Autism Simulator

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Contents

Chapter 1

Introduction

For this report I will be giving the overview of my thesis thus far which includes work carried out this semester and some incomplete sections (with notes as to what will be in there or improvements)

1.1 Selecting a project

The project started with the purpose of creating software to benefit someone with autism or ADHD or those in contact with these conditions such as family members or carers. Owing this is a very broad topic it was important to create multiple proposals and select the most useful. All proposals were put on a website and a selection was made after considering results from an online survey, conversing with professionals and people with ASD and considering systems and research currently available.

Project proposals:

Proposal name	Description
Online diary	Online system to improve communication between carers, parents, social workers, schools. Parties could post questions and ask for suggestions when dealing with certain behaviours as well as document the child's day allowing easier identification of patterns of behaviour or problems
Social simulator	Simulated social scenarios for autistic users to trial various social situations and see possible outcomes
Dynamic scheduler and planner app	A planner that would re-schedule tasks when not completed and present basic to-do lists with tasks broken down into manageable chunks
Environment app	Phone app aimed to encourage children to look and question their environment
Autism simulator	A 3D virtual environment where the user plays as a child with autism and can thus experience some of the obstacles faced through a visual/game environment

1.1.1 Questionnaire

A questionnaire was anonymously completed by six people in total and included people with ASD/ADHD, professionals, carers and parents and was compiled with both qualitative and quantitative questions.

1. Please give some information about yourself, for example if you have ASD/ADHD or are a professional/carer.
2. Please select and rank three proposals you feel are the best
3. Please explain reasons for selection

Results

Below summarises some of the comments given in the feedback questionnaire as well as considerating factors from other areas

Proposal name	General reasons for/against
Online diary	For: Cross communication between doctors, teachers, parents and carers which is often problematic with information missed. Against: Good in theory but may not be practical due to data protection. Relies too heavily on parents/carers being able to read emails or notifications. May be difficult for some schools to gain access to wifi.
Social simulator	Against: Big project given the time-frame. Other companies working on a similar concept. Much research on this topic already. Conveying 'social stories' could be a better approach to deal with context specific situations.
Dynamic scheduler and planner app	Against: least unique proposal, many other planners available. For: No planners available that specifically target planning/executive functioning difficulties within ADHD and Autism
Environment app	Against: Hard to back with literature. Difficult concept to understand(possibly not explained well) For: Least amount of implementation work. Could be simply but effective.
Autism simulator	Against: Big project given the time frame, no previous simulators which can be drawn from. For: Most unique and popular idea. Misunderstanding from the general public is a big problem. Could be extremely helpful for teacher's training.

** TODO: Give more quotes and information from questionnaire from people who gave feedback.

1.1.2 Choice

In summary, the selection of the project followed by considering:

1. Advantages and disadvantages of all options.
2. Looking at factors such as time constraints and the learning curve involved for each.
3. Conducting an online survey.
4. Speaking to a range of individuals at the ADDISS ADHD conference(London 2012) which also contained parents and professionals with experience and knowledge of autism.

From all sources it became evident that the autism simulator was the most unique and useful concept with the only concern being its potential size and lack of restriction. This was the final project chosen as it was felt if focus was directed onto conveying just the sensory differences within autism to start with and a game engine was selected rather than developing from scratch, it would be attainable in the given time-frame.

Chapter 2

Literature review

2.1 What is Autism?

- add a bit of information/brief introduction on repetitive behaviours

2.2 Triad of Impairments

**** This section needs to be re-written once I can find DSM-V changes.

There are three key areas of difficulty that people with autism share.

2.3 Information processing

It is suggested that people with autism process information holistically, a theory known as Gestalt perception. Gestalt perception is posited to be a cause of fragmented or distorted perceptions in people with autism[6]; processing information as a whole instead of in parts make it difficult to drawn connections and thus make predictions about the world. "I had always known that the world was fragmented. My mother was a small and a texture, my father was a tone, and my older brother was something, which was moving about" [12].

It is argued that people with autism perceive the world more accurately because their inferences are less dependent on previous experience but a negative consequence of this is being less able to filter irrelevant stimulus [9]. Difficulties filtering information can cause problems differentiating between background and foreground noise and so in a room with many people talking it may be hard to tune into an individual conversation [9].

Delays in information processing are a common feature in autism. In extreme cases, it can take weeks, months or even years to process information and one of the reasons given to the cause lye in the theory of gestalt perception. Processing information as a whole leads to over-selectivity and thus even familiar environments are looked upon as entirely new and one small change to the environment can cause a large amount of distress[6]. This would offer a suggestion as to why people with autism have a strong desire for strict routine. Questions asked to a person with autism should be given ample time for a response, if their process of thought is interrupted it can cause a complete disruption and the individual has to start this process again[6]. As a result of distorted perception, it may take someone with autism longer to adjust to their surroundings.

Distortions are reported to become worse in the state of nervous over-arousal and information overloads[6] and thus a cycle of problems occurs; the more stressed a person with autism may be, the more these distortions occur and the harder it is to make sense of the world, consequently resulting in even more stress.

2.3.1 Sensory processing

While social and communication difficulties are core symptoms and most commonly associated with autism in the public view, "Many people with Asperger syndrome/High functioning autism define their sensory processing problems as more disabling than the deficits in communication/social behaviour[6]. Sensory processing differences in autism are highly reported, 81% of respondents reported differences in visual perception, 87% in hearing, 77% in tactile perception, 30% in taste and 56% in smell [13]. Senses play a vital role in how we model and perceive the world around us so if one senses the world in a differently, their view and resulting behaviours will also be different.

Senses in autism can be hyper(more sensitive), hypo(less sensitive), agnostic or fluctuate between hyper and hypo[9]. As with all areas of autism, sensory atypicalities differ and are unique to each individual, however, these fluctuations make it an area of particular challenge for carers and for a person with autism to identify or predict troubling sources before they occur. Fluctuations can be described as a 'FM radio that is not exactly tuned on the station when you are driving down the freeway. Sometimes the world comes in clearly and at other times it does not" [6].

When a sensory channel is in a state of agnosia, although able to see, one may not be able to assign it to any meaning. The result is one can become 'mind-blind', or 'mind-deaf' where the person can appear as if they are genuinely deaf.

Catering with for the many different sensory needs for many different children can be very demanding. In the classroom if a child is hypo-visual and feels a need to stimulate their visual senses by constantly switching on and off a light, in contrast to another child in the class being hyper sensitive, the result could lead to a sensory or information overload(this was commented on in one of the interviews from the teacher...).

Below are some examples of the effects someone with autism may experience depending on the state of their sensory channel:

// (below is probably not much use at the moment, but useful for later justifying the game character's traits and responses to the environment if I can structure it in properly...)

Sensory processing patterns can be categorised into four-types[13]:

1. Sensory avoidance pattern: Low sensory threshold.
2. Sensory seeking patterns: A high sensory threshold and make seek out stimulus.
3. Sensory sensitivity patterns: Low thresholds and may respond to stimulus more intensely or for a longer period of time.
4. Low registration: High sensory threshold, may appear not to detect incoming sensory information and also show a lack of responsiveness.

Correlation between sensory difficulties and difficult temperament characteristics such as activity level, adaptability to changing context, quality of mood, threshold of responsiveness, intensity of reaction and persistence[8].

Sense channel	Hyper	Hypo
Vision	Vision may be magnified	Attracted to light or fascinated with bright colors
Auditory	Sounds are amplified. Temple Grandin a write with autism described her ears as like 'microphones'	Is attracted to sounds/noises
Tactile	Clothes may hurt. One person with autism described clothe labels as feeling like 'barbed wire'. May not like being hugged.	Enjoys being hugged or seeks pressure by crawling under heavy objects.
Taste/Smells	Smells or texture of foods may be intolerable.	Mouths and licks objects
Vestibular	Difficulty with walking or crawling on uneven or unstable surfaces.	Spins, runs round and round, rocks back and forth

2.3.2 Sensory and Information overload

*** Need more comments and to hunt down literature which I have definitely read somewhere which explains more of what it is actually like to experience a sensory overload. Justification for lights becoming brighter is below.

When the amount of information required to be processed comes in large volumes too quickly it can result in an 'Information' or 'Sensory' overload. Overloads can result in hypersensitivity causing lights becoming brighter or sounds becoming louder. Visual/auditory causes of overloads can cause tactile sensitivity and so being touched might become painful. Donna Williams reports that "sensory overload caused by bright lights, fluorescent lights, colours, and patterns makes the body react as if being attacked or bombarded, resulting in such physical symptoms as headaches, anxiety, panic attacks or aggression"[9].

The resulting behaviours again differ for each individual and are discussed in the following section.

2.3.3 Resulting behaviours

Meltdowns

If a sensory overload is not dispersed quickly enough it can lead to a full sensory shut-down in which all senses enter a state of agnosia and the person with autism withdraws from the world. Another reaction to a sensory overload is entering a state of 'fight or flight', running away from the source without any sense of danger, or exhibiting temper-like tantrums or self injurious behaviour. These behaviours can be collectively known as 'meltdowns'; the individual experiencing them feels a loss of control. Meltdowns can be caused by not only by sensory, but an emotional and cognitive overload.

Mono-processing

Mono-processing is described as an involuntary response to information overloads where all but a few sensory channels are closed. Vision may become hyper-sensitive whilst but the individual may not be able consciously hear. Subconsciously however, this information may be absorbed and processed later, further increasing the information processing delay.

Repetitive and restricted behaviours

// Note: find information on 'attractive stimulus' and Sensory soothing objects. Relate it more to content that can be use as justification for simulator choices.

Repetitive and restrictive behaviours are highly prevalent in people with autism and are thought to be caused by:

1. Needing to induce sensory sensory stimulation[18].

2. As a reaction to sensory stimulation[18].

Repetitive behaviours and sensory issues have been found to be positive correlated[19][**?**]. High levels of restricted behaviours were associated with less severe levels of depression, indicating that such behaviours may act as a mechanism to protect against or be a direct cause[**?**]. Those with low-functioning autism were more likely to engage in repetitive behaviours such as 'stimming', repetitive manipulation of objects and self-injurious behaviour in contrast to high-functioning autism having restricted interests, language or attachment to objects[**?**]. People with high-functioning autism were reported to have higher levels of anxiety with restrictive behaviours thought to a developed coping mechanism[**?**].

93% of children with autism were reported to be distressed by change [7]. With an ever changing perceptions of the environment, routine can be their only sense of familiarity and reassurance. Interestingly it is reported that people with autism can have more problems with small changes in a familiar environment in comparison to entirely new situations[9].

2.4 Effect of Autism

Social interactions are unpredictable following no set guidelines or rules and differing from culture to culture. For one to feel part of a group we need positive reinforcement that our actions fit within that group. Continuity helps us build feelings of safety and security which can be transferred to social trust, allowing us to predict the behaviours of people around us and reduce uncertainty. For many of us, we take for granted our innate ability to know when and how to communicate, but for someone with autism they have to learn scientifically what we have learnt naturally. Receiving negative feedback in social encounters can result in feelings of embarrassment or ridicule, threatening an individuals ontological security which has further possible consequences; a negative self-image, the world and future.

It is proposed that it is our moral duty to be compassionate and sympathetic towards the group, to monitor our facial expressions and reactions as to not cause offence. This can be problematic in two ways - if the group have little understanding of someone who is different the group cannot adjust to the individual. Likewise if the individual struggles to understand the workings of the group, they cannot adjust and consequently feel an outcast.

One person with Aspergers syndrome(a form of high-functioning autism) it as like "living in a bubble or living on the other side of a plate glass window to everybody else. It is like you are just a spectator in this thing"[20]. In interviews conducted by Sara Ryan and Ulla Raisanen(2008) three themes emerged: not belonging, trying to fit in and the need for safe spaces. Inspite of this, interviews showed their desire was not to rid themselves of Aspergers but to simply fit into main-stream society. Interviewees were extremely aware of their differences but inspite of desperately trying to learn the rules and social norms it was often felt their efforts were not reciprocated by neurotypical people.

Of course, one solution to aid those on the Autistic spectrum to fit into main-stream society would be increase public awareness, acceptance and understanding. However, explaining emotions and feelings has proven to be extremely challenging for some individuals which makes such possibilities difficult to achieve. The act of trying to express themselves with words was described as painful [20].

2.4.1 Effects on children with ASD

Notes on things supervisor has suggested writing here:

State what difficulties from what part of the spectrum and age group. At the moment using examples and symptoms from the higher end of the spectrum when it should be more for young children/lower part of the spectrum. Social communication difficulties would therefore be more like eye-contact, responding to cues such as name being called and any use of language. Language delays are a huge feature of pre-school children with autism.
Social interaction - emphasize child-level issues i.e taking turns, sharing enjoyment with others.
Social imagination - Emphasize interests and repetitive behaviours here. I.e lining things up, limited play such as playing with parts of objects, obsessive fixations on specific toys and specific routines

2.5 Previous work

2.5.1 Education software

How other education software can be used to help children with understanding autism or general learning. Include information from the paper Alyssa sent.

2.5.2 Other Autism simulations

In Febrary 2013 a playable 3D virtual environment depicting sensory difficulties in autism was released. The simulation allowed the user to navigate around a playground with other children who are all identical and if the user gets too close to them, visual distortions occur and high-pitched sounds are played. The simulator from the public perspective was very well received and thought as a good step in increasing awareness and understanding of autism. From those with autism the feedback was mixed with some commenting that the portrayal was not an accurate representation whereas to some it was which highlights the breath of experiences these individuals have.

In addition to the above, some autistic individuals have created short videos to demonstrate the impact of sensory problems on their day to day lives and these have been very well received(Gary G. Porter). One great benefit of conveying difficulties visually is that it helps obviate, to some extent, the ever-present language barrier. Owing the communication obstacles faced by those with autism this seems a realistic approach. // ** Do I put video links to these? Or write a brief explanation of each with 1-2 pictures?

2.5.3 Other simulations

Previous computer simulations have aimed at conveying experiences of other conditions such as dyslexia and schizophrenia have been created however there is no formal research that could be found to indicate the success or failure of these. Physical simulator experiences have been previously trailed, for example blind-folding to enable a person to experience being blind although such attempts have not proven to be effective[21] as the user is unable to see the hidden cognitive differences or use coping mechanisms developed such as heightened hearing(in the case of being blind) and such can lead to misconceptions. In this context a computer simulation may hold an advantage over physical simulators by virtue of having tools which would enable depiction of aspects like heightened hearing or senses. A further advantage of a computer simulation is the ability to highlight thinking differences by visualising the in-game character's thoughts and feelings when approached by various obstacles.

*** Perhaps offering an argument as to why simulators may not be a good idea/useful. For example it could give misinformation if people take them too literally and think that all people with autism experience things in this way.

2.6 Other

Just for now, some information that might be of use to put somewhere, not sure where.

Not sure whether to use this...or where, but it's quite a powerful quote...

> The overriding theme was a desire to fit into mainstream society and 'get' its tacit rules. Given this desire and the efforts participants described to try to achieve this, future research might explore or question the moral obligation of the rest of society to facilitate and support the inclusion of people with AS in mainstream life. [20]

> Action to increase understanding of autism across the whole school and to provide support with social activities can make a huge difference to whether a child with autism feels included at school.[4]

> It doesn't appear that mainstream teachers have had access to training. The fundamental issues relating to communication, behaviour and language disorder continue to be misinterpreted as 'bad behaviour', 'not listening' and so on.[4]

Chapter 3

Design process

As the project selected has a very large scope it was important to identify the most important goals and decide on restrictions. Autism as previously described comes with a vast amount of difficulties, some of which may be too complex or time consuming to convey(such as social difficulties). Owing the vast environments a child can be exposed to on a day to day basis(school, work, parks, etc), a house was chosen as this is the place we will most often be and with understanding the pitfalls and hazards around the house, understanding could be generalised to other environments. Once the environment was selected, interviews and a consultation from the LAER group aided the selection of autism difficulties which may be the most important.

3.1 Interviews

Interviews were carried out with five people from varying backgrounds and exposure to autism: **** what is the best way to convey interview information? Do you know if the previous method used in a prior report was acceptable?

1. Candidate one: teacher of a school for autistic children
2. Candidate two: special needs teacher of a school with varying disabilities.
3. Candidate three: parent of a teenager with Aspergers syndrome and ADD. Described themselves as neurodiverse having severe sensory difficulties but less social ones.
4. Candidate four: parent of a child with Aspergers syndrome and is themselves neurodiverse. Candidate describes having high sensory issues and less social ones.
5. Candidate five: person with high-functioning autism whom has higher social difficulties and less sensory.

3.2 Difficulties chosen

Following interviews and reviewing literature available, the following aspects of autism selected are:

1. Sensory atypicalities: selected as the primary difficulty to convey due to their prevalence and hidden nature which is less known to the public

2. Meltdowns: As these can be caused by sensory atypicalities and it is important to convey to the user the impact of difficulties, not just the difficulties themselves.

3. Special interests: A means in the game to 'soothe' the character and counteract meltdowns.

4. Ambiguous instructions and processing delays: commented as a problem in the classroom.

3.3 Game design

The following is the initial game design which was heavily used in the prototype simulation. Following this, a more in-depth plan was created for the first version as experience and knowledge of the system grew and allowed for this.

3.3.1 Story boards

As a way to navigate and prompt the user to inspect and learn about their environment the concept of "Missions" arose. Missions are tasks given to the user which they are required to complete whilst circumventing any obstacles which may cause a sensory overload or meltdown. For example:

'User attempts to get a drink from the kitchen and is overwhelmed by the noise from the washing machine'

From here the player will experience sensory overload problems when entering the room and persistent attempts to force themselves to overcome the effects will trigger a meltdown. After 2 attempts, the parent in the environment will turn off the washing machine which will allow the user to complete the task.

"Inner thoughts" of the character will be displayed to act as prompts and give hints. Inner thoughts will be construed on the basis of descriptions provided by people with autism, taken from scenarios they felt were difficult.

For the prototype version of the game, two tasks will be given: To get dressed and then proceed to obtaining a drink from the kitchen. For the first complete version a more in depth storyboard will be created.

3.3.2 Autism aspects

Due to the complexity of conveying social and communication problems it was decided not to include this in the first version despite its prevalence in autism life. Sensory processing problems were instead selected as "Many people with Asperger's syndrome/high functioning autism define their sensory processing problems as more disabling than the deficits in social communication/social behaviours"[6].

As the scope and range of difficulties within autism is broad the prototype version will be restricted to three/four difficulties:

- Sensory processing difficulties (sound, touch, visual)
- Meltdowns
- "Special interests"
- Instructions being ambiguous/processing delay.

Consultation for the selection came by attending the Universities Learning And Environments Research lab which was attended by other students working on autism related projects and gave ample opportunity for feedback; interviews and finally consideration of time and difficulty to implement.

To start with the user will have minimal guidance on exploring the environment and will be expected to discover what environmental aspects are attributing to difficulties when completing tasks. This highlights interview-obtained information that children with high-functioning autism were unable to pinpoint what was causing them to meltdown until they were older and able to verbalise. After an attempt or two if meltdowns keep occurring, prompts, hints and information will be given.

Meltdowns

Meltdowns occur when someone with Autism becomes stressed or overwhelmed. This will be represented as 'Contentment' instead of a health bar, commonly seen in games. There have been multiple suggestions to convey this:

- During a meltdown, make the character harder to control. When pushing "right" the character instead moves left and vice versa.
- Make the screen blackout and reopen with items in the house destroyed.

The first option was selected and moulded for the prototype. As contentment gets closer to zero, the camera will shake, giving the player a few seconds to attempt to prevent the meltdown. The closer contentment gets to zero, the more the camera will shake. When contentment reaches zero, a meltdown will occur and the player will restart in the bedroom. One of the interviewees also specified that for them, contentment could be affected by factors such as the weather or previous days success.

Sensory overloads

Following interviews, reviewing literature and observing on-line materials designed to visually simulate sensory overloads, several concepts for conveying this emerged. One of the effects of sensory overloads was for lights to get brighter which can be easily conveyed in JMonkey using filters. A Guassian filter is suggested to make the overall environment harder to navigate and to mirror dizziness described.

Interviewees specified that when one sense is overloaded more senses can be affected hence problems with sound can cause hyper sensitivity to lights and vice versa.

2 of the 3 people interviewed specified that found the below image uncomfortable to view and was quite accurate. This demonstrates again that a sensory overload differs for each individual and indicates more should be consulted as 3 is a small sample. However, the projects core aim is to raise awareness of these problems rather than attempting to give an identical experience of having autism and thus this approach will be used unless feedback in the formative evaluation indicates changes are required.

Sensory overloads will affect and be affected by the players contentment. If the player does not move away from troublesome objects quick enough, contentment will drop, which, if not addressed quick enough can lead to a meltdown. In addition, if contentment is low sensory overloads will occur quicker.

Special interests

'Special interests' were chosen as a way to alleviate some of the difficulties within the environment and as a means to replenish energy or contentment. When engaging with a special interest, troublesome sounds will be reduced and if experiencing a sensory overload or meltdown the effects will subsidise. The special interest selected will be a Dinosaur toy which the user can interact with.

Information processing delay

Information processing delay was highlighted in interviews by a teacher as one of the main causes of meltdowns in school. When the user clicks on an object to interact or is expected to give a response, actions will be made harder to select by moving around. If the character has lower contentment the selections will move even quicker which should result in a greater delay from the player. Such delays could affect responses from other characters in the game.

3.3.3 Tool selection

It was decided to use a game engine to allow time and focus to be directed onto the higher level concepts. Suitable game engine candidates were identified by looking at those highly rated on gamedev.net (extensive online resource for game developers), whilst taking some previous knowledge into account. Blender will be used as the modelling tool as it is freely available, powerful and well supported with lots of tutorials and documentation.

Game engines

** Put this in a table

Unity

Unity is one of the most popular game engines available with good support for models. Unfortunately the licence costs 1500 and the free version comes with limitations.

Advantages: popular game engine to use. Quick development with scripting. Phone app support.

Disadvantages: Interface heavy, limited to just scripting, costs, good computer required to run it efficiently.

JMonkey

JMonkey is a java 3d game engine that has been in development around for a few years. It has an extremely active and helpful community, allows complete customisation and holds little limitation being open source.

Advantages: Provides development environment with scene graph. Active community where you often get responses from developers themselves. Java is quick to develop in. Support for online use and phone apps.

Disadvantages: Java is not seen as the preferred language for graphics or games.

Panda3D

Originally created by Disney, Panda3D is an engine which can be used via python or C++ although support is mostly for python.

Advantages: Quick to develop for with a choice in language. Good community with lots of tools.

Disadvantages: No phone app and limited online support. Lack of documentation.

Ogre3D

Ogre3d is primarily a graphics rendering engine and but it does have additional plugins such as 'physics' or drawing interfaces.

Advantages: Lots of modules and plugins. Powerful and used commercially. Active support community.

Disadvantages: Longer development process. Lack of tools such as a scene graph. No support for putting online.

JMonkey was chosen for its active community, development environment, because its programmed in Java and open-source. Although Java is not seen as the programming language of choice for graphics it allows quicker development than C++ counterparts. Unity allows very quick development with great results but the pro version would be required for some features, which is very expensive. As JMonkey is in Java it can be easily transferred to both an online game and an Android app which increases accessibility. Although an Android app may not be possible during the project timeline, converting the game to online should be straightforward. Finally there were no foreseen limitations with using JMonkey.

Modelling tools

For modelling there several options:

- Maya
- 3DSMax
- Blender
- Sketchup

Blender was the primary 3D modelling tool of choice as it is free, open source, widely used for various game developers and professionals and the tool JMonkey is most built to accommodate.

3.3.4 Character

The character the user will play as. What difficulties they have/ what age they are.

Chapter 4

Prototype

4.1 Implementation

The program structure was built from scratch using JMonkey. The scene contains a model of a house which was produced in sketch-up and contains two bedrooms, a kitchen and a living room all on one door). More detailed furniture models were created in blender and some (such as the character model) were taken from free online repositories. Particle emitters were added to models that were a source of sound in order to visually represent the sound disturbances reported by those with autism(the more objects emitting sound that the player is near, the harder the environment will become to view and as such it should intuitively prompt them to move away).

4.2 Gameplay

The player moves around and explores a realistic home environment. They are able to interact with the environment, such as turning of lights, opening and closing doors. Their well-being is monitored at all times by a contentment gauge visible on screen. The players goal is to interact with the environment, and later perform specific tasks, while maintaining contentment at a high level. If contentment drops, this is represented by the gauge graphic and when it reaches zero, the player experiences a meltdown and restarts. When being affected by unpleasant sensory inputs such as light or sound there is an introduction of visual flters on screen which are uncomfortable to view and inhibit accurate navigation of the environment and task completion. The player can perform various activities to increase contentment again.

4.2.1 Game modes

Task mode

In the task mode, the user is required to navigate around the environment whilst experiencing some of the sensory obstacles in order to complete tasks. In essence, this is the game or story mode of the program.

The program structure is designed to allow flexibility when giving the user tasks to complete in the environment. "Tasks" are java classes which can be dropped into the system and loaded. These classes can define custom actions on objects which may only be applicable when the task is active, e.g, get a drink, get dressed, ask Mum for help. Task classes must also set the conditions

for completion such as player is holding a drink, is dressed, spoke to mum and on completion the next task is selected and displayed to the user. One of the benefits of this comes with testing as specific tasks can be selected and it doesnt require going through a series of events to trigger the tasks that need to be checked or needing to comment out large portions of code.

Exploration mode

In the exploration mode the user can navigate and explore the environment without the worry of the contentment bar reaching zero or meltdowns although sensory disturbances still occur.

4.2.2 Autism aspects

Representing sensory overloads and meltdowns

The three sensory problems currently implemented are sensitivity to sound, light and tactile. The proximity and amount of objects around the player will firstly affect the sensory health. When this falls below a specified threshold the first level of a sensory overload occurs and the impact of surrounding objects become more prominent, lights becoming brighter for example. If the player does not move away, the second level is reached in which visual effects worsen making it harder to see, a representative of a sensory overload. When the first level is reached, the contentment bar is slowly reduced and when the second level is reached and a sensory overload occurs the reduction is quicker, reflecting the exponential impact of unpleasant sensory stimulus over time.

The sensory system both effects and is affected by the contentment bar which is the equivalent of a players "health" or well-being. Interviews showed that if someone with autism is feeling particularly drained from their day or awakens feeling particularly anxious their tolerance to their surroundings is lower and hence when contentment is lower, a sensory overload is more likely to occur. Translating the information from interviews and readings to implementation proved challenging because of the amount of differing information. The specific triggers do require work and adjustment, for example having only certain types lighting causing problems as currently all of them are. Sound is currently represented by visual sound waves emitting from objects and these need to be made bigger and more dense so that the more sound-emitting objects around, the more disturbances occur and the harder it is to interact with surroundings. A final improvement is for contentment to slowly increase if not around any objects causing sensory problems and if not around people.

Effects on contentment

Contentment of the player reduces when experiencing sensory overload effects and will stop reducing after a period of time if the player moves away from them. There are other specific actions within the game that will also cause the contentment to reduce such as getting dressed(to represent tactile sensitivity) or being told off by the parent. Currently the contentment can replenish if the player engages with special interests which are represented in-game as playing with the dinosaur. More will be implemented later to reflect some of the other experiences that those with autism find soothing.

Other features

Information processing delay: The delay in information processing exhibited by someone with Autism is demonstrated by creating a options which represent in-game choices which constantly rotate, making it harder to read, choose and also select a response. The speed in which this occurs is dependent on the contentment level so that the less content the character is, the harder it becomes to make a choice as they rotate faster.

Description box: Users can click on certain objects and obtain information in the form of pop up boxes on certain items that may cause problems or be of interest to someone with autism. I.e explaining that information on TV may be taken literally and a child may thus expect a toy to react in the same way as advertised or may not be able to identify that what is seen on TV is not real. This adds an extra layer to the system allowing a person to visually walk around an environment and learn about Autism which may alone be more effective and engaging than reading a textbook on the topic.

Special/repetitive interests: Interactions with favourite objects such as a toy dinosaur cause contentment to slowly increase whilst reducing any sensory problems, reflecting one known real-world function of such repetitive interests.

4.2.3 Overcoming challenges

At the start of the project significant amounts of time were spent trying to import rather than create models. It was a tedious task because small changes to the models required the whole house scene to be remade in JMonkey or time had to be spent on editing models better work with JMonkeys import system. It also became evident from using Blender that it has a very steep learning curve and is a tool which can take some considerable time to master. However, in the last two months of the game development process, these obstacles have been largely overcome. Experience acquired, coupled with updates in February to the JMonkey import system, made it easier and less time consuming to acquire, create, change and import models. The whole scene was no longer required to be rebuilt allowing time to be better spent. Moreover, the update allowed direct use of google sketchup, a 3D modelling tool which is easier and quicker to use than Blender (although it produces less quality assets) and offers a wealth of free models in the online repository, most of which are home components such as furniture.

Overall, JMonkey has proven to be a good choice. No additional limitations have been found and development was quick once a solution was found to the model import pipeline. The modularity offered by Java allows further extensions to be created with ease without needing to change a large portion of the program structure. Finally, being able to combine sketchup and Blender has been a great help and with practice, asset creation should continue to speed up.

4.2.4 Technical

More technical information of the programming. Class and system diagrams.

- Explanation of missions interface
- Scenes
- object states
- player class

Question	1	2	3	4	5
How likely would you be to play the simulator?	0	0	1	2	4
How much do you think playing the simulator could help you understand the behaviour of a child with autism better?	0	0	0	2	5
How much did you like the visual effects?	0	0	1	3	3
How much did you like the graphics?	0	0	2	2	3

Table 4.1: Questionnaire results. Participants responded giving an answer between 1 and 5. 5 being the highest rating

- gui
- action manager
- Class diagrams

4.3 Evaluation

The current version of the simulator has been evaluated in two settings. The first was the presentation of the simulator to the LAERLab group(see below). The second was a questionnaire sent to some parents/family members of children with autism and adults with autism.

TODO: More details information on the evaluations, specifically the LAER one.

4.3.1 Expert feedback

The LAER group consists of students and academics with an interest in the field of accessible and educational technology design. A focus group of 10 members provided comments and feedback. A short video demo was presented and narrated, showing exploration of the environment and then one task being completed (which was to obtain a drink from the kitchen) including demos of sensory overload effects, meltdown and information processing delay concepts.

4.3.2 User feedback

A video was sent out with verbal instructions and descriptions along with a questionnaire which was filled out by 1 family member and 3 parents of children with autism as well as and 3 people with autism. It contained both qualitative and quantitative questions.

The qualitative questions asked were:

1. Who would you think the simulator would be useful for?
2. How accurate do feel the representation of a sensory overload is? Please include any additional comments.
3. Do you have any other scenarios, examples or information(that could go in description boxes for example) that could be offered that you think may be useful for others?

Overall feedback in relation to qualitative question 3 was that the sensory overload representation was good but "more effort in depicting the pain felt from sound would be good".

** put more of the responses from the simulator questionnaire in here.

4.4 Improvements planned

Following constructive feedback from these sources, the following amendments to the simulator have been prioritised:

1. Some viewers with autism commented they found it difficult to watch as it was causing them to have a sensory overload. Thus, one improvement is to allow certain effects/components to be turned on or off.

2. Remove pop-up description boxes which users felt interrupted the simulation and instead represent this information in a side-bar.

3. Improve game-play controls which are currently too sensitive and make viewing difficult.

4. Adjust threshold for a meltdown occurring as these are happening too quickly.

5. Certain objects should present more sensory problems than others i.e fire alarm causing a quicker reduction in contentment than the noise from the TV. Overall, comments in relation to the sensory overload effects were very positive.

Interviews need to be further conducted with parents, teachers and carers to and more scenarios with which they commonly experience difficulty. Such information can be used to create a storyboard of scenarios and tasks. As well as gathering information from individual interviews, the simulator will also be presented at a workshop for a charity to an audience of carers of children with autism and other disabilities. This could be given in the form of a visual demo and/or allowing them to play.

Chapter 5

Formative evaluation

The formative evaluation will be carried out with 5 participants and will be predominantly testing usability, checking that accompanying materials such as help-guides and game controls.

Through watching it became clear as to where prompts would be required.

Chapter 6

Summative evaluation

One issue that came up arose from how the formative evaluation was conducted, however this provided interesting results. With the formative evaluation as users were following a set of predefined tasks, they were reaching all appropriate goals. With the summative evaluation, much less instruction was given and users were able to explore. User approached problems in a variety of ways, and there was clear evidence of users varying and attempting different strategies. With less guidence, certain objects of interest were missed although this did not seem to hinder.

What may have been more beneficial in the formative evaluation would have been a combination - testing with a strict set of tasks to make sure it was easy to carry out, and then simply observing the user playing with the in-game instructions and improving prompts.

Consequently,

Chapter 7

Conclusion

Chapter 8

Plan and future work

Additions to simulator prioritised as required for the formative evaluation:

1. Change start screen to have an image behind it with a more informative help screen.
2. Recording of sounds: Door bell, TV noise.
3. Spinning soothing object in bedroom.
4. GUI changes: Make thoughts more readable as they can be quite difficult with certain backgrounds.
5. Completion of storyboard implementation: morning routine is complete as is the afternoon(except the doorbell and introduction of another character) but needs final touches.
6. Tooltip: As the process of selecting actions was changed it is not obvious what will happen when the user interacts with other objects or what room they will walk into when clicking on a door. A tool-tip would be an easy addition that would not interfere with play.

Task	Deadline
Complete plan for formative evaluation	January 24th
Finishing additions and improvements to simulator	February 3rd
Start formative evaluation	February 4th
Finish formative evaluation	February 6th
Improvements to simulator based on feedback	February 17th
All sections of dissertation complete(except summative evaluation)	February 17th
Summative evaluation	February 21st(end of ILW)
Completion of dissertation writing	March 6th

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