after the original idea. When the user presses the button the hand goes up, ready to catch the ball and goes back down after a period of time. When the user caught the ball an audio reward was given. When a ball was missed or caught a new ball appeared to the left on the screen.

Pick an item



Figure 32: Pick an item

This game idea was revised into using objects that were related to each other and to interact with each other on button press. The red frame in the picture moves periodically and when the user presses the button the cuddly animal does something. For example, when the teddy bear is pressed he hugs the lynx.

Edit face



Figure 33: Edit face

Edit face is Alms idea implemented. When the user presses the button an object appears on the face, like a beard or clown hair.

Reflection



Figure 34: Reflection

Reflection was also developed into having the person on the screen moving different body parts when the buttons were pressed. First the person on the screen would blink with different eyes and after a while the person would wave with different arms on button press. An important change in this game was to actually show the face of the person to emotionally connect to the child.

6.1.8. Experiment of the prototypes

The prototype experiment was performed at Datateket at Lasarettet and at Hällbyskolan in Västerås. All user tests were performed with the special education teacher Eva-Karin Alm present. She was the one who communicated with the test persons and asked what they thought about the games.

The experiment have been performed by letting each test person test one game at the time and filling in an evaluation form after each game. Alm has made sure the child understands the scale in the evaluation form after each game. The evaluation form was designed by Alm and it had the same structure as evaluation forms used at Datateket. This means that most of the children have filled in similar evaluation forms in the past. While the test person has tested the games, Alm has talked to the child about the events on the screen. This is the normal working method for special education teachers at Datateket. The evaluation form had the following appearance:

		Boring	Middle	Fun
Clown game				
Hand hello				
Walking hand				
Catch				
Pick an item				
Edit face				

Figure 35: Evaluation form

The test person has played with Alm, a teacher or another test person when two buttons have been used in a prototype. The tests have been filmed if an approval was given from the child's guardian, otherwise notes have been taken. The *Reflection* game was not a part of the evaluation because Alm did not include it in the form. The *Car game* was not a part of the evaluation either because the game only had one mini game, hence one choice to make. In the *Car game* an observation on the test persons interest and understanding of the game was made.

The interesting factors of the test are if the game was entertaining and easy to understand. This was measured partly by the evaluation form and partly by the behaviour of the child.

The test group had been picked out by Alm and teachers at Hällbyskolan. Factors that has affected the test group composition is time pressure and limited access to the target audience. The following table shows the participants of the experiment. The game created could also be for severely physically impaired children, which is why two test persons were without cognitive impairments.

Test person	Gender	Age	Physical Impairment	Level of cognitive impairment
Test person 1	Girl	10	None	Mild
Test person 2	Girl	12	None	Moderate
Test person 3	Girl	11	None	Mild
Test person 4	Girl	9	Cp, visual impairment	Moderate
Test person 5	Girl	9	Severe physical Impairment, Cp	None
Test person 6	Girl	9	Severe physical impairment, cp	None

The results of the experiment are not scientific which would need more tests and a more accurate test group. In a project with limited recourses this experiment gave me an insight of what the target audience might be interested in and what might be unintuitive. Some conclusions are made based on the results, these conclusions are not proved, but basing the ideas on real tests will most likely get a more accurate picture of the target audience interests and needs than before the tests. Because of the lack of experience of the target audience, the experiment was also important to understand the target audience further.

These are the results from the evaluation forms:

Test person	Clown game	Walking hand	Hand hello	Edit face	Pick an item	Catch
1	Fun	Fun	Middle	Fun	Fun	Fun
2	Fun	Fun	Middle	Fun	Fun	Fun
3	-	-	-	-	-	-
4	Fun	Fun	Boring	Fun	Middle	Fun
5	Fun	Fun	Fun	Middle	Fun	Middle
6	Middle	Middle	Boring	Middle	Boring	Middle

Test person 3 did not want to fill in the form. She was embarrassed according to Alm.

The test person's behaviour was also observed during game play. This will not give a scientific result either but will give some hints on which games might be hard to understand

and also if the test person is enjoying the game. Observation on both controls and body language are made. Here are some of the observations made on the behaviour:

The behaviour indicated that some test persons did not completely understand the strategy in the *Clown game* but everyone seemed to enjoy the game based on body language, like laughs.

The shaking hand part of the *Hand hello* prototype seemed to be hard to understand for some test persons, maybe because the hand movements were very choppy. One test person completely lost interest in this game.

The *Car game* and *Walking hand* seemed to be easy to understand and the moving environments in these games seemed to interest the test persons.

The scanning behaviour did not seem to be fully understood in *Pick an item*, some test persons clicked continuously causing the same item to be picked time after time. This turned out to be a design flaw in the prototype, because after an item was picked the marker started at the same item.

The *Reflection* game gave a lot of positive reactions during game play.

Catch seemed to be significantly more interesting to the test persons that had trouble catching the ball. The expressive auditory reward in this game seemed to have a positive effect on the test persons.

6.1.9. Adjust ideas after results

The results from the tests were discussed together with Alm. The following ideas for further development were suggested:

Walking hand could be further developed into having varying environments and different objects to jump over. The game could for example take place in a house where the hand can walk in different rooms. The objects found in each room would be objects related to that room. For example if the hand walks in the kitchen, the hand would jump over objects that usually are found in the kitchen. Alm believes that this game has great potential and that this type of game could be very helpful in pedagogical practice. Special education teachers would be able to talk to the child about the environments and the objects the hand jumps over while the child is playing.

Alm believes that the *Car game* would be really interesting if it could be made realistic using real photographs.

Edit face has a high potential if own pictures can be used in the game according to Alm. A higher difficulty level could be that the user is able to choose which objects that should be applied to the face.

Alm believes that *Reflection* has a high potential too. She had an idea of using prepositions in this game. This means objects position relative to each other. For example, in front of the table or to the left of the table. She also suggested that facial expressions could be used, like happy or sad.

Alm explains that the *Clown game* obviously has a high potential according to the test results. She thinks that this game encourages interaction socially when played by two users.

After the discussion with Alm and with the experience from the tests the *Clown game* was furthered developed into having different controls depending on the number of buttons to be used in the game. If one button were to be used, the game would function as the prototype. If two buttons were to be used, one button would make the clown duck/pick up balloon and one would through. If the clown would not have a balloon in the hand he would make the through movement but no balloon would be thrown. This means that this could be a higher difficulty level and train the user in a pedagogical way about cause and effect. This would also give the user the opportunity to duck at any time. Also an extra feature would be added when playing with two buttons. The user will be able to catch a flying balloon if the throw button is pressed at the right time (when a balloon is within range). The good thing with this extra functionality is that it doesn't have to be used. The user would be able to explore the opportunities and maybe be surprised if it is done by mistake. This leads to a game that can be more advanced depending on the user's own ability and will.

6.2. Discussion

The hypothesis before the research was that the game had to be really simple and that the events responding to button clicks had to be predictable. This turned out to be different than expected. The results of *Clown game* indicate that a more complex Control Structure can be used in these types of games without losing the entertainment value. Control Structure 3 may seem too complicated for the target audience but we believe that a logic and pedagogical context can make it easy to understand. Even though they can't predict what event the button will generate, it can make the game exciting and stimulating. Using a predictable pattern in Control Structure 3 is probably a good idea, so that the pattern can be learned after a while.

Challenging the user in some way seemed to be very important. Games that were hard in some way for the test person were often appreciated in the tests. The hypothesis about the difficulty level of the game was that a wide range of difficulty levels should be provided. The results show that this is important to keep the game challenging on a personal level. When seeing the *Clown game* being played, we realized that the game can be used both with Game Concept 1 and Game Concept 2 because the game can be stimulating even though the user doesn't compete with the computer or another person. The idea of this concept came from the different usage of the clown game of different test persons. This gave us the idea of creating a game not just with different difficulty levels but with a special type of structure. This structure will originally demand little from the user but have the ability to demand more depending on the user's own perspective of what the game is supposed to be. The structure will encourage more advanced users to explore the possibilities of the game while the game still can be used in a simple manner. I believe that a pedagogical context based input can stimulate a wide range of users, and with the ability to exclude functionality, these types of games could be revolutionary in this field.

After meeting the target audience, I realize that most of the games on the market probably have too low difficulty level for a large amount of the target audience.

The use of photographs and creative usage of the hand seem to interest the test persons. The ability to put in own pictures in the game will probably give good results because the results of *Edit face* that had pictures of another person still gave pretty good results. Putting in own pictures will most likely make it more interesting.

The *Clown game* which was played by two users seemed to be a great success and confirmed the hypothesis of the emotional and social importance in the game. The game's entertainment level seemed to be boosted by the fact that they played with another user.

The goal of this thesis was to make a game that could fit for a large part of cognitively impaired children. Some of the ideas created may not include the entire target audience and some might be further developed into a more flexible game to include more children within the target audience. This thesis intent is not to say that these ideas fit for all children with cognitive impairments because everyone is different and cognitive impairments comes in many different forms. This thesis intent was to give these children a different alternative to the current market.

The company expected that the results from the *Car game* and *Clown game* to be the best which was a good guess. I think the results from the games involving the hand were over their expectations though. The final decision for the game was pursuing the following ideas: *Clown game*, *Car game*, *Walking hand* and *Edit face*. These games were estimated to have the highest potential to become a successful game and will bring something new to the industry. The other ideas are not necessarily bad but are less likely to succeed in Motion Controls game based on the knowledge and experiences at the point when the decision was made.

The impact to the academia is new ideas on how games can be created for children with cognitive impairments and a creative model that can be used. The ideas have not been proven so further research is needed.

7. Conclusion

In this thesis new ideas in the field has been presented, like using own pictures in the game, using photographs, using a familiar object in a creative way and testing out a new way of controlling a game with button clicks responding to different events depending on the game context. The tests indicate that some of the ideas produced might have a high potential of becoming a great game for children with cognitive impairments. The ideas might even broaden the target audience to include children with severe physical impairments.

My computer background has helped me during the development of the ideas by making me able to create real prototypes that could be correctly tested on the target audience. This was really important because for example paper prototypes could not be used on this target audience. It would be too hard to understand. The use of prototypes where I would manually change pictures to simulate when the user presses the button would most likely result in a simulation that would not exactly respond to the button events which probably would confuse the user. This would also limit the structure of the prototypes. Another advantage of my computer background is that I'm able to see the level of complexity of implementing an idea.

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Appendix: Company experiences

This appendix will describe my company experiences and show my entire process of creating a game for children with cognitive impairments.

Method

The method used in this project was the waterfall method. Weekly reports were written and detailed information about working hours has been documented. My work hours were mostly spent at the company premises.

Motion Control Documents

Here follows a list of the documents created for Motion Control during this project (all of the documents are written in Swedish).

Market research of Switches

A document that gives an overview of the Switches currently on the market and their current price from different vendors. This research was initiated because the company needed switches to test out the game in a later stage.

Market research of games for children with cognitive impairments

A detailed document over the settings and game play of the games on the Swedish market was made. The document also contains the interview made at Lasarettet in Västerås.

Demand specification

A document that describes the demands on the product.

Concept tests

A document describing the prototypes and the tests made.

Design specification

A document that describes how the product will be implemented.

Results

This topic will superficially describe the product implemented and designed during this thesis.

The following state diagram will describe the behaviour of the game. The game has two target audiences which is a child with cognitive impairments and an adult assistant of some kind. The different states of the game have different colours depending on which target audience the state is for. The structure is to clearly separate the two target audiences so that both target audiences clearly understand when they are supposed to be in charge.

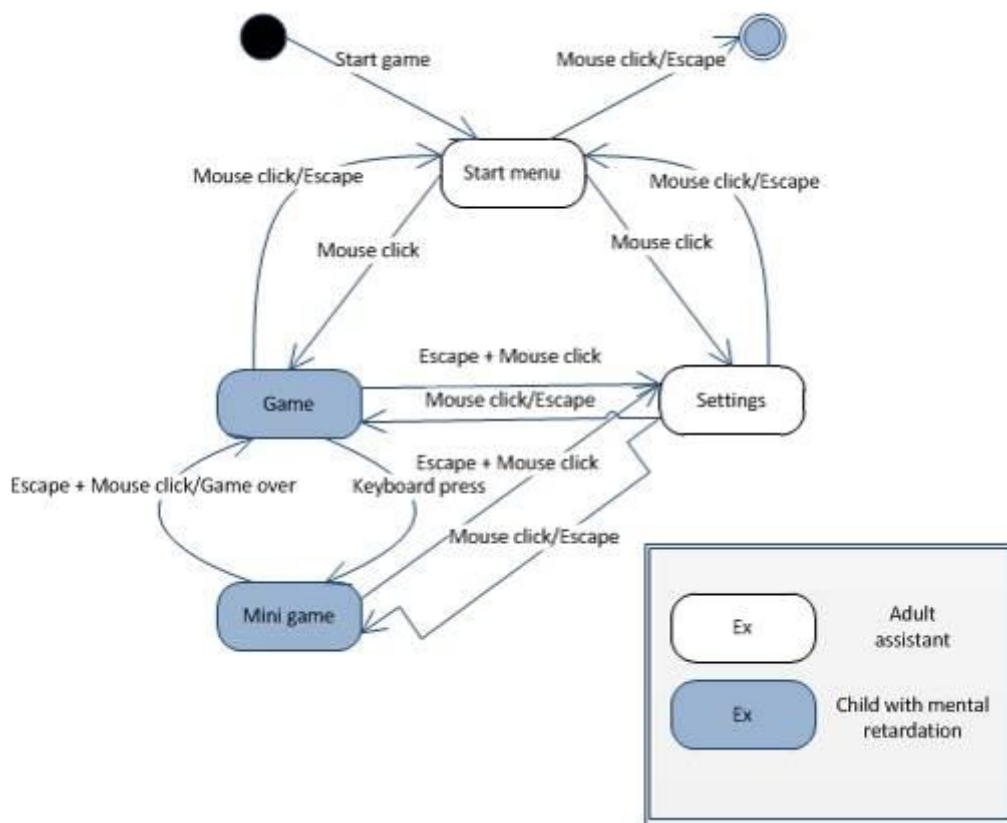


Figure 36: Overview of game behaviour

All the text in the game is in Swedish because it was a demand from the company. The game is still at prototype level which means there are a lot of adjustments to be made. For example the Swedish text does not include "åäö". This will be fixed at a later step in the process. There are also some buttons that hasn't been bound to any functionality.

The picture below shows the start menu in the game. The “1p” and “2p” symbolizes 1 player respectively 2 players. This will be adjusted to a two row button that explicitly expresses the number of players.



Figure 37: Main menu

The following pictures show the settings in the game. The settings have a main tab and will have a tab for each mini game. The only settings in the main tab that make a difference in the game at this stage is the difficulty level. The settings in the *Clown* game can change the speed of the game, if score should be shown and the colour of the clowns.

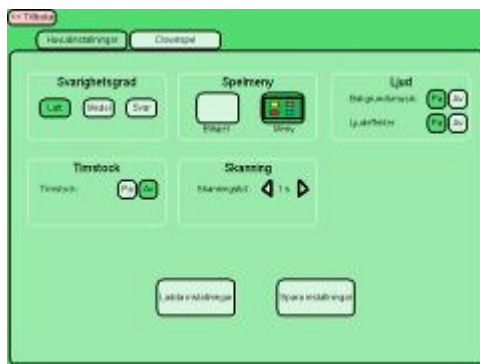


Figure 38: Settings, main settings

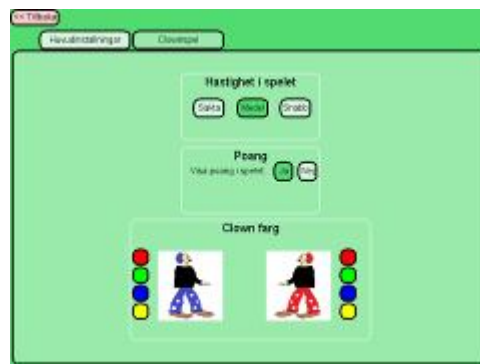


Figure 39: Settings, Clown game settings

When “Start game 1p” and “Start game 2p” is pressed the following menus are shown (depending on which button is pressed). This menu is for showing the user the most important settings without having to change them if they already are set to satisfactory values. To start the game “OK” is pressed.

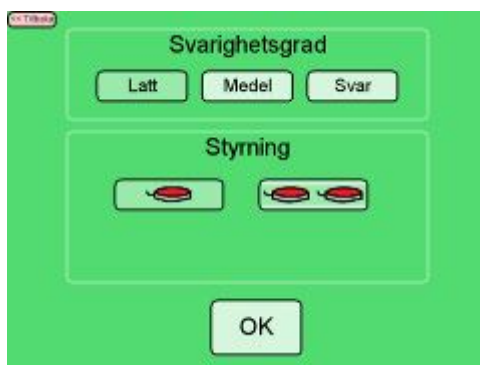


Figure 40: Start settings, 1 player



Figure 41: Start settings: 2 players

At the moment the Clown game starts when the game is started. This will be adjusted to a menu of mini games or the *Car game* depending on the settings made. The game has an AI for one Clown if 1 player has been selected. When the difficulty level is changed the Clown AI gets better. The AI does not however put more pressure on the user unless the user puts more pressure on the AI. The AI “reflects” balloons that are thrown at him. This means that the user partly can decide how hard the game should be. When two buttons are used the functionality of catching the balloon is added and functions as described earlier in the report. When Escape is pressed a popup menu is shown that causes the game to pause. This menu will give the user the possibility of ending the game, going back to the current game or making settings. All the settings made will immediately have effect in the game. Showing points is optional and the use of both balloons for each point and a numerical value will hopefully help the child relate the number to the actual number of objects in an intuitive and fun way.

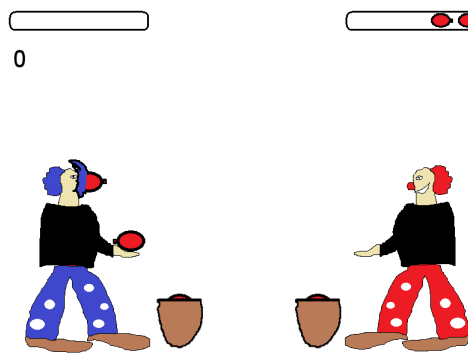


Figure 42: Clown game

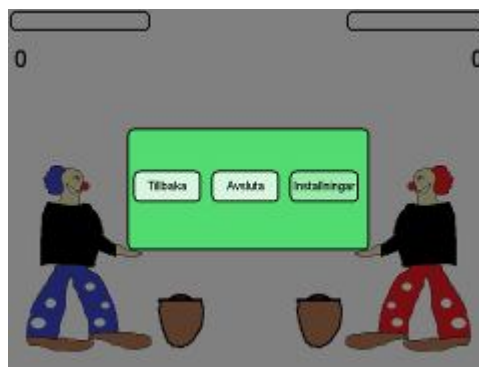


Figure 43: Pop up window