



University of **HUDDERSFIELD**

University of Huddersfield Repository

Kean, Robert Neil

An investigation into the efficacy of a game-based learning tool to assist school children with an autistic spectrum condition to overcome sensory difficulties

Original Citation

Kean, Robert Neil (2014) An investigation into the efficacy of a game-based learning tool to assist school children with an autistic spectrum condition to overcome sensory difficulties. Masters thesis, University of Huddersfield.

This version is available at <http://eprints.hud.ac.uk/id/eprint/23400/>

The University Repository is a digital collection of the research output of the University, available on Open Access. Copyright and Moral Rights for the items on this site are retained by the individual author and/or other copyright owners. Users may access full items free of charge; copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational or not-for-profit purposes without prior permission or charge, provided:

- The authors, title and full bibliographic details is credited in any copy;
- A hyperlink and/or URL is included for the original metadata page; and
- The content is not changed in any way.

For more information, including our policy and submission procedure, please contact the Repository Team at: E.mailbox@hud.ac.uk.

<http://eprints.hud.ac.uk/>

**AN INVESTIGATION INTO THE EFFICACY OF A GAME-BASED LEARNING
TOOL TO ASSIST SCHOOL CHILDREN WITH AN AUTISTIC SPECTRUM
CONDITION TO OVERCOME SENSORY DIFFICULTIES**

Robert N Kean

FdSc, BA (Hons)

**A thesis submitted to the University of Huddersfield in fulfilment of the requirements
for the degree of Master of Science (Research)**

The University of Huddersfield

June 2014

Dedication

I would like to dedicate this to my family as without their continued support this thesis would not have been possible. I would especially like to thank my mother who has stuck by my side, not just through this degree, but through my whole life helping me to deal with my own autistic problems which in turn has inspired my work here to try and help others with their issues and for that I am eternally grateful.

Acknowledgements

I would like to thank the students, teaching and support staff of School S and School C and the parents, guardians and carers who participated in the investigation. Without their assistance the study would not have been possible.

I would also like to thank my supervisor, Dr James McDowell, for his continued support, advice and feedback which was always knowledgeable, constructive and motivating.

Finally, many thanks go to my mother who has devoted a significant amount of time to the project by listening, reading and helping me with my memory problems. On a personal level, she kept me going through times when I was struggling and gave me the confidence to keep going to the end.

Abstract

This thesis discusses an investigation that has explored the efficacy of a game-based learning intervention designed to assist children with an autistic spectrum disorder overcome sensory dysfunctions. The aim of the study is to verify, through examining past research and solutions, that there is an existing need for coping strategies to address sensory dysfunction.

The investigation aims to corroborate the background research by creating an intervention generated by participants on the autistic spectrum, their family and education support network that fulfils a need to minimise sensory distress. The overall purpose of the study is to show that a game based intervention catering to sensory dysfunction can be a successful application as a learning tool.

The design-based research methodology used reflected the game based and participatory process which drive the intervention's development. The data provided by the participants was instrumental in enabling a design to be made that ostensibly met the needs of its users based on the information disclosed.

Discussion takes place of the challenges that affected the investigation and how the direction of the study was steered as a result of the data acquired and adjustments that were made. The findings allowed a number of conclusions to be reached and the last chapter reflects on how the background research contributed towards the results and how the design of the development was affected as a result.

The final chapter deliberates on the autistic diagnostic process, the place that sensory dysfunction takes within this procedure and how the investigation highlights the need for more consideration to be given to sensory behaviours within this process. The thesis concludes with possible answers to the research question, accompanied by an explanation of the reasons for the outcomes. Finally, contemplation is given to the findings and how the study could benefit from further research.

Table of Contents

Dedication	2
Acknowledgements	3
Abstract	4
Table of Contents	5
List of Tables	8
List of Figures	9
List of Abbreviations	10
Chapter 1 Introduction	
1.0 Context and Justification.....	12
1.1 Motivations for the Research	12
1.2 Wider Context for the Research.....	14
1.3 Research Domain	15
1.4 Research Questions	16
1.5 Research Approach	17
1.6 Overview of Chapters	17
Chapter 2 Literature Review	
2.0 Introduction.....	19
2.1 Explanation of Autism and Asperger Syndrome	19
2.2 Levels of Function	22
2.3 Sensory Processing Disorders.....	23
2.3.1 Scope of the Problem	23
2.3.2 Existing Research into Sensory Difficulties	25
2.4 Diagnostic Tools	27
2.5 Psychological Tolerance	32
2.6 Game Based Learning.....	33
2.7 Link between Games Based Learning and Autism.....	35
2.8 Computer Games in a School Environment.....	36
2.9 Reward Systems.....	37
2.10 Reality within 3D Games.....	39
2.10.1 Uncanny Valley	39
2.10.2 First or Third Person	40
2.11 Existing Software Solutions, Coping Mechanisms or Interventions	40

2.12	Summary	41
Chapter 3 Research Design and Methodology		
3.0	Introduction.....	42
3.1	Research Question and Aims	43
3.2	Discussion of Research Methodologies	43
3.2.1	Factors Influencing the Choice of Methodology	43
3.2.2	Consideration of Case Study Methodology	44
3.2.3	Consideration of Action Research Methodology.....	45
3.2.4	Consideration of Design Based Research Methodology	47
3.3	Research Design and Methods.....	49
3.4	Data Collection and Analysis.....	50
3.5	Factors Influencing the Research Design	51
3.5.1	Access to the Study Population.....	51
3.5.2	Ethics, Confidentiality and Participation Consent	53
3.5.3	Discussion and Questionnaires	54
3.5.4	The Role of Physical Artefacts in the Research.....	55
3.6	Summary of Methodologies and Research Design Methods	57
Chapter 4 Description of Cycles and Findings		
4.0	Introduction.....	58
4.1	First Cycle	61
4.1.1	Research.....	61
4.1.2	Design	71
4.1.3	Implementation	73
4.1.4	Evaluation	73
4.2	Second Cycle	76
4.2.1	Research.....	76
4.2.2	Design	81
4.2.3	Implementation	82
4.2.4	Evaluation	82
4.3	Third Cycle	83
4.3.1	Research.....	83
4.3.2	Design	87
4.3.3	Implementation	88
4.3.4	Evaluation	89

4.4	Discussion	90
4.5	Summary	91
Chapter 5 Discussion, Conclusions and Further Research		
5.0	Introduction.....	94
5.1	Intervention as a Useful Learning Tool	94
5.2	Challenges Faced in Answering the Research Question.....	96
5.3	Research Outcomes.....	98
5.4	Contribution of the Research	99
5.5	Implications for Theory, Practice and Policy	101
5.6	Reflections on the Research Methodology	102
5.7	Aspects Relevant to Practitioners	104
5.8	Suggestions for Further Research	105
5.9	Conclusions.....	107
Appendix 1		110
Appendix 2.....		111
Appendix 3.....		112
Appendix 4.....		114
Appendix 5.....		118
Bibliography		119

List of Tables

Table 1: A Comparison of Over and Under Responsiveness to Stimuli

Table 2: Comparison of Benefits and Drawbacks of Diagnostic Tools

Table 3: Methods of Data Collection

Table 4: Student Data from School S

Table 5: Student Data from School C

Table 6: School C Questionnaire Results

Table 7: School S Questionnaire Results

Table 8: Analysis of Student Responses

Table 9: Analysis of Parent Responses

Table 10: School S Environmental and Scenario Comments

Table 11: School C Scenario Comments

List of Figures

Fig 1: Representation of Triad of Impairment

Fig 2: Input-Process-Outcome Game Model

Fig 3: Phases of the Research Cycle

Fig 4: School Building

Fig 5: Kitchen Classroom

Fig 6: Classroom

Fig 7: Science Lab

Fig 8: Library

Fig 9: Changing Rooms

Fig 10: Exit Signs

Fig 11: Canteen Vending Machines

Fig 12: Fire Alarm light

Fig 13: Reward

Fig 14: End Goal Beacon

List of Abbreviations

ABC - Autistic Behaviour Checklist

AI - Artificial Intelligence

APA - American Psychiatric Association

AS - Autistic Spectrum

ASD - Autistic Spectrum Disorder

CARS2 - The Childhood Autism Rating Scale

CRB - Criminal Record Bureau (now the Disclosure and Barring Service)

DBR - Design Based Research

DBRC - Design Based Research Collective

DHSGIT - Dangerous High School Girls in Trouble

DSM - The Diagnostic and Statistical Manual

ESA - Entertainment Software Association

GADS - Gilliam's Asperger Disorder Scale

GLASSLab - Games, Learning and Assessment Lab

HFA - Higher Functioning Autism

IEP - Individual Education Plan

IQ - Intelligence Quotient

LFA - Lower Functioning Autism

PECS - Picture Exchange Communication System

PEEP - Personal Evacuation Escape Plan

SPC - Sensory Profile Checklist

UAB - University of Alabama, Birmingham

UCSD - University of California, San Diego

UDK - Unreal Development Kit

WHO - World Health Organisation

Chapter 1

Introduction

1.0 Context and Justification

The characteristics of autism and in particular Asperger syndrome are categorised in the triad of impairment (Wing, 1976) and encompass the areas of communication, social interaction and imagination. Hans Asperger, who first described Asperger Disorder, or Syndrome, noted that children could be particularly sensitive to particular sounds, aromas, texture and touch (Asperger, 1944). Autism is sometimes defined as sensory dysfunction (Delacato, 1974) - a sensory integrative disorder in which the brain is not able to attach meaning to sensations and organise them into percepts and finally into concepts (Ayres and Robbins, 1979).

When the senses are considered they would usually concern the visual (sight); auditory (sound); tactile (touch); olfaction (smell) and gustatory (taste) areas. Also included within the senses are vestibular (balance and spatial orientation) and proprioception or kinesthetics (the sense of one's own limbs in space). It is estimated that 80% of people diagnosed on the spectrum have some form of sensory dysfunction (Blake, 2010). Reactions to sensory stimuli can comprise of sensitivity to sounds that most people would not notice, difficulty in processing multiple senses together avoiding situations or places where the stimuli is likely to be overwhelming (Jones et al, 2003).

The theory of sensory integration dysfunction was based on the work of Dr A. Jean Ayres (1972 and 2005) who researched how children respond to or register sensory information without the ability to screen out non-essential sensory information. Dr Ayres recognised a common theme in children with learning difficulties that related to problems with processing sensory information.

1.1 Motivations for the Research

I underwent assessment for autism when I was 8 and on completion of the process, which took around a year, I was given a diagnosis of Asperger's Syndrome and Short Term Memory Deficit. The memory diagnosis was awarded because my memory difficulties were

significantly outside of the scope of what would normally be expected for someone on the spectrum (Williams et al, 2006). After a successful application to the Local Authority for a Statement of Special Education Needs (SEN) I was awarded assistance in areas where I displayed the most difficulty, plus speech and language support. During my school years I was socially isolated and developed an interest in computer games and after completion of a BTEC in Games Development my interest increased and I applied for University. At Huddersfield University I completed an FdSc, followed by a BA in Computer games design.

As someone on the Autistic Spectrum I have both personally experienced and observed the effect that sensory impact can have on a person and the problems that can evolve when sensory dysfunction arises. I will describe some of the reactions I have to sensory overload and my observations of other people later in the thesis. Following on from both my personal awareness and understanding of the problem and my interest in computer games design, I wanted to examine the possibility of developing an intervention that could act as a coping strategy for those with a sensory impairment. The motivation for pursuing this line of research stems from a gap in my own experience as someone affected by Asperger's Syndrome, I that I was not afforded opportunities to engage with mechanisms designed to aid with issues around sensory dysfunction, and it is difficult for others who do not experience this problem to understand how debilitating this can be.

The purpose of the research is to discover whether a successful intervention can be provided through a game-based learning tool which can be used as a coping mechanism so that the person with autism can use the tool to reduce the impact that their particular sensory dysfunction has on them. It is my experience that the impact that these problems have on people with autism are underestimated and in searching for an existing solution or coping strategies for myself, I have found that these choices are generally limited to the aspects of autistic behaviours that appear in the criteria for the autistic diagnostic process.

The research question evolved from a need to discover if game based learning could be a successful medium in raising personal awareness of the sensory problem supported by suggestions of coping strategies to minimise individual sensory dysfunction.

1.2 Wider Context of the Research

Over recent years there has been much research and studies carried out concerning different aspects of the senses and how they affect those on the autistic spectrum and these are discussed in more detail in the literature review. Attwood (2007) refers to the way in which people with Asperger Syndrome may avoid situations and even become phobic if the sensory experience is too intense. He says that sounds may be magnified or invasive and can take over all thoughts and affect concentration and that 70-85% of children with Asperger's experience sensitivity to sounds.

One study that has investigated sensory-perceptual abnormalities in people affected by autism argues for further research in this area (O'Neill, Jones, 1997). Another study considering the neurophysiologic findings of sensory processing in autism asserts that further research is needed in several areas including behavioural intervention trials such as computerised training modules and self-regulation programmes (Marco et al, 2011). The authors argue that research into the issues is carried out from two perspectives, psychological research and first-hand accounts. Whilst evidence from these clinical studies suggests that unusual responses are present in the majority of autistic children the research does have limitations that need a more systematic investigation.

Individual sensory thresholds within the general population are usually something that, for most people, is a normal function and, therefore, it is something that is taken for granted. However, for some, the sensory world is a unique world where perceptions are heightened from what would be considered 'normal' to something that affects their daily life and can be quite debilitating. A comparison of reactions to sensory stimuli between individuals and those with Asperger's Syndrome was made in the Conceptual Model of Sensory Processing (Dunn, 1997). There have been countless individual testimonies recorded of sensory experiences. Grandin (1996) talked about pulling away when people tried to hug her because being touched sent an overwhelming wave of stimulation through her body as follows:

Luke Jackson, who has Asperger Syndrome, has written several books in which he records experiences in his daily life, how autism influences his behaviours and coping strategies that he has implemented. Below is a quote explaining how he minimised the effects of noise:

“My balaclava was something that gave me great security. I used to wear it 24 hours a day, 7 days a week. I like the balaclava so much because it was more than just comfort, it served a purpose. It shielded my ears from some of the noise that went on all day every day. I felt safe behind it and the pressure and tightness of the material around my head was like being squeezed constantly”.(Jackson, 2002)

The problems that the autistic community experience can be categorised under umbrella headings as in the triad of impairment (Wing 1976) and their sensory problems are quite individual and may cover a multitude of different scenarios. With the identification of the sensory difficulties experienced during the investigation, the aim of the intervention is to create a computer game that can act as a tool to help individuals overcome sensory difficulties and ideas for coping mechanisms that will aid their functioning abilities.

Whilst the areas of difficulty experienced can be categorised, such as auditory, tactile or optical, the effect on the person will be very personal as shown above. Interventions that were found as part of the research were implemented based on individual research projects as opposed to a strategy that had a more generic purpose and these will be explored further in chapter 2.

The aim of the intervention is to offer a way for the autistic person to be more self reliant in respect of their sensory difficulties in terms of making suggestions of coping mechanisms or strategies that can be adapted according to personal choice. Therefore, the ongoing development of the intervention will be concerned with individuals taking ownership of their sensory difficulties in an environment where they can be in control and then take the suggestions forward to be applied in their daily lives.

1.3 Research Domain

The domain of the study encompasses computer games design and the development of a game-based learning intervention created throughout a cyclic process. The progression of the intervention will be driven by the participants of the investigation by virtue of their personal experiences, observations and evaluations throughout each cycle.

The design of the intervention is pivotal to the study in terms of the specification being sufficient quality to engage the user and it has to be realistic enough to be able to cross the barrier between fantasy game play and something that can be adapted to real life. Therefore, if this crucial element is not achieved, the ability to be able to answer the research question will be severely diminished.

In undertaking the route to being able to provide a functional product, another key element of the design development is the facilitation of quality data concerning the sensory dysfunctions that are either experienced or observed by the participants. This will enable the design to meet the needs of its users through an ongoing measurement of psychological tolerance and coping strategies to improve the ability to take ownership of their individual problems.

1.4 Research Questions

The overriding research question is whether a game-based learning tool can aid children with an Autistic Spectrum (AS) condition and sensory difficulties to overcome their problems. However, to enable this question to be answered, copious qualitative and quantitative data needed be ascertained and dissected in order to procure sufficient and pertinent information to develop an appropriate intervention that catered to individual requirements.

In order to acquire this information the questionnaires were segregated into different types to satisfy the data needed from the different participant groups. The groups consisted of the students with autism, their parents or guardians and the teaching and support staff. The purpose of the separate questionnaires is to aid corroboration of data and also to gain detailed information from different perspectives. This would enable the development of the intervention to concentrate on the sensory behaviours found and the coping strategies that could be implemented into the intervention to act as a tool to minimise the effects of sensory input.

Whilst the questionnaires differed in tone and complexity in deference to the role that each group played, the theme for each remained the same. The objective was to ascertain any sensory dysfunction in any of the common sensory areas, to discover how the problems manifested themselves, how it affected the person and what, if any, coping strategies were implemented to reduce the problems perceived.

The identification of this information allows the development of the intervention to directly address the difficulties experienced by the participants and enable appropriate feedback to be attained. Therefore, the collaboration drives the investigation to allow an answer to the research question to be reached.

1.5 Research Approach

The research approach was initially governed by the schools that agreed to participate in the study and the levels of ability of the students incorporated in each school establishment. In order to establish whether the research question had the potential to be answered, the participants needed to be functional to the degree that allowed for satisfactory data to be attained and feedback was able to be communicated at an adequate level to allow the development of the intervention to progress.

Another major factor of the research was the ability to compare information from students displaying different levels of function so that a determination could be made of the suitability of the intervention over different areas of the autistic spectrum. This would enable the research question to be considered in a multi-dimensional manner as opposed to being a straightforward positive or negative answer.

A cyclic process was used to generate sufficient information to establish both the sensory data and the ongoing evaluation that allowed the momentum to be maintained towards achieving an intervention that was able to answer the research question. The route to completing the final development was reliant on the intervention being flexible enough to change as required in order to meet the needs of the participants.

1.6 Overview of Chapters

Chapter 2 provides an overview of the characteristics of autism, the diagnostic process and how sensory dysfunction fits into this process. This is followed by an examination of past and current research that has been carried out with regard to sensory behaviours and strategies that were used to benefit those behaviours. An evaluation of game based learning and its links to autism will be carried out in order to ascertain the potential benefits that an intervention of this nature could have.

In Chapter 3, consideration will be given to the potential methodologies suited to the investigation and the reasons behind the final choice and why other options were excluded. Following this, discussion will be carried out on the methods of data collection and how these reflect the choice of methodology and aid the progression of the development to enable a conclusion to be reached.

Chapter 4 shows the data that was retrieved from the participants in the study and how the information steered the focus of the intervention towards the final product. The Chapter analyses the sensory data and compares the findings against each of the participant types and against findings in previous studies. It describes the cycle process and considers how the elements fit together and evaluates why particular choices were made and reasons why other options were discarded. Finally, after deliberation of the findings has been given, an answer to the research question will be divulged.

A discussion of the conclusions takes place in Chapter 5 and an examination of the potential benefits of the intervention along with the obstacles that were encountered. An appraisal of how the literature review and the methodologies contributed to the study is followed by a deliberation of what further research could be undertaken to create an intervention that would enhance the benefits and minimise the challenges found during the investigation.

Chapter 2

Literature Review

2.0 Introduction

The literature review begins with a description of the evolution of autistic spectrum disorders and discusses the diagnostic tools and how these are used. This is followed by an examination of sensory dysfunction and research that has been undertaken in this area. The Chapter reviews games-based learning and discusses the link between game-based learning and autism and discusses how reward structures can enhance the experience. The Chapter ends with a review of solutions and interventions that have been used and how they have been applied.

2.1 Explanation of Autism and Asperger Syndrome

The term autism came about decades before the disorder was recognised. Autismus, the New Latin word that autism is derived from, was coined by the Swiss psychiatrist Eugen Bleuler in 1910. He used the term as a descriptor of symptoms of schizophrenia (Berrios, 2011). The word Autismus was derived from the Greek word autos meaning morbid self admiration which referred to the tendency of his patients to have a preference to be alone.

It was not until 1930 that this word was used in the current sense when Viennese paediatrician Hans Asperger began using Bleuler's term "autistic psychopaths" when studying an autistic spectrum disorder that was eventually named after him – Asperger's Disorder. He observed autistic-like behaviours and difficulties in boys who had normal intelligence and language development and noted that it was much more common in boys than girls (Wing, 1981). However, this was not classified as a different diagnosis from autism until 1994.

Around the same time as Asperger's studies, Leo Kanner began studying what he called "early infantile autism". He was also the first person to use the English word "autism" in 1943 when he identified 11 children with very similar behaviours. Prior to Kanner becoming aware of a pattern of symptoms, such children would be classified as emotionally disturbed

or mentally retarded. However, Kanner observed that these children often demonstrated capabilities that showed that they were not merely slow learners and neither did they fit the pattern of emotionally disturbed children (Kanner, 1943).

An Autistic Spectrum Disorder is a complex developmental disability that affects the way a person communicates and relates to people. The term 'autistic spectrum' is often used because the condition varies from person to person. Asperger syndrome is a condition at the more able end of the spectrum. At the 'less able' end of the spectrum is Kanner's syndrome, sometimes referred to as classic autism.

However, in the DSM-IV (APA, 1994) and the ICD 10 (WHO, 1993) Asperger Syndrome is differentiated from autistic disorder by specifying that there is no clinically significant general delay in spoken or repetitive language or cognitive development up to 3 years of age. They also state that self-help skills, adaptive behaviour and curiosity about the environment should also be developing normally during the period of up to 3 years old.

The characteristics of autism and in particular Asperger syndrome are categorised in the triad of impairment (Wing, 1976). The triad envelops the area of sensory processing as can be seen from the following diagram:

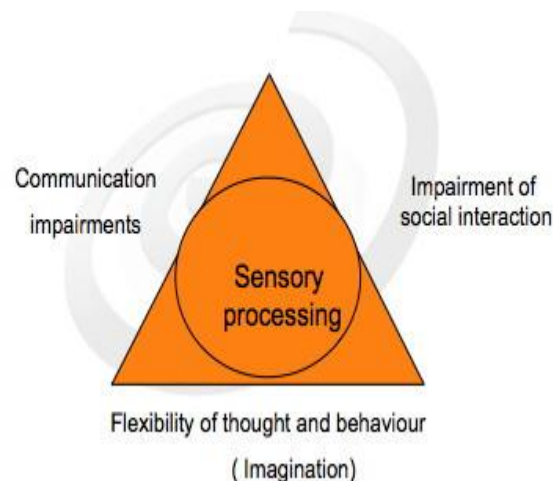


Figure 1: Representation of Triad of Impairment (NAS, 2009)

The Triad of Impairment was introduced by Wing and Gould (1979) and this has become the backbone of diagnostic criteria for autism. The main characteristics contained within the triad are discussed below:

Social Interaction Impairment

This characteristic arises from a lack of ability to understand and use the rules governing social behaviour rather than a desire to withdraw from social contact. These rules affect speech, gesture, posture, movement, eye contact, choice of clothing and other aspects of behaviour. This lack of intuitiveness can manifest itself in the following areas:

- Difficulties in meeting other people and making friends
- Problems understanding what other people think and feel
- Trouble with understand social etiquette and non-verbal signals
- Need to be taught to understand body language, voice intonation and facial expressions

Communication Impairment

With regard to communication impairment, a person with autism may display difficulties with areas of making themselves understood as well as understanding what is being communicated to them. This can mean that they are unable to sustain a conversation and may use many of the following characteristics during a discussion:

- Use of very precise language
- May be insensitive and blunt in conversation
- Tone of voice may be void of inflection
- Repetitive speech and asking repetitive questions
- Cannot 'read between the lines' of what people mean
- Makes factual comments inappropriate to the context

Imagination Impairment

People with autism have limited development of interpersonal play and imagination. They often pursue activities rigidly and repetitively and some of the characteristics of this area of impairment are as follows:

- Does not understand other people's points of view or feelings and takes everything literally
- Having a set routine and being resistant to change
- Has special interests
- Enjoyment of the repetition of certain actions, eg arranging toys

Having described the characteristics of autism above, the functioning abilities of individuals within the spectrum also require discussion. This will be a facet of the investigation in terms of the participants' capacity to communicate their difficulties and evaluate the development of the intervention as it progresses. Therefore, an explanation of the levels of function continues below.

2.2 Levels of Function

Some professionals feel that Asperger's Syndrome is simply a milder form of autism and use the term "high functioning autism" to describe these individuals. Professor Uta Frith described individuals with Asperger's Disorder as "having a dash of Autism" (Frith, 1991). In terms of high functioning autism (HFA) and low functioning autism (LFA) this is decided by Intelligence Quotient (IQ) levels but as stated below some oscillation is taken into consideration.

Low functioning means non-verbal but not necessarily unable to communicate. Persons affected by LFA may use alternative methods of communication such as Picture Exchange Communication System (PECS) which begins with the giving of a picture of something they want and they receive the item back without the need for speech, such as a drink and this develops through a number of stages to enable expansion of vocabulary. They are likely to be severely autistic and not able to live independently. To be diagnosed as low functioning, their

IQ will be below a certain point – usually below 70 (Wechsler, 1974, 1981) but this can fluctuate up to a level of 85.

To achieve a diagnosis of high functioning autism the IQ will usually be above the 70 level. Attwood (2003) records that studies have been carried out that examine the cognitive profile of what may be called High Functioning Autism (HFA) which concerns children with a diagnosis of autism with an IQ above 70 which concurs with Wechsler above. However, as with the fluctuation in low functioning, there is no black and white cut off point to distinguish an exact point between the two.

With regard to Asperger syndrome, there has been some debate about the difference between this and high functioning autism. It is thought that the difference between the two is language development, in that those with Asperger syndrome will not have delayed language development when younger (National Autistic Society).

Attwood (2003) says that research and clinical experience suggests that there is no clear evidence that they are different disorders. Therefore, for the purposes of this research I am not going to distinguish between high functioning autism and Asperger Syndrome and will use the term high functioning to encompass both diagnoses.

2.3 Sensory Processing Disorders

In addition to the main triad of impairments, additional difficulties may be displayed such as poor motor skills, physical problems and sensory dysfunction. These sensory difficulties may manifest themselves in many different ways. People with autism can be over-sensitive to certain sounds that may be inaudible to others or they become hypersensitive or hyposensitive to smells, taste and touch. An examination of these problems is explored below.

2.3.1 Scope of the Problem

As stated in Chapter 1, around 80% of people on the autistic spectrum have some form of sensory dysfunction (Blake, 2010). Those that are oversensitive to sensory input can be overwhelmed by common sensory experiences such as shopping (Marita, 2008) while those

that are under-sensitive to sensory input may self-stimulate or even self-injure to get the input their nervous system requires (mugsy.org n.d.).

Commonly, autistic people tend to have a fluctuating mix of oversensitivity and under-sensitivity. Negative and odd behaviours are frequently caused by sensory issues as described earlier in the Chapter. Therefore, the prevalence and diversity of reactions to sensory stimuli discussed appear to support the need for the development of an intervention that has strategies that can be applied to minimise the effects.

According to Jones et al (2003) sensory abnormalities can include:

- Distorted perceptions of physical objects, depth or body positioning
- Periodically tuning out certain senses (failing to notice certain sounds, sights, etc)
- Synaesthesia (sensory cross-wiring – i.e., perceiving colours in relation to smells, textures in relation to colours etc)
- Difficulty processing information from multiple senses at the same time
- Sensory overload

As stated above those with ASDs tend to be either over or under-responsive to stimuli. The following table gives examples of this.

Table 1: A Comparison of Over and Under Responsiveness to Stimuli (Dunn et al., 2002)

Under-Responsive	Over-Responsive
<ul style="list-style-type: none"> • Fails to notice what is happening nearby • Appears to ignore sensory cues (eg someone call their name) • Uninterested in surroundings or people 	<ul style="list-style-type: none"> • Easily distracted • May be hyperactive • Derives great joy from activities that are not enjoyable to most non-autistic (neuro-typical) people, such as making certain sounds, repeatedly touching objects, watching ripples on water or a crawling insect for a long time • Highly irritated by things that do not bother most neuro-typicals (eg a ticking clock, “normal” touch, textures of common foods, certain types of lighting)

<ul style="list-style-type: none"> • Clumsy (low proprioception) • High pain tolerance / physically tough or stoic 	<ul style="list-style-type: none"> • Extremely distressed by things that others just find aggravating such as sirens or car horns • May appear to have “super senses”, perceiving things such as an approaching airplane before neuro-typicals do • Has difficulty filtering out competing stimuli (eg working when people are talking nearby, focussing on a conversation when the other person is wearing a tie with an interesting pattern • May adhere to rigid rules and rituals to control the immediate environment in order to limit confusing, stressful or overwhelming sensory input • May avoid situations or places that are over-stimulating such as crowded shopping centres • Avoids certain foods, fabrics or other things that are perceived as unbearable
--	--

To give an example of the above from a personal perspective, when I was 15 I attended a youth club specifically for autistic children from the ages of 11 to 16. The number of places was limited due to the support network required so it was only a small group. Within that group, as described above was a mix of those with over and under sensory difficulties. One person sewed words or names into their body; another was so under-sensitive that she required no anaesthetic when undergoing operations. For myself, the act of someone putting the lights on feels like I am getting an electric shock and the noise emanating from the lights gives me a headache. There were many others within the group that experienced sensory difficulties which supports the estimated percentage of people that experience the problem as discussed earlier.

2.3.2 Existing Research into Sensory Difficulties

Much research has been carried out into the problems that are experienced by people with autism. The research of the literature I have undertaken as part of my study reveals that the research has been done on an individual sensory basis and examines what the problem is and

how it manifests itself without realising a solution. Below are some of the studies and research that have been undertaken into the problems associated with sensory processing.

With regard to sensory integration, as discussed in Chapter 1, a study was carried out into sensory processing disturbance in autistic children between the ages of 3½ to 13 with regard to responsivity to visual, auditory, tactile, vestibular, proprioceptive, olfactory and gustatory stimulation (Ayres, Tickle 1980). Following an evaluation, each child received therapy that provided stimulation and produced adaptive responses to the stimuli. Examination of the results suggested that the children who reacted defensively to the sensory input had a better response to therapy than those who failed to adjust to sensory input or who were hypo-responsive.

In 1994 the Geneva Centre for Autism (Walker & Cantello, 1994) (Walker & Whelan, 1994) conducted an internet based survey to gain more insight into the sensory experiences of autistic people where people were asked to complete the survey anonymously. The data obtained found that 81% of respondents reported differences in visual perception, 77% in tactile perception, 56% in smell, 87% in hearing and 30% in taste. However, while these showing that there is the possible substantiation of the role of distorted sensory perception in autism this data cannot be substantiated due to the anonymity of those completing the survey.

A study conducted by Wendt et al (2005) into the prevalence of sensory issues within ten families comprising of 58 individuals who fulfilled the diagnostic criteria for AS. Using a method of structured interviews the findings were that 91.4% of those with Asperger Syndrome displayed sensory abnormalities broken down as follows:

- Tactile 53.4%
- Auditory 50.0%
- Olfactory 44.8%
- Light 43.1%
- Pain 15.5%

The study also found that 60.3% of the participants in the study had aberrant eating habits, the findings of which are consistent with the following research.

In 2011 a clinical study was carried out concerning the link between sensory processing and eating problems in children with autistic spectrum disorders (Nadon et al, 2011). It found that whilst 25% of children experience eating problems during early childhood this may increase to 80% in children with developmental difficulties. The participants of the study were aged between 3-10 years old and information was obtained through questionnaires, data from assessments undertaken by a professional multi-disciplinary and psychiatric team and information provided by parents through observation.

The results of the study indicated that eating is not a singular sensory undertaking but is instead a multi-sensory experience which impacts on taste, olfactory, tactile, visual and temperature sensitivities. This outcome, therefore, has a bearing on the data that is obtained from the participants of the study in terms of their perception of their difficulties experienced and the possible impact it has in different sensory areas.

A 2 year study was commissioned for Cardiff University's Schools of Psychology and Biosciences (Blake, 2010) to investigate, by using brain imaging techniques, how touch is processed differently in those on the Autistic Spectrum. Dr McGonigle, who led the study, proposed to use experimental techniques to create a clearer picture on how the brain responds to touch sensations in people with an ASD.

The studies mentioned above show that research into sensory difficulties concerning autistic children has been investigated in different ways over a long period of time. Whilst these studies corroborate each other's findings by agreeing that people with autism experience a range of difficulties with sensory processing, the suggestion of solutions or interventions are limited. Recommendations that further research needs to be carried out are made by a few and these are as described later in this chapter (O'Neill & Jones (1997); Marco et al, (2011)).

2.4 Diagnostic Tools

With regard to the diagnostic process, there are a number of tools that professionals use in order to generate a complete picture of the problems experienced by the person receiving the diagnosis. These involve obtaining information through direct observation and questioning of the person presenting autistic spectrum traits, but also information from secondary parties

such as parents and teachers. The same diagnostic tools will not be used all the time but will vary depending on the person's age and functioning abilities as described below.

Gilliam's Asperger Disorder Scale (GADS) (Gilliam, 2003) is the only scale solely for children at the high functioning end of the spectrum and has been noted for its ability to distinguish Asperger Disorder from Autistic Disorder. The checklist evaluates children with unique behavioural problems who may have Asperger Syndrome and is commonly used by school psychologists and can be used as part of the assessment process. GADS is used by giving frequency based ratings within 32 diagnostic characteristics which are divided into four sub-scales. These sub-scales are social interaction, restricted patterns of behaviour, cognitive patterns and pragmatic skills.

The Autistic Behaviour Checklist (ABC), (Krug et al, 1980), is a standardised rating scale of autistic behaviour and was originally developed for identifying autistic behaviour in children with severe autistic disabilities. The checklist was designed to be completed by a parent or teacher familiar with the child and then forwarded to a trained professional for interpretation. It has questions in the categories of sensory, relating, body and object use, language, social and self-help. It does not take account of subtle impairments typical of individuals with autism in the near normal or normal range of intelligence (Rutter & Schopler, 1987).

The Checklist for Autistic Spectrum Disorders is the only checklist or rating scale designed to evaluate children with both low functioning autism (LFA) and high functioning autism (HFA) or Asperger's disorder. It is completed by a clinician based on a 15-20 minute structure interview with the parent. It also takes into consideration information from the child's teacher or care provider, observations from the child, previous evaluations and any other available records. During the interview parents will be asked if any of the 30 symptoms on the checklist were ever present (past or present) (Dickerson Mayes et al, 2009). This follows the structure of the Sensory Profile Checklist compiled by Bogdashina (2001) which also considers past and present experiences and which has been modified for the parent questionnaire as part of the investigation.

The Childhood Autism Rating Scale (CARS2) (Schopler et al., 2010) is used to evaluate young children who may have an autistic spectrum disorder. Evaluators using CARS rate the child on a scale of 1-4 in 15 different areas relating to autism behaviours and including a

category of 'Taste, Smell, and Touch Response and Use. Whereas the first edition of this publication catered more towards low functioning children, the second editions expands the test's clinical value making it more responsive to those on the high functioning end of the spectrum. The manual also includes a form for parents and caregivers which is unscored but can serve as a framework for follow up interviews and gives the clinician more information on which to base their ratings.

The original diagnostic criteria for autism did not include 'odd' responses to sensory stimuli, for example high pain tolerance, over-sensitivity to sound or touch and excessive reaction to light or odours. However, over a period of time sensory sensitivities and peculiarities have been incorporated as diagnostic feature of the syndrome (Wing, 1969; DeMyer, 1976; Ornitz 1989). The inclusion of sensory behaviours as part of the diagnostic criteria is recognition of the importance that this area plays in the lives of those with autism.

The Diagnostic and Statistical Manual (DSM) produced by the American Psychiatric Association (APA) recently revised its diagnostic manual and the 5th edition was published on 18 May 2013 (APA, 2013). This manual is one of the two main international sets of diagnostic criteria for autism and, whilst it is not the main set used for the UK, it is influential. The manual takes into account the most up-to-date research and now incorporates sensory behaviours which have been included in the 'restricted, repetitive patterns of behaviours' descriptors.

A number of different questionnaires have been devised to evaluate sensory perception, for example Dunn's Sensory Profile questionnaire where parents reported that their autistic children overreacted to cold, heat, pain, tickle and itch and avoided being touched by other people (Dunn 2001; Kientz & Dunn, 1997).

The Sensory Profile (Dunn, 1999) is a questionnaire to be completed by care-givers aimed at children aged 3-10 years and used to measure children's responsiveness to sensory events in everyday life. There are two versions of this profile, one for diagnostic purposes with 125 items and one for research purposes with 38 items looking at behavioural and emotional responses to associated with sensory processing. From the responses given, professionals can calculate scores from a factor structure which reflects children's responsiveness to sensory input.

The Sensory Sensitivity Questionnaire (Aron & Aron, 1997) is a self report checklist which includes questions regarding common reactions to sensory stimuli reported by individuals with autism including areas of sound, sensitivity to the environment and pain tolerance. The questionnaire refers to the extent to which individuals detect and respond to stimuli in the environment. The questionnaire was devised to examine and test the idea that individuals who perceive lower intensity stimuli also become more easily distressed in response to higher levels of stimulation.

The benefits and drawbacks of these diagnostic tools are summarised below:

Table 2: Comparison of Benefits and Drawbacks of Diagnostic Tools

Diagnostic Tool	Designed For	Benefits	Drawbacks
Gilliam's Asperger Disorder Scale (GADS)	Children with higher functioning autism.	Ability to distinguish Asperger Syndrome from Autistic Disorder. Used in conjunction with other tools as part of the assessment process.	The characteristics rated are those included in the Triad of Impairment but do not take account of sensory behaviours.
Autistic Behaviour Checklist (ABC)	Children with severe autistic disabilities.	Information is sought from multiple sources for analysis. Takes into consideration sensory behaviours.	Professional interpretations may vary. Only used for those with severe autistic abilities.
Checklist for Autistic Spectrum Disorders	Children with both low and high functioning autism.	Evaluation of low and high levels of function. Considers information from multiple sources. Uses a structured interview method.	Does not include sensory behaviours.
Childhood Autism Rating	Young children who may have an	Assesses all ages and levels of function.	Does not use information from parents and/or carers

Scale (CARS2)	autistic spectrum disorder.	Incorporates a sensory category.	as part of the diagnostic process.
Diagnostic and Statistical Manual (DSM)	All ages and abilities.	Updated to incorporate sensory behaviours.	The manual relates to all medical conditions, not only autism. It is not the main diagnostic tool in the UK therefore sensory behaviours are not yet included in the UK assessment process.
Sensory Profile Questionnaire 1997	Parents.	Specifically relates to sensory input and behaviours.	Does not included personal sensory experiences and the information obtained is not corroborated from the child being assessed.
Sensory Profile Questionnaire 1999	Carers for children aged 3 to 10.	Specifically relates to sensory input and behaviours.	Does not included personal sensory experiences and the information obtained is not corroborated from the child being assessed.
Sensory Sensitivity Questionnaire	Autistic individuals of any age and level of function.	Relates to reactions to sensory stimuli based on individual experience.	Tolerance levels to sensory stimuli may vary from person to person and so the outcome could be based on subjective data.

It should be noted that diagnostic tools other than the ones discussed are obtainable but the main ones used in the assessment process are examined above. As can be seen, their focus is aimed at gathering information from different aspects of autistic impairments such as diagnosing the autistic condition, level of function or effect of sensory stimuli. These tools can be used in combination with each other by clinical professionals and enables the investigation to consider information obtained using different methods which is discussed Chapter 3.

As can be seen in chapter 4, I have followed a similar pattern in gathering data from parents, teachers and the autistic children. For the purposes of gathering data to answer the research question, input from professional clinicians or psychologists was not necessary as the intervention will be formed from the direct information received from the people who have formed a more personal relationship. Therefore, the people providing the data will have either experienced or observed and identified the sensory difficulties displayed.

2.5 Psychological Tolerance

Ethical consideration needed to be given to the methods being used to obtain data as part of the research and any risk that may be caused to the participants. The risk for the students who were assisting in the development of the game is that they would be subject to a minor level of psychological tolerance.

This is because the nature and focus of the study means that participants must inevitably be subjected to some sensory stimuli that could cause them a degree of distress. In order for the intervention to progress, this is a necessary part of the cyclic process and consent would have to be given by the head teachers of the schools for the involvement of the students to go ahead. Any potential for upset should be revealed through the information disclosed from the structured interviews and questionnaires thereby reducing the likelihood of unexpected problems and it is not the intention of the study to cause anyone any distress. However, in order to be able to answer the research question, the investigation necessitates that they have to be exposed to some stimulus throughout the creation of the development.

However, my research showed that there have been a number of research studies that have been carried out concerning children with autism that involved a level of psychological tolerance.

In 2009, Tania Vidosevic carried out research into teaching tolerance of skin care products to children with autism. She carried out a graduated exposure to teach acceptance of the application of the sun care products that they previously avoided.

Rapp et al. (2005) carried out a study on a 14 year old girl with Autism who had an aversion to swimming pools exhibited by behaviours including screaming, face hitting and choking. Again, graduated exposure and reinforcement was carried out by gradually increasing the depth.

Ricciardi et al. (2006) used in-vivo exposure, which is the direct confrontation of feared objects, activities or situations by a person, on an 8 year old boy with autism who displayed behaviours including aggression, screaming and trying to run away from people who were blocking him from escaping animatronic toys. In this case treatment was implemented in which reinforcement was made contingent on remaining at decreasing distances to the toys.

Love et al. (1990) conducted a study which successfully treated avoidance behaviours of two children with autism aged 4 and 6. Again, graduated exposure was carried out with the participation of the children's parents whereas the research into how using psychological tolerance as a method of gathering data would potentially affect any of the children participating led to a belief that previous studies had been successful with no damaging effects to any of the children involved.

Therefore, the examples described above show that exposure to psychological tolerance can be applied successfully and that a precedent exists that could be utilised as part of my investigation. However, it was paramount that the protection of the students was maintained through the process and that they did not suffer any detrimental effects from being questioned and observed through the game development process on their particular area of sensory dysfunction.

2.6 Game Based Learning

The focus of the investigation is to use game based learning as a route to explore the effects of sensory stimuli on autistic children and apply strategies to the game that could be used to modify their reaction to the sensory input. There are a number of studies and research that suggest that have examined the effects of game based instructional programmes on learning. Whitehall and McDonald (1993) and Ricci et al (1996), found that instruction incorporating game features led to improved learning, including enhanced motivation leading to greater

attention to training and greater retention. Also, the integration of a reward structure led to increased risk taking resulting in greater persistence on the task and improved performance.

A report commissioned by Becta (Williamson, 2009) focussed on the use of games as a resource to support educational aims, objectives and planned outcomes for teachers who see games as an important medium in contemporary culture and young people's experiences. The report provides an assessment of game-based learning in schools and says that games have the capacity to influence players' thoughts and actions and can be seen as an ideal environment for developing and practising skills. The report goes on to say that the majority of teachers believe that computer games can help support children's cognitive development, ICT development and higher order thinking skills such as logical thinking, planning and strategising.

Nicola Whitton, of Manchester Metropolitan University, says that game based learning provides an environment that is safe from external consequences (Whitton, 2012). She says that players have the ability to control their own actions and flexibility to make their own decisions, therefore, this is safe simulation with a safe place to fail.

My proposed intervention, whilst involving some level of psychological tolerance as discussed earlier, is also a safe environment where the user can make choices that they perhaps would not choose to do in their real life, without consequences, and it is hoped that the user can then take this forward to their real lives and use the information provided through the scenarios and the rewards structure in a positive manner and this is discussed further in chapter 4.

Whitton also discussed that games do not have to have a high technical specification and graphics quality to be effective. As my intervention shows, the content and the desired outcome is more important than the specification and my choice of games engine to achieve this is discussed later.

A study was carried out to explore the effects of applying game based learning to webcam motion sensor games for autistic students' sensory integration training (Li et al, 2012). They found that the participants had a positive attitude towards the training and that motion sensor games can enhance autistic students' learning interest.

It has been said that computer game based learning can be instructional and enlightening (Garris et al, 2002). Their study also noted that there has been a major shift in the field of learning from a traditional model of instruction to a more active learner role. The aim of their research was to examine the unique aspects of games that can enhance learning including how instructional games affect learning outcomes, as can be seen in the model below:

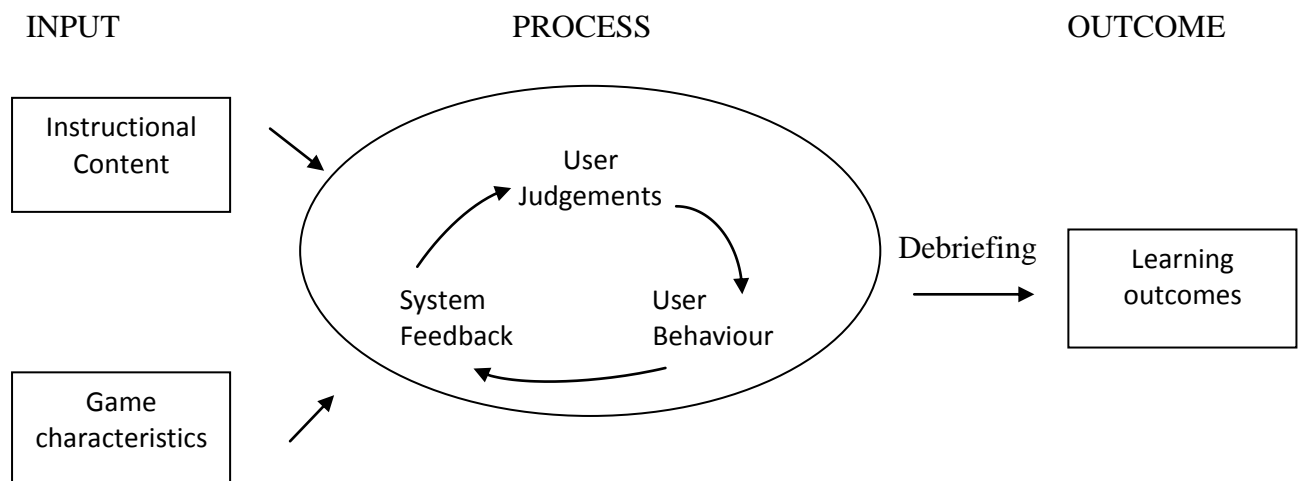


Figure 2: Input-Process-Outcome Game Model (Garris et al, 2002)

Crookall and Saunders (1989) viewed a simulation as a representation of some real world system that can also take on some reality for the participants or users and where the cost of error for the participants is low, protecting them from the more severe consequence of mistakes. This is what I am aiming to achieve within my investigation and this is discussed further in Chapter 4. Garris et al (2002) argues that simulations can involve game features and those that include, amongst others, sensory stimuli become more game like.

2.7 Link between Games Based Learning and Autism

In respect of game based learning through computer games specifically geared towards autistic people research has been carried out concerning a need to take account of autistic characteristics and the incorporation of some flexibility within the game (Sehaba et al., 2005). This flexibility should take account of how the person responds to the stimuli presented and the action subsequently presented which generates a cause and effect scenario. Flexibility is an essential ingredient because of the range of reactions likely to be displayed from the different scenarios of the intervention and I have tried to integrate this to cater for the diverse

types of reactions discovered through my discussions and observations as can be seen later in chapter 4.

Richard Mills, head of research at Research Autism and the National Autistic Society says in respect of touch screen computers that “people with autism have a different kind of intelligence. Their visual memory is strong, so PCs are highly motivating” (Roxby, 2012).

A study by psychologists at the University of Alabama, Birmingham (UAB), says that an interactive computer software called FaceSay™ has been shown to improve the ability of children with autistic spectrum disorders to recognise facial expressions and emotions (UAB, 2007).

Looking at the available information concerning studies and research carried out into game based learning, it seems that it has many benefits for people generally and can have very specific positive uses when utilised by people on the autistic spectrum.

2.8 Computer Games in a School Environment

There are a number of games that have been produced that are set within a schools environment including Pretty in Pink and Dangerous High School Girls in Trouble (DHSGIT), Bully and Surviving High School. The common element of all these games is that they seek to identify with social problems that are experienced by a lot of children while they are at school.

Pretty in Pink and DHSCIT are more about relationships and using your strengths for the greater good whilst including an element of puzzles, mystery and reward structures. Surviving High School is slightly different in that it is an interactive game that allows the player to make decisions throughout and the choices that are made set the course of how the story goes and, therefore, is likely to be different for every player.

Bully has been described as being appropriate for teenagers but with the real target being adults especially parents, educators and policymakers who have the power, authority and life experience to help counsel teens in the real world (Hamilton, 2011). Bully, as the title suggests, taps into something real and relatable – the angst of growing up but again, the

message is more about people and relationships than it is about education. Other games such as Kenka Bancho, Persona and Grim Grimoire, whilst set in a school environment and with the characters being of school age, are all of a mystery and sci-fi nature that does not relate to school education or relationships in any way.

With regard to computer games that have an educational side to them the Games, Learning and Assessment Lab (GLASSLab) is supported by the Entertainment Software Association (ESA), Institute of Play, the MacArthur Foundation and the Bill and Melinda Gates Foundation to explore games' potential as learning and assessment tools. They develop their own games and examine popular game titles to identify elements that increase student comprehension and enhance classroom performance. An example of a game they have developed is called Vanished and requires players to discover what caused a catastrophe using current scientific data (ESA, n.d.).

It would appear that overall the development of games within a school setting is directed at a particular age group and the situations used as ones that the users will be able to identify with through their own personal lives or in people that they know. Whilst GLASSLab are developing specific educational games and promoting the use of games as an educational tool, they are not necessarily contained within a school setting.

Being able to identify with the environment is an important factor to take into consideration when deciding on the setting of the intervention. Therefore, by creating scenarios that are set in surroundings that are familiar to the user and using sensory situations that have been identified as being problem areas within that environment, the intervention could aid awareness of individual sensory difficulties as described above.

2.9 Reward Systems

Reward systems have become an intrinsic part of computer gaming. Björk & Holopainen (2005) say that games do not work without incentives for the players to perform actions and to strive towards their goals.

Adams (2010) says that a risk must always be accompanied by a reward. He also believes that this is a fundamental rule for designing computer games. The psychological issue of risk and reward in game design is explored by Williams et al (2011). They concur with Adams that the value of reward has to be offset by some level of risk. The reward is an instrument for engagement and by using a game-based tool as a vehicle for the intervention, the inclusion of a reward is more likely to hold the attention of the participants.

With regard to my intervention, the reward that is given for completion of a scenario is offset by having to navigate their way through an area of sensory difficulty. Therefore, only a minor 'discomfort' is experienced which is mitigated by the 'reward'.

For the proposed intervention, I intend to use a reward system with a difference to the traditional reward structures of power-ups and trophies and use items that are designed to impart a sense of comfort and wellbeing for the user and that are relevant to the purpose of the investigation. Halford & Halford (2001) describe this as a "reward of glory" which they define as "all the things you're going to give to the player that have absolutely no impact on the game play itself but will be things they end up taking away from the experience".

In considering the use of reward systems within gaming, research shows that it has very positive benefits. Wang and Sun (2011) say that reward systems can be used to motivate or change behaviours in the physical world and this is something that my intervention is seeking to achieve.

Sutton-Smith (1997) analysed play according to value systems which includes play as a way to progress where children adapt and develop through play. This is a key aspect of my proposed intervention where users can learn from the experience and use the reward system as a way of minimising or controlling the effects of negative sensory experiences outside the structure of the intervention and take it into their real lives.

2.10 Reality within 3D Games

The characterisation of the avatars that are used within computer games is important in terms of how the user responds to its appearance and how this subsequently affects the realism of the game. An exploration of this area of game play follows below and examines the impact that virtual characters can have and how this applies to the development of the intervention.

2.10.1 Uncanny Valley

The theory of uncanny valley by Dr Masahiro Mori holds that robots, whose appearance is very close to being human, will invoke a very negative human reaction in terms of how comfortable people are with its appearance (Schneider et al, (2007). Using Mori's robotic design theory they investigated the relationship between human-like appearance and attraction using virtual characters from video games with the outcome that the characters can be seen as human but not fully human and this, therefore, makes them less attractive and correlates with Mori's theory.

A project undertaken by the University of California, San Diego (UCSD), explored uncanny valley and the uneasy feeling that people can get when they see a robot or animated character that too closely resembles a human (Robbins, 2011). The project found that the brain becomes more active when people watch an android that resembles a human but does not move like one.

In terms of developing the intervention this is an important aspect because, with the added component of the users being on the autistic spectrum, it is imperative that the users are comfortable with the characterization and do not feel any negative emotions that would impact on the purpose of the intervention. In consideration of this point there are arguments to be given as to whether the intervention should be undertaken in the first or third person in order to gain the optimum results possible.

2.10.2 First Person or Third Person

Third person avatars are more commonly used in action and action adventure games. This is because in these types of games extensive orientation is usually required and the character is used to make the user feel more included in the adventure. However, consideration has to be given to whether someone on the autistic spectrum would be more comfortable in seeing a character, being able to identify with it and, therefore, getting a more positive outcome from the intervention.

Playing the intervention in the third person would mean that the user would be able to see their character at all times. The issues involved with this are that by having an avatar that the user has to have a positive connection with it. The difficulty with the development of this aspect is that, even if a choice of avatars were created, the connection may not be realised and this is support by the uncanny valley theory discussed above.

A way in which any potential for upset could be minimised is through making the game playable in the first person. In this way the player would not play as a person and, therefore, characteristics could not be associated or identified as any particular person and the player would play the game as someone who was invisible from view. They would then follow directions to solve the sensory problem that they experienced personally, be able to see a solution that they could adopt when the situation arose but be able to do this in an abstract way and without identifying the character with them-self.

Taking all of the above into consideration, I believe that using the first person will reduce the possibility of any characterisation issues associated with uncanny valley that the users may find off-putting.

2.11 Existing Software Solutions, Coping Mechanisms or Interventions

I have been unable to discover any software based interventions that are designed to aid autistic people with sensory difficulties. There are a plethora of toys available for autistic children with regard to sensory comfort and learning. These toys assist with motor skills, promote relaxation and have educational input such as helping to identify facial expressions

and their meanings. Examples of this are the KISMET and ROBOTA dolls which are robotic systems for dealing with social protocols and interaction (ROBOTA, 2008).

Numerous computer games are available to autistic people learn about people and emotions, aid speech development and there are various websites detailing autism specific software (MouseTrial, n.d.).

Looking at solutions that are currently available, there is nothing that identifies with my proposed game based intervention as an educational tool for those with sensory processing difficulties. This, therefore, suggests that if the results of the development were positive, that it could be beneficial to a large number of people. The findings of my investigation are shown in Chapter 5.

2.12 Summary

In this chapter I have discussed the background to autism, the levels of impairment and how levels of function within the Autistic Spectrum are decided. I have examined the different tools that are used in the diagnosis of autism and the how these complement each other within the assessment process.

I have explored sensory dysfunction, the effect this has on autistic people and the research that has been carried out to discover the extent of the problem. Following this I have reviewed interventions and solutions, discussed their success and limitations and how an intervention could potentially holds the components to have a positive impact on those with autism. In addition, I have examined computer games, the influence that they have as an educational tool and the elements that make a game engaging.

The research from the elements contained within this chapter goes toward forming the basis for the development of the intervention. These components consist of the most suitable environment and specification for the intervention, utilisation of the most appropriate parts of the diagnostic process suited to the investigation and methods to extract data from the participants relating to exposure to sensory stimuli and this is discussed in more detail in Chapter 3.

Chapter 3

Research Design and Methodology

3.0 Introduction

This chapter returns to the background of the research question outlined in Chapter 1, discusses the choice of methodology implemented, explores the research design prompted by the research question, and examines the data collection and analysis methods used.

As discussed earlier in the previous chapter, whilst a growing body of research is being undertaken into sensory difficulties experienced by people affected by an autistic spectrum condition (e.g. Blake, 2010), much of this research has sought to examine the problem, but has not explored solutions and interventions. Further, while game based learning has emerged as an area offering pedagogic benefits (e.g. Williamson, 2009, Whitton, 2012), there is no indication that work in that field has begun to explore its potential for learners affected by an autistic spectrum disorder such as Asperger's Syndrome.

Against a background of the sensory difficulties that I experienced personally, the scale of the problem as discussed in Chapter 1, and the apparent absence of solutions or interventions suggested by the literature review in Chapter 2, a gap in the literature was identified that offered an opportunity to introduce a different form of strategy aimed at autistic children who display sensory behaviours through the development of a game-based learning intervention.

The development of the intervention would require the design and production of a computer-based game, and its evaluation as a game-based learning tool within an educational setting. This combination of game design and pedagogical evaluation work therefore required the adoption of a research methodology that would allow both the incorporation of software engineering principles, in order to produce the game, and the use of qualitative methods from the field of educational research, in order to assess the value or otherwise of the intervention. Finally, as the investigation aimed to explore the potential for a generic game based intervention both to assist those on the autistic spectrum to overcome sensory difficulties, and to act as a vehicle to promote self awareness of those sensory difficulties, the choice of

methodology also needed to acknowledge those additional challenges around communication associated with persons on the autistic spectrum.

3.1 Research Question and Aims

In addition to the identification of a generic intervention as discussed in chapters 1 and 2, the investigation aimed to:

- a. Investigate whether a game-based intervention could be of benefit to people on the autistic spectrum with regard to sensory dysfunction.
- b. Examine whether and the extent to which such an intervention might impact on the autistic persons' self awareness of their sensory problems.
- c. Explore use of the intervention as a tool to develop coping mechanisms that could minimise the effects of particular sensory difficulties.

3.2 Discussion of Research Methodologies

The cross-disciplinary investigation described above has more than one dimension to it as, and as such there was no obvious single choice of methodology. Against this background, it seemed that in order to produce the optimum outcomes from the research it was necessary to implement a methodological approach which allowed for the combination of features traditionally associated with divergent research methodologies.

3.2.1 Factors Influencing the Choice of Methodology

The decision of which research methodology to use required consideration of a number of points:

- i) The autistic participants in the study may yield data that could be used to build a series of case studies.
- ii) The intervention required the design of a computer based product.

- iii) Iterative development work would be undertaken which would be informed by feedback from the autistic population taking part in the investigation.
- iv) The study would be examining the success or otherwise that the intervention has in terms of addressing the research question through the application of a variety of data collection methods.
- v) The participants of the research group with regard to the development of the intervention were of varying levels of function on the autistic spectrum.
- vi) The location of the participants and the place where the study would be carried out.

3.2.2 Consideration of Case-Study Methodology

In considering using case study methodology (Stake, 1995), a variety of data collection methods would be used such as interviews, documentation and artefacts, where the data would be triangulated to authenticate and corroborate the findings in order to contribute to the validity of the research (Yin, 2003).

People with autism frequently experience memory problems (Williams et al, 2006), and consequently can require prompting in order to respond to questions. Whilst data can be corroborated through other sources such as parents and teachers, either as participants or as ‘expert witnesses’ (Yin, 2003), it is possible that questions can appear to be leading a particular response or direction.

Regarding sensory difficulties and the development of a generic game-based learning intervention, it was necessary to look for common themes to inform the development of the intervention, as opposed to single and unusual cases to investigate in depth, and adopting this approach would take me away from the path of developing a generic game-based intervention.

Citing Yin (2003), Baxter and Jack (2008) highlight that the researcher “cannot manipulate the behaviour of those involved in the study” (p. 545), suggesting that case study

methodology is based in a tradition of reporting on the impact of an intervention developed by a third party, as opposed to the researcher being directly involved in the implementation, evaluation and refinement of an intervention that is designed to effect some change in the behaviour of the participants of a study.

Case study was therefore rejected as the choice of methodology for the three reasons above.

3.2.3 Consideration of Action Research Methodology

Action research was a term that was first imparted by social scientist Kurt Lewin (Lewin, 1946). His description of action research was portrayed in his paper as a social action that uses “a spiral of steps, each of which is composed of a circle of planning, action and fact-finding about the result of the action” (p.201). The method concerns people working together to improve the work process and, as suggested by Lewin, it has cycles of development and improvement.

Consideration of action research arose because the research to be undertaken required the participation of a range of people including those who support the students on the autistic spectrum who are the focus of the research. The abilities of those participating on the autistic spectrum are likely to vary greatly between low and high functioning as discussed in Chapter 1 and, therefore, a number of people will also be involved in the initial research so that the information received from the autistic participants can be verified as reliable.

Gerald Susman (1983) distinguished five phases to be conducted within the research cycle (Figure 3) beginning with the identification of a problem and collection of data to allow a deeper interpretation. This is followed by the assumption of possible remedies, resulting in a plan which is subsequently implemented, after which the results are collected and analysed for success or otherwise of the intervention. Thereafter the problem is reanalysed and the cycle recommences.

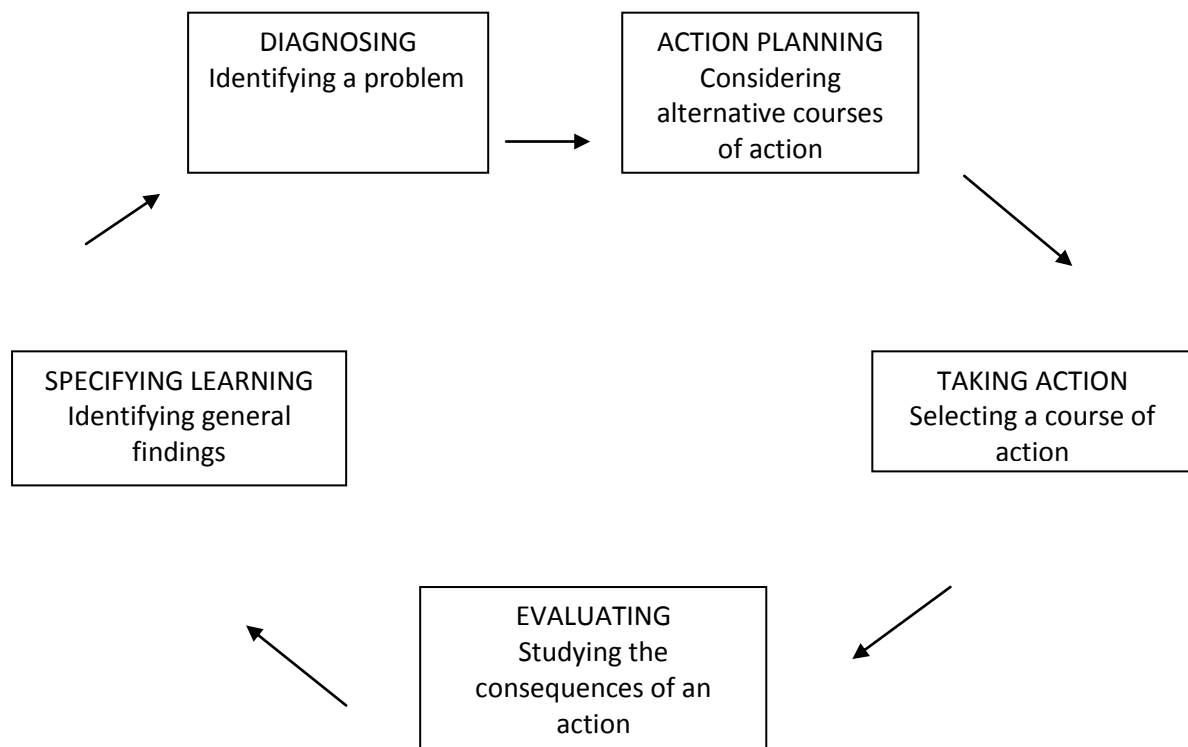


Fig 3: Phases of the Research Cycle (Susman, 1983)

While the iterative nature of action research initially made it appealing as a methodology, this approach is more frequently associated with the evaluation of pedagogic interventions, than with the longer-term development, evaluation and refinement of technological interventions such as computer game scenarios.

Additionally, while the early forms of action research were characterised by the iterative, cyclic nature of the approach, more recently there has been an emphasis on the role of critical theory in action research (e.g. Kemmis, 2008), however the focus on development of technological artefacts in this study meant that it would not be possible to enter into discussion of critical theory within the scope of the investigation.

For these reasons, action research was discounted as the methodological approach.

3.2.4 Consideration of Design Based Research Methodology

Originated by Brown (1992) and Collins (1992), design-based research rejects the clinical approach to educational research by insisting on undertaking evaluative investigations within authentic educational settings. The Design Based Research Collective (DBRC, 2003), a group of faculty and researchers founded to examine, improve, and practice design-based research methods in education, argue that design is central in efforts to, foster learning, create usable knowledge and advance theories of learning and teaching in complex settings.

The development of my proposed intervention was intended to be a collaborative process in which feedback from participants located within the usual educational setting would inform the refinement of the intervention. The investigation, therefore, appeared to be consistent with the five components that the Collective suggest are integral to design-based research:

- a. Designing learning environments and developing theories.
- b. Maintaining a continuous cycle of design, enactment, analysis and redesign (Cobb, 2001: Collins, 1992) to enable research and development to take place.
- c. Ensuring that the designs being researched lead to theories that can be shared with practitioners and other educational designers (cf Brophy, 2002).
- d. Being able to account for how the design functions in a genuine environment and be able to document success, failure and interactions that enhance understanding of the learning issues involved.
- e. The ongoing development of the design process relies on documentable methods and the ability to connect processes of enactment to outcomes of interest (DBRC, 2003).

The outcomes of this investigation rely upon the development of an intervention, which, as discussed in Chapter 1 and Chapter 2, can be used to help the participants identify coping strategies in response to sensory difficulties. This educational tool it sought to improve the negative and dysfunctional aspects of the person's individual sensory difficulties by presenting ideas for everyday use.

The characteristics of the design based research methodology adopted by Wang and Hannafin (2005) are a match both for the research to be undertaken and the intervention it is hoped will be achieved. These characteristics are:

- Pragmatic
- Grounded
- Interactive
- Iterative and flexible
- Integrative and contextual

These characteristics fit the research undertaken in the following ways:

- a. Pragmatic where the goal was to design an intervention based on solving a real-world problem in a way that is different to existing interventions. This is because I could not find any research that produced an intervention design to be used by users with different needs and problems whereas the proposed product will seek to extend theories and coping mechanisms used by both professionals and individuals.
- b. Grounded in terms of theory of real-world context but took into account the complexities, dynamics and limitations of authentic practice which led to effective application of the intervention.

The limitations and complexities were apparent in terms of the abilities of those on the autistic spectrum, the sensory problems they displayed and the ability of the intervention to resolve the issue based on the idea that not all the core senses are tangible.

As discussed further on in this chapter, the diverse capabilities of the population used within the research and their abilities to describe their difficulties meant that the data received may not have been wholly reliable and therefore collaboration with other sources such as parents, carers and teaching staff was essential.

- c. Interaction played a large part in the research into the sensory difficulties displayed, how and where they manifest themselves, the coping mechanisms used and the development of the product. Collaboration took place between those on the spectrum, their parents, carers or guardians, teachers, assistants and the SENCO of the participating schools in effecting corroboration of the data.

The very nature of the proposed intervention meant that the product would have to be flexible because it would need to cater for resolving the same core problem but in different ways depending upon the effect it had on the individual and this needed to be taken into account.

- d. The design process was iterative based on the feedback generated by those on the autistic spectrum and throughout each cycle the data was analysed, implemented and put forward for further evaluation in order that the design of the intervention became an effective learning tool that could be used in practice (DBRC, 2003).
- e. In order to discern this information, a mixture of quantitative and qualitative data was used and this will be discussed further on in this chapter.

Further, both the background research and the design process are connected to the research question and the setting where the research and results are generated, making design-based research the appropriate methodological approach for the research.

3.3 Research Design and Methods

In undertaking this study, the paradigm structure that I used was that of having sets of data for the participants and parents or carers which required the completion of questionnaires designed to complement and corroborate the information given and based on the research question of sensory difficulties to which the game based intervention would be developed.

People on the autistic spectrum are known for their monosyllabic responses and consequently the data received was likely to be basic and require prompting to expand on answers. There is also the common problem of the understanding or interpretation of a question which may

need to be rephrased in a number of different ways in order to ascertain an appropriate response which is something that I understand from my own autistic difficulties.

Information would then be sought from teaching staff to collect their observations and knowledge to support the data given through the questionnaires so that the design of the intervention is carried out on a credible and informed basis.

In addition to the research questionnaires, and once the core data had been collected on which to base the development of the intervention, observation of the behaviours of the participants would occur during the ongoing cycles of the development process alongside informal questioning.

After data has been gathered and analysed on the conclusion of each cycle, the information was analysed and the intervention updated to incorporate the new findings.

3.4 Data Collection and Analysis

Data gathered from the research was used to guide the development of a game-based intervention, with the aim of providing coping ideas and mechanisms that might mitigate the impact of sensory dysfunction on the everyday lives of those on the autistic spectrum.

As discussed in Chapters 1 and 2, difficulties experienced relating to the senses by those on the spectrum have been known of for a long time but have not been an element of the diagnostic criteria, and personal experiences such as those described earlier can be quite debilitating. By focusing the research on school children, it was hoped that the design tool could be used as an early intervention and, therefore, have a greater positive outcome than it might for someone older who has evolved their own coping mechanisms.

A range of both qualitative and quantitative methods were used to enable the collection of data, which subsequently underwent thematic analysis, and was used in the iterative, cyclic process underpinning the development of the game-based intervention.

Data collection methods therefore included:

- Individual informal discussion with students
- Students questionnaires
- Parental/Guardian/Carer questionnaires
- Discussion with SENCO, teachers and teaching assistants
- Physical products
- Game design and updates from feedback

3.5 Factors Influencing the Research Design

3.5.1 Access to the Study Population

Working with people on the autistic spectrum with differing levels of function meant that it was critical to make an informed choice on what age group to collaborate with in the development of the intervention. The elements of this choice related to communication abilities in terms of being able to understand the requirements and respond with data and feedback that could be deemed informed and credible. Also I wanted to work with an age group that was the most likely to be open and able to understand and use the intervention as a tool for learning about themselves and adapting the suggested coping mechanisms to their daily lives.

From a technology perspective I also needed them to have at least basic computer skills to be able to offer practical feedback from both a useable and autistic point of view to enable the implementation of a reviewed course of action as part of the ongoing cyclic approach.

The decision was made to work with students covering the ages of primary and secondary school because these are impressionable ages and any successful solution is more likely to have an impact at an earlier age than with people that are older and with the potential to have developed their own coping mechanisms.

Geographic locations also had to be taken into consideration and the fact that there was a requirement to be able to access the schools on a regular basis to obtain the relevant data. Therefore, distance to travel was also part of the criterion for the choice of schools to request

participation from. In addition, my options were limited due to the sensitivity of the subject area.

Initially, it had been the intention to have a very distinct difference between the school types chosen and the level of function of their students. Originally, my plan was to work with two mainstream schools and two schools working specifically with special needs.

I believed that by using these individual components it would be possible to garner very different results which would enable comparisons and analysis between the function levels to achieve a definitive conclusion to the question of whether a game based tool could be used successfully with those on the autistic spectrum with a sensory dysfunction.

This situation had to be reviewed when a mainstream school responded by saying that they did not believe that they had any students that fit the criteria and would, therefore, be unable to participate (Appendix 1). This is an interesting perspective and it is possible that there are conclusions to be drawn from this statement alone but this would mean diversifying away from the point of the investigation.

There was, however, a very positive response from schools specialising with children with special needs. The decision then became about contrasts in abilities and levels of function to allow a comparison to be made of the data obtained between schools that which, essentially, had the same specialist function.

On speaking to the Heads of the schools it was ascertained that the level of function of the students was the key to being able to obtain comparable data. On this basis two schools were chosen – one which had students with a higher functioning level and the other which had students who were lower functioning.

Also, both schools had a significant percentage of the school (over half) who were on the Autistic Spectrum and therefore, the number of students that were available to work with was high enough for preliminary data to be gained and thereafter to filter the information to gather a final group of students who it was believed could work co-operatively to be able to create a game that met their needs.

3.5.2 Ethics, Confidentiality and Participation Consent

For data gathering and analysis purposes it was important to be able to identify the school, the students and input from other sources such as parents, guardians or carers, teachers and teaching assistants or anyone else with any input.

The data needed to be able to be matched with individuals in a way that enabled discussion but without divulging their identity and so a simple structure of pseudonymization was used to protect the identity of the individuals, the schools and other parties involved.

The schools would be allocated a letter and this letter would be used in every case as the first item. The students would be allocated a number. The parents, guardians, carers, teachers, teaching assistants or others would be allocated a letter. Any information received from them would appertain to a particular student; therefore, the number allocated to that student would also be used.

The letter allocated to the school would be relevant to that school. The letters allocated to everyone else would be as follows:

Parent, Guardian Carer	P
Teacher, SENCO	T
Teaching Assistant	A
Student	O

In addition to this I intend to indicate whether the participating child is male or female represented by an M or F.

To give an example of how this would work, if information was received from a teacher at the higher functioning school they would be identified in the research as ZT8 where Z represents the school, T the teacher and 8 the student under discussion or for one of the students XO7M where X is the school, O is the student, 7 the child participating and M acknowledges the gender.

In this way, anyone reading the research will be aware of who provided the information but the identities are protected.

Initially, it was important to safeguard the students involved with the research. In order to satisfy this requirement, firstly, the schools requested the undertaking of a CRB check. Once the clear results of the check were received the schools then sought the approval of parents, guardians and carers for their child or charge to participate in the research.

In discussion with the schools about maximising the amount of data that could be achieved, the schools agreed to forward a letter asking parents, guardians and carers to complete a questionnaire concerning sensory difficulties experienced by their child or charge, how these difficulties manifested themselves and any coping mechanisms that they put in place. This letter was accompanied by an explanation of who I was and the research that was being undertaken (Appendix 2).

3.5.3 Discussion and Questionnaires

It was deduced that information would have to be sought from sources other than the students themselves because of a number of issues that were needed to take into account as described below.

People with an AS diagnosis do not generally feel comfortable with strangers and as a result of this it might be difficult to get them to reveal all the data that was required within the timeframe that was available because there was not the time to develop a relationship with them to enable them to feel comfortable enough to speak freely. Whereas, by gathering information from others that they have developed a relationship with, and who should be aware of a significant proportion of their difficulties, it should be able to compile a reliable amount of data between the sources.

The age of the younger students was likely to mean that they would not necessarily be able to express themselves in anything other than the most basic way and the type of questions that can be asked, consequently, will have to remain very simple. However, as can be seen in Chapter 5, age is not a barrier to a successful outcome.

Whilst a problem was not foreseen with the students who were at a higher functioning level, the ones who were lower functioning would be likely to have problems with communication, understanding the questions and generally being able to participate fully in the research beyond giving the most simplistic of responses.

I have devised two sets of questionnaires. The first one is a simplistic one for the autistic participants which will be worked through with each person individually, and where questions can be reworded and more detail ascertained as required (Appendix 3). The rewording issue is important as I know from personal experience that the same question can be asked 10 different ways before an appropriate response is divulged.

The second questionnaire is for the parents, carers or guardians and this is more complex (Appendix 4). It has been devised based on a questionnaire that was specifically written for parents to complete in diagnosing sensory difficulties (Bogdashina, 2001). The responses to this will corroborate the answers from the children and add the detail that the children will not have the answers to.

Overall, by attaining data relating to one student from themselves, their parent, guardian or carer, teacher, teaching assistant and the SENCO it was believed that it would be possible to compile reliable data from which their exact difficulties could be ascertained and any current coping which could be worked with to put in place new solutions through the creation of a game using the data received.

3.5.4 The Role of Physical Artefacts in the Research

As discussed earlier, it is difficult to get instant responses from people generally when asked to provide specific information on likes and dislikes because they might know what something looks like or feels like but they may not know what it is called. This was likely to be much more evident in the group of people participating in the research for reasons of age, knowledge and autistic traits that may include speed of thought process and comprehension.

To this end, physical products may be introduced as prompts such as textile materials or foods. This is because of the potential problems with communication, knowing the names of products and being able to express them in an understanding manner. However, the difficulty

with the introduction of physical products is that it may be seen to be leading the response in a particular direction and the information given is unlikely to be credible without any supporting evidence from other parties.

Data will be collected from a number of sources as follows:

- The student with autism
- Parent of the student
- Teacher
- SENCO
- Teaching Assistant

The focus of the data received will be concerning the student. However, as all the students have varying degrees of autism, their communication skills will also differ and the lower functioning students will have the greatest difficulty in providing the necessary information for the research.

In recognition of this factor, having access to a greater catchment of information will enable the data to be verified and expanded upon to give sufficient detail to be analysed for the purposes of incorporation into the game.

This information will be provided by any or all of the sources listed above and the data received will be cross-referenced against the information provided by the student to give a greater description of the sensory dysfunction experienced by the student.

The information provided by these sources will only be used at the initial research stages both for the purpose of finding common data so that a greater group of students can participate in the development of the game in each sensory area and, therefore, providing more data for analysis and also for any unusual case that may be revealed.

The data received from the initial information will be looking for common difficulties covering each of the sensory areas so that each area will be included within the game and have its own separate development and analysis based on the information received.

Once the initial data has been analysed, the most common difficulties found in each sensory area will then be created into a game scenario. From this point onwards only the students will be involved in the development of the game. However, in the case of the lower functioning school, explanation and interpretation may be required from teaching staff and their assistants.

A cyclical process of analysis will then take place with the progress of the look and development of the game being determined by the students until the end product is achieved. The initial cycle will be regarding the environment of the game, followed by the creation of a scenario containing sensory stimuli and the cycles thereafter will address the fine tuning of these scenarios. At each stage an evaluation will take place with the students and their opinions for improvement will then be incorporated into the intervention.

3.6 Summary of Methodologies and Research Design Methods

This chapter has examined three different methodologies considered for the study, the reasons why they were chosen or rejected, and how the characteristics of each fit the purpose of the investigation being carried out. It also examines other options that may have been suitable and the reasons why these approaches were rejected. This chapter has also explored the factors that influenced the research design and how these components matched the reasons why the methodology used was selected.

In Chapter 4, the focus shifts to the development and evolution of the intervention through three iterative cycles.

Chapter 4

Description of Cycles and Findings

4.0 Introduction

The cycle process is an iterative procedure whereby data is procured, analysed and evaluated in order to make improvements to an item being developed and the rotation is continued until the end product is achieved. To meet the objectives of this study and in order to answer the research question, I have used a design-based research methodology as discussed in Chapter 3, which will involve phases of research, design, implementation and evaluation.

The purpose of the study, as indicated in Chapter 1, was to determine whether a successful intervention could be developed to aid the everyday lives of those with an autistic spectrum disorder (ASD) who experience sensory difficulties. Therefore, the design of the intervention necessitated a cyclic approach that I believe is best served by the Boehm model (Boehm, 1988) in terms of amalgamating software simulation with rotational development and the process revealed by Lewin as discussed in Chapter 3 (Lewin, 1946).

Chapter 2 describes the core characteristics of autism (Wing & Gould (1979)) and the escalating recognition of people with autism's sensitivities to sensory input which is validated by the inclusion of sensory experiences in the Diagnostic and Statistical Manual (DSM) in May 2013 (APA, 2013). The objective of the study is to collate sufficient data from the participating population to develop an intervention that can have a positive impact on helping autistic people manage the sensory difficulties they experience through the approaches described above.

My research into game based learning and the motivational aspects that PCs can have to those with autism, as described by Roxby (2012) in Chapter 2, indicate that a sensory intervention would be potentially advantageous to its users. Also, I have been unable to find any software based coping mechanisms that resemble the type of intervention that I propose as an educational based tool and which, therefore, could fulfil a need in sensory awareness from the perspective of those with autism with sensory difficulties and those who seek to make a difference in the lives of those with autism.

In order to be able to discern a group of participants who were likely to yield sufficient data to aid the development of the intervention, certain criteria needed to be fulfilled:

- a. Ability to communicate
- b. Identified sensory problems
- c. Computer skills

The ability to communicate is essential because the participants need to be able to relate their sensory experiences and evaluate the design of the intervention sufficiently to enable understanding of what is being conveyed. As described in Chapter 2, for people on the autistic spectrum communication skills vary significantly, but it is a component of the disability and therefore will be experienced by everyone participating in the research at some level.

However, the information obtained throughout the iterative process is integral to the progression of the intervention development. If they are unable to convey their thoughts or ideas the process will break down and be unproductive and consequently the intervention will be unsuccessful.

As the objective of the study is concerned with sensory difficulties, identification of students with a variety of problems in this area is a key component of the process. This is to maximise the ability to determine

- (i) The most common problems in different sensory areas so that a variety of scenarios can be developed for evaluation, and
- (ii) Whether they would be successful within the intervention.

With regard to computer skills, whilst advanced skills are not necessary, the participants need to have a basic awareness of how to navigate their way around a keyboard and understand the concept of game play. This is also a key element as the intent of the investigation is that the intervention is a tool that can be used by almost anyone on the autistic spectrum, even if

support is required to accomplish this but there will be some participants for whom the severity of their difficulties precludes them from participating.

Taking into account the principles of the accessibility guidelines, which are consistent with the guidelines of the Equality Act (HMSO, 2010), users of the intervention should not need to utilise all their senses to understand what is required. They should be able to operate the controls to achieve a purpose that is obvious and the design of the intervention should be robust enough to cater to the abilities of its disabled users (WCAG, 2008). Therefore, in acknowledging the diverse breadth of disabilities experienced by the users of the intervention and the levels of ability that may inhibit its use, the intervention will be progressed in a manner promoting inclusion and whereby the success or failure of the development does not require this to be carried out independently.

The varying levels of function of the participants that will be contributing to the study will mean that some participants will require support or direction but this will not distort the data findings and the tool is meant to be inclusive and not discriminatory. Therefore, following Yin's approach, I will also be collecting data from those in a support role in an expert witness capacity (Yin, 2003).

The identification of this population was narrowed down initially by the SENCO and qualified teaching staff from their existing knowledge of abilities and known sensory difficulties. Following on from this the population was then determined using a variety of qualitative and quantitative means as described in Chapter 3:

Table 3: Methods of Data Collection

Qualitative	Quantitative
Questionnaire	Questionnaire
Interviews	Interviews
Observation	Observation
	Record of discussions

As cited in Chapter 2 concerning the difficulties that those on the autistic spectrum display (Wing & Gould (1979)), it takes time to develop a relationship where they are comfortable. One of the advantages that I had in this regard is being on the spectrum myself and also displaying sensory difficulties, examples of which are described in Chapter 2. I was able to expound on this shared experience in order to create a relationship with the participants, formed from an understanding of the problems faced and in this way generate stronger lines of communication and information.

In order to cement a relationship with the study population, prior to commencing the development of the intervention, I spent time in the classrooms observing and interacting with them, as a teaching assistant would, so that they were familiar and comfortable with my presence. By doing this it was hoped that they would be more more likely to be forthcoming about their difficulties and be more communicative during the creative process by giving appropriate feedback for analysis and the implementation of change for the next cycle.

4.1 First Cycle

4.1.1 Research

The first cycle was carried out with the purpose of obtaining sufficient information required to be able to develop a basic template of the intervention that could be built on throughout the cycle process. In order for the research question to be answered the sensory data needed to be gained on a functional basis to be able to potentially enhance everyday living of those on the autistic spectrum with sensory difficulties. The information required during the first cycle was to ascertain the problems as seen both by the parents and the students so that the common difficulties could be defined for the purposes of developing scenarios that could be used for the intervention as coping mechanisms. As discussed earlier, students had already been identified by the teaching staff from their knowledge of existing sensory problems.

The gathering of the sensory data in terms of the students took the format of semi-structured interviews and questionnaires (Appendix 3). The reason for this is because of the breadth of data I was aiming to obtain over the core sensory areas, as discussed in Chapter 1. The sensory experiences related were unlikely to be the same and meant the questions needed to be adaptable as some rephrasing and explanation was expected applicable to each person's

needs. In addition, the disability itself requires flexibility as each person's level of function can vary widely, as described by the term 'autistic spectrum' discussed in chapter 2, in areas of communication, comprehension and motor skills and a rigid approach would not be appropriate.

In direct antithesis of this, the questionnaires that were given to the parents, carers and guardians of the children within the schools were very structured in nature (Appendix 4). The questionnaire that they were asked to complete was based on the Sensory Profile Checklist (SPC) compiled by Bogdashina (2001) as discussed in Chapter 2. Whilst this checklist was originally designed to diagnose sensory dysfunction, I intended to use a modification of the checklist as a means to determine sensory problems experienced as described by Jones et al (2003). In order to be able to determine any common scenarios that could be used in the design process, I was aiming to extract additional information to give details of circumstances of where and when problems occur, any triggers that had been determined through observation and experience that generated an adverse reaction plus any coping mechanisms that were used to either pacify or minimise the response to the sensory element.

Both of the questionnaires asked a set of questions relating to auditory, tactile, olfactory, gustatory and optic factors as they are the core senses and I believed they were the ones most likely to generate responses with regard to problems. However, both sets of questionnaires did allow for other difficulties with the sensory domain to be explained. Once the information from the questionnaires and interviews were returned and completed, the data was analysed to determine common areas of sensory difficulty and corroboration between family members.

My expectations of the results of the questionnaires were that the responses given would be different because the autistic children were giving personal information whilst the data that the parents were providing was given from an observational perspective which meant that it was possible that when marrying up child and parent responses they would not necessarily show the same outcome. However, whilst this may have been the case, the data protection measures implemented by the schools meant this was not possible to determine and this is reviewed later in Chapter 5.

Another area where I expected to see contrasts in the responses given to the questionnaires and interviews was between the two schools assisting with the research. This is because of the functioning abilities of the students as described in Chapter 3 and their capacity to understand and respond. This proved to be the case but not in the way that I anticipated and this is discussed further in Chapter 5.

As described in Chapter 3, in order to maintain the confidentiality of the schools and the participants, the findings shown below have been allocated a key for identification purposes. The functioning level of the students within each school was lower for school C and higher for School S. All the students in school S were age 14 and those in school C were around the age of 12 and the similar age groups allowed for comparison of results with the different levels of function.

In order to obtain data that enabled a complete picture to be drawn, information was sought from three different parties, namely, the students, their parents or carers and their teaching staff. Each had their own different perspectives of sensory difficulties displayed and the data their responses produced enabled the design to be productive in terms of making it relevant to each group's needs.

Interviews with Teaching Staff

Prior to meeting the students I had several meetings with the Heads of the schools, Deputies and SENCOs. In order for them to be able to establish what my requirements were I discussed with them the prevalence of sensory problems within the autistic community and what my investigation was aiming to achieve.

As described earlier in the chapter, the schools then filtered the students into those that they knew displayed sensory difficulties, had sufficient communication skills to be able to contribute to the study and those who had abilities or interests in gaming. This was the criteria that I needed the students to be able to fulfil in order to be able to obtain sufficient data from them for the purposes of my investigation.

In addition, I also showed the teaching staff the prototype of the school that I had already designed so that they could see how an intervention would work and also give feedback on the basic environment that I had designed and how the students would use it. Their comments, below, were constructive and gave a starting point in making refinements to the design of the intervention.

Teaching Staff Comments: School C

Regarding the design of the school environment, Teacher A said “The concept fits into the school curriculum particularly concerning maths and geography as the lessons consist of movement in terms of moving backwards and forwards and moving yourself around a big space like a maze This is something the school has sought to purchase in the past but with no success” Taking the navigation theme a step further, the staff thought it would be a good idea to add a map that can be accessed at any time that identifies where the students are within the intervention and where their destination is so that if they are struggling they can formulate a route. The SENCO and qualified teaching staff were aware of a number of students that struggled with finding their way around when corridors looked the same and they proposed that different patterns were put on corridor walls or the doors were colour coded so that it was easier for them to identify whether they had been somewhere or were in a new area.

In respect of playing the game, Teacher B said “I like the fact that the controls basic but think that some students may have trouble with the mouse and keys with the movement of the character because of their poorer motor skills”.

As the school classes were of smaller groups of students due to their learning difficulties and the design was based on a larger secondary school, and it was suggest that I remove some of the tables and chairs so that the students could identify more with the classrooms they were used to.

With regard to the sensory issues that the students display, a number of the teaching staff and support staff thought that care should be taken with information displayed on walls and on boards and to make allowances for interchangeable colours so that if a student had negative reactions to a particular colour they could change it.

Teaching Staff Comments: School S

The teaching staff stated that a lot of the students displayed sensory issues, particularly relating to noise and light and they used individual strategies as coping mechanisms according to the needs of the students. In some cases they used social stories where the approach was concerned with stories about a particular relevant situation. Teacher C said “I feel that this adds another dimension to the story methods we use and could act as an interactive social story”.

They were of the opinion that because school and home were separate entities for some students, and they did not mix the two, it would be better to locate the game within a school environment because they would be undertaking it within school and would be unable to relate to it if they did it at home. It was something that they thought the students could do at the beginning of term, particularly the ones that were likely to find it more challenging.

With regard to concerns about psychological tolerance as discussed in chapter 3, the staff felt that as a computer designed based intervention it had a non threatening aspect to it. They believed that exposure was unlikely to be a problem and felt that because it looked real but was not real it was more likely to be helpful than it was to provoke challenging behaviours.

The school had a number of students who they felt would be valuable in terms of the sensory problems they had and their abilities to communicate and the coping strategies that they had developed for themselves.

Student Questionnaires and Interviews

On the first visit the number of students seen at school C was 3 and at School S was 5 and the informal questions related to drawing out their feelings and self awareness regarding the core senses and how they cope at their young ages and their responses are as follows:

Table 4: Student Data from School S

Ref	Sense	Responses Given
SO1M	Auditory	Does not like anything that is loud. Shouting makes him upset and angry
	Tactile	Hates labels in clothing – removes them
	Optic	Loves bright lights, thinks they're amazing Dislikes the colour brown
	Olfactory	Hates faecal smells – makes him sick
	Gustatory	No response given
	Other	Likes being in his bedroom with his toys and teddies. Feels safe.

Ref	Sense	Responses Given
SO2M	Auditory	Does not like fire alarms. The noise makes him panic and he cannot concentrate
	Tactile	Hates jeans material. Clothing labels irritate him. Loves silky items – makes him feel good
	Optic	Likes bright lights except when he has a headache. Particularly likes the colour pink
	Olfactory	Hates faecal smells
	Gustatory	No response given
	Other	Has a number of the day and will base the whole day on that number. For example if '5' is the number of the day he will have 5 sweets or 5 chips or read 5 pages of a book. When things bother him it stops him from thinking

Ref	Sense	Responses Given
SO3M	Auditory	Dislikes loud noises, particularly bells, the vacuum cleaner and the fire alarm. The game over sound in computer games makes him remember clowns.

		When he hears loud noises it makes him angry and he displays his temper.
	Tactile	Dislikes labels in clothing because they feel rough on his skin. Likes hard objects and soft materials
	Optic	When he sees yellow, black, green and pink colours it makes everything appear weird and blurry. Bright lights prompt and onset of a headache.
	Olfactory	No response given
	Gustatory	The smell of lasagne makes him feel like he has a blocked nose.
	Other	Whenever problems occur it gives him a fit. Finds the numbers 2, 5 and 9 weird

Ref	Sense	Comments
SO4M	Auditory	No response given
	Tactile	Likes furry objects like his dog. Does not like labels on bottles – has to peel them off
	Optic	Does not like bright lights
	Olfactory	No response given
	Gustatory	Does not like peas, eggs and mushrooms because they're slimy. Does not like some meats because it means he has to chew and he does not like to do that.
	Other	Likes rounded numbers like 5, 10 and 15 because they make him feel good. Dislikes dark colours such as black or brown – finds them scary.

Ref	Sense	Comments
SO5M	Auditory	Does not like loud noises such as the vacuum cleaner or alarms. Noise such as background chatter he finds a disruptive noise and it makes him feel useless. Noise is worse when he's not expecting it and finds it very upsetting.

	Tactile	Likes bubble wrap. Uses it as a stress ball when he is upset.
	Optic	Loves bright colours – finds them mesmerising. Hates strip lights or bright lights when they are flickering as it gives him a headache.
	Olfactory	The smell of fried food, eggs, fish and pancakes makes him sick.
	Gustatory	No response given
	Other	Finds timers and gel comforting

Below are the pupil responses from school C.

Table 5: Student Data from School C

Ref	Sense	Comments
CO1M	Auditory	Dislikes loud noises – cannot concentrate and it gives him a headache.
	Tactile	Likes to touch things and feel the fabrics and materials. Particularly likes the feel of sand.
	Optic	Has to close his eyes when there are bright lights because he feels as if his eyes are burning.
	Olfactory	No response given
	Gustatory	Likes to eat the same foods at each meal.
	Other	No response given

Ref	Sense	Comments
CO2M	Auditory	Hates loud noises, cannot think. Finds the noise the lights make distracting (white noise)
	Tactile	Likes to wear tight clothing because it feels like he is being hugged and it makes him feel safe.
	Optic	Dislikes lights that are bright or flashing
	Olfactory	No response given
	Gustatory	Does not like runny or soft foods such as custard or mash. Cannot stand the feel of them in his mouth.
	Other	No response given

Ref	Sense	Comments
CO3F	Auditory	Does not like going shopping – too much noise, and too many people. Loud noises particularly when not expecting them. Likes to be warned if a loud noise is likely to occur. Makes her head feel like it's about to explode.
	Tactile	Does not like having people too near her
	Optic	Does not like bright lights – they give her a headache.
	Olfactory	No response given
	Gustatory	No response given
	Other	No response given

Parent Questionnaires

The schools forwarded the questionnaires to the parents of all the autistic students within the schools. Unfortunately they were unable to confirm how many were distributed and data protection dictated that the responses were able to remain confidential unless they chose to specify a name. Therefore, for those that chose the confidential option, it was not possible to say whether replies had been received from the students that had participated. This made matching the responses for corroboration purposes impossible. However, the information that was received was still a valid resource in terms of being able to determine the problems perceived and the severity displayed so that scenarios could be developed for the intervention.

The number of questions asked was 41 and as can be seen at Appendix 4 they were very specific questions within the core sensory areas giving the person completing the questionnaire the option to comment on each particular situation in terms of situation, effect and how the situation was managed.

In collating the information from the responses I looked at each question individually for the number of responses that had indicated to determine the most common situations as follows:

Table 6: School C Questionnaire Results

Question	Current Issue	Was True	Question	Current Issue	Was True	Question	Current Issue	Was True
1	3		16	2		31	0	
2	7		17	3		32	0	
3	5		18	4		33	0	
4	6		19	2		34	0	
5	0		20	2		35	8	
6	6		21	4		36	5	
7	2		22	8		37	2	
8	3		23	1		38	4	
9	8		24	7		39	0	
10	5		25	5		40	1	
11	7		26	3		41	0	
12	4		27	2				
13	4		28	1				
14	4		29	9				
15	6		30	1				

Table 7: School S Questionnaire Results

Question	Current Issue	Was True	Question	Current Issue	Was True	Question	Current Issue	Was True
1	0	1	16	0		31	0	
2	1		17	1		32	1	
3	2		18	0		33	1	
4	1		19	1		34	1	

5	0		20	2		35	1	
6	1		21	1		36	1	
7	1		22	2		37	1	
8	1		23	0		38	0	
9	2		24	1		39	0	
10	1		25	1		40	0	
11	2		26	1		41	0	
12	0		27	1				
13	1		28	1				
14	1		29	2				
15	2		30	0				

4.1.2 Design

As the proposed intervention is an educational tool, and the assisting population spend a significant proportion of their time in school, the environment that the intervention was based was in a traditional secondary establishment. The reasons for this were that a school is a surrounding that is familiar and this thought was corroborated by the teaching staff I saw which is described below. I had researched local schools and looked at size and layout and found that the components that are found within were quite generic, so whilst the layout would not be replica of their own school environment, the rooms such as classrooms, library, science rooms and gym which are generally found in all secondary schools could be incorporated and nothing unusual would be implemented that would serve as a distraction or look out of place.

Taking into account Whitton (2012), the specification of my design is not technically of a high standard but it is sufficient for the purposes of the study and should not prevent the purpose of the development to be achieved in terms of answering the research question. Also, as the design process is a time consuming process, I designed a basic school environment with all the components that would be seen within any secondary educational establishment as described above so that following on from the initial questionnaires and interviews I could immediately begin developing scenarios based on the results procured.

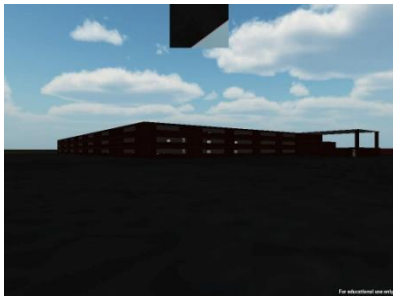


Fig 4: School Building

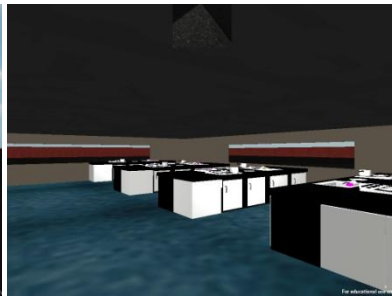


Fig 5: Kitchen Classroom

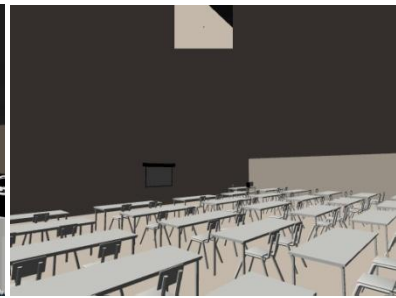


Fig 6: Classroom

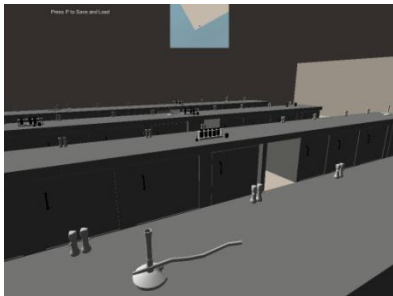


Fig 7: Science Lab



Fig 8: Library



Fig 9: Changing Rooms

Looking at the information provided by the teaching staff, I was able to incorporate their observations of the basic school environment to replicate the smaller classrooms and remove items that were likely to promote sensory overload which was a problem noted by Jones et al (2003).

Once these changes had been input the responses given at the questionnaires completed by the students and parents as shown above, gave a starting point to determine which sensory issues were the most common and how they could be implemented within scenarios that could be identified with in everyday life. The outcomes of the responses given are consistent with the findings of other research outlined in Chapter 2 such as Bogdashina (2001) and Wendt et al (2005) in terms of percentages within each of the core sensory areas.

4.1.3 Implementation

Having developed the basic design of the intervention's environment, the next stage was the incorporation of a sensory scenario within the school environment that had already been developed. The first scenario I created was based on the findings of the initial investigatory stage and was concerned with fire evacuation where the fire alarm goes off and the objective for the person with autism is to navigate their way through the school to the meeting point before the time runs out.

This scenario fits the criteria for an issue that happens on a regular basis within school and is something that all the participants will have had happen in the past and could expect it to happen in the future. It is also something that could occur in other areas of their lives such as in shopping centres and could go off on an unexpected basis and they would be expected to follow evacuation procedures. This fit the criteria of the research question in providing a coping mechanism that they can use in their everyday lives to manage the problem regarding understanding what needs to be achieved in this circumstance and putting the emphasis on that and not the sensory difficulty.

4.1.4 Evaluation

I analysed the responses given from the interviews and questionnaires carried out with the students, parents and the qualified teaching staff in order to ascertain the most common information that could be developed as a scenario. This information was gathered by taking each sensory area, accounting for each person that had a problem and then noting the specific difficulty that they had in that particular sensory area. The answers from the students generated the following analysis:

Table 8: Analysis of Student Responses

Sensory Area	Number of Students Asked	Number of Students with Difficulties	Number of Students with Same/Similar Problem
Auditory	8	6	6
Tactile	8	8	4

Optic	8	8	6
Olfactory	8	2	2
Gustatory	8	4	0
Other	8	5	3

As can be seen, the most common areas of difficulty were in the auditory, tactile and optic categories and within these sectors the same or similar problems that were experienced by each person were in the auditory and optic groups. These problems in the auditory section were with loud noises in general but alarms and bells were specifically mentioned by half of the students. In the tactile section, half the students encountered problems with labels in clothing. In the optic group, three quarters of the students experienced headaches resulting from bright lights.

With regard to last category which allowed for other information that was received that did not specifically fit into the other sections, three out of the five responses were concerned with numbers. In general, the responses could be placed in the optical group where the experiences were about numbers seen. However, in the unusual case of the student who had the number of the day, dependent on what his daily experiences were, any of the categories could become relevant.

The information gathered from the remaining sensory categories generated more diverse information. Whilst the students experienced problems within these sections there were no common elements that would enable a scenario to be developed that would generate sufficient feedback to enable the research question to be answered.

Table 9: Analysis of Parent Responses

Sensory Area	Number of Parent Replies	Number of Children with Difficulties	Questions Numbers Showing Common Problems
Auditory	14	10	9, 11, 15
Tactile	14	11	22, 24, 25, 29
Optic	14	9	2, 3, 4, 6
Olfactory	14	1	None

Gustatory	14	9	35, 36
Other	14	1	None

When looking at the most common problems perceived from the parental replies, I looked at the answers that derived over 7 responses to the 14 replies. As can be seen from the table above, the categories that mirrored the most common replies from the students were auditory, tactile and optic. However, in contrast to the student's responses, the parents had observed many common difficulties with the gustatory section.

As described above the qualified teaching staff had already defined a group of students that they had determined had sensory difficulties and fit the criteria I required for participating in the study in terms of communication abilities and computer skills. Their thoughts on the design of the school environment were also implemented.

In proceeding forward to develop scenarios as an intervention from the information found, the auditory and optic categories had the most common replies with the most similar instances with regard to bright lights and alarms. As I stated in the implementation segment, I had decided to create a fire alarm situation but given the number of reactions to optical stimuli it was an ideal opportunity to merge this into the evacuation scenario.

Whilst there was a common theme from parents and students regarding labels in clothing in the tactile category, this did not easily lend itself to the development of a realistic scenario that would produce results that would answer the research question. For this reason I decided to discount this sensory area from the study at this time. Also, as stated above the responses in the gustatory section from parents and students did not match and because the lack of information was more on the student side, and again this meant that there was not enough information to create a scenario that would answer the research question.

However, I will note that within the gustatory area there was an unusual parent response regarding their child's eating habits as he suffered from Pica. The Diagnostic and Statistical Manual of Mental Disorders (APA, 1994) classified this as a childhood feeding and eating disorder which is the persistent craving and compulsive eating of non-food substances.

With regard to the olfactory and ‘other’ categories, on the basis of finding common elements, there was insufficient or inappropriate data received from both parties to enable a scenario to be developed. Therefore, for the reasons described above I decided to concentrate on the development of scenarios in the auditory and optic categories during the following cycles.

4.2 Second Cycle

This cycle was concerned with the feedback from the students on the school environment and the evacuation scenario that was developed from the information gained in the first cycle (Appendix 5). Now that the research for the sensory information had been determined, analysed and evaluated, the data that was being used from the second cycle onwards was now only from the students, teaching staff and assistants, as the focus was now on the development of the intervention.

4.2.1 Research

As mentioned above the scenario that was developed from the initial research was aimed at enabling the student to find their way outside the school after the fire alarm sounds. In addition to this, taking into account the other most common sensory area, the noise of the alarm would be accompanied by a flashing light. The purpose of the research in the second cycle is to obtain feedback from the students as before through an informal interview with semi structured questions and also observation of them playing the scenario.

The process involved looking at how they reacted when the scenario came into play and also their responses to the strategies that were in place to lessen the impact that the situation had on their particular sensory dysfunction. Taking into account the breadth of communication skills, observation of behaviours was an important aspect of the analytical process. Where people found it difficult to articulate the answers to questions or initiate feedback without prompting, observing how they played the intervention was a crucial method of obtaining data as discussed in Chapter 3.

The fact that some level of psychological tolerance was required necessitated the monitoring of diverse reactions towards the sensory issue that was being implemented. As discussed in Chapter 2, successful applications have been used in this way without negative behaviours

escalating and instead the problems did become more manageable. Therefore, observation during the process is not only concerned with the successful application of the intervention but also the awareness of the development of any reactive challenging behaviour is crucial so that the process can be stopped to prevent any distress being incurred.

At School S I saw 8 male students, 4 of whom I had seen in the first cycle and 4 that were new to the process. However, the students that I had not seen before had been selected by the professional teachers with their knowledge that each experienced sensory difficulties and, therefore, met the criteria set out earlier in the Chapter. Their comments, which are divided between the school environment and the actual evacuation scenario, are below.

Table 10: School S Environmental and Scenario Comments

Ref	Environment	Evacuation Scenario
SO2M	Less lockers Could have the trip to school in it / school bus Could be more detailed	The alarm noise does not sound like a proper alarm Needs item drops / pickups AI / bullies Needs an inventory / shop / upgrades Cut scenes More fire exits Liked the level
SO3M	Smaller classrooms / less desks Bigger whiteboards Bookshelves in classrooms Automatic doors Specialist rooms (art, science) need teacher desks Warning signs in science labs and kitchens Numbered lockers Pictures on walls: people's work	Difficult to concentrate with the alarm going Could have AI / bullies Medals for completing tasks Unlockables Too much sensitivity from the mouse

SO4M	<p>Whiteboards in the library</p> <p>Bigger lockers</p> <p>Play area outside</p> <p>Big doors not clear so people do not know where they are</p> <p>Overall thought it was fine</p>	<p>Found the light distracting, found it easier to cope with the alarm rather than the light</p> <p>A mini map would be better in the top right corner</p> <p>Instead of a yellow beacon, have a teacher with an arrow pointing at them</p> <p>Not clear where to go when you get outside without the signs telling you like in the fire exit signs inside</p> <p>The light was distracting.</p> <p>Could change the light to the colour of the environment</p>
SO5M	Liked the school	<p>The alarm was annoying</p> <p>Game was lagging, got used to it</p> <p>Lost without signs: memory problems</p>
SO6M	<p>Classrooms: bigger whiteboard, windows, less tables</p> <p>Library: bigger tables, good sized room, not too many books</p> <p>Art Room: more space to move, different object in the middle</p> <p>Outside: needs a sports court, eg football pitch</p> <p>General comments: Needs posters on the walls, dinner trays in the canteen but otherwise thought everything was good</p>	<p>Loading screen: 15 seconds each screen, chance to see the 'help' option from in the game</p> <p>Menu: bolder/fancier text, background image logo</p> <p>General comments: needs a victory sound, easier controls, AI, fire extinguishers with fire exit signs, warning signs in the kitchen, need more time to exit the building, an option to try again or not at Game Over</p>
SO7M	Everything is OK	Use the keys to turn instead of the mouse
SO8M	<p>Classrooms have too many tables</p> <p>Needs windows</p> <p>Fridges in kitchens</p> <p>More tables in library</p>	<p>Would be better with direction keys to turn</p> <p>Alarm sound could be changes to more of a 'nee-naw'</p>

	Sports areas outside needed eg football pitch Change the doors for better recognition eg numbers or colours	
SO9M	Statue/fruit bowl in the middle of the art room instead of table/chair Till in the canteen Daily menu in the canteen Outside games eg hopscotch	Bigger text in the start menu Arrows to show you where to go

Table 11: School C Scenario Comments

Ref	Environment	Evacuation Scenario
CO1M	No comments given	Does not like the noise of the fire alarm Was able to complete the scenario but did so on instinct and did not follow the exit signs. Used one-finger keying to complete.
CO3F	Needs a playground Windows in the canteen and a fridge Hand dryer in the changing rooms	Needed the signs to follow and got lost once. Disliked the sound of the alarm but it did not stop her completing the scenario. A one-finger player and took longer to complete. Thought the light should be brighter
CO4M	Enjoyed moving round the environment	Had several attempts, struggled using both hands but was able to adapt and followed the signs better on the last try. Thought the alarm was too loud but the light could be brighter.
CO5M	No comments made. Struggled with the basic keyboard functions and found it difficult.	Completed the scenario but needed a lot of assistance. Was bothered by the sound of the alarm but it didn't stop him completing the task.

CO6M	Smaller tables for little people Pictures on wall	Struggled with directions and got lost without signs. Need better sign placement. Easy to follow instructions but more time needed to complete.
------	--	--

School S: Teaching Staff and Assistant Comments

Thought that the evacuation task mirrored the objectives that were required when the alarm went off in school and that it was able to teach the students what they needed to do when the situation arose. As it was not possible to carry out regular exercises with the fire alarm, it enabled the students to practice the evacuation and concentrate on getting to the meeting point rather than focussing on the alarm and the lights.

School C: Teaching Staff and Assistant Comments

The class teacher liked the fire alarm scenario but thought some students may be bothered by the noise so the sound may need to be altered as part of the coping strategies and build up to the normal fire alarm sound. As some of the students cannot read and are hearing impaired, the flashing light would act as a visual aid. The teacher said that the game was a good idea as the students would not pick up the information as well if it was written or verbal but as something that they could physically undertake in a game environment it was a useful learning tool as it was not something they would teach in class.

The teaching assistant said that it was possible that when asking questions the students may repeat the last thing that was said. Whilst supporting the students in carrying out the task, she observed that all the children were able to understand that they needed to leave the building when the alarm went off which was a positive outcome.

4.2.2 Design

The comments received from the students and teaching staff in the schools facilitated the design to progress to completion. In respect of the school environment the changes that the students would like to see made were mainly cosmetic and, as had been noted by the teaching staff in cycle one, were requested so that the school had surroundings that the students were used to seeing.



Fig 10: Exit Signs

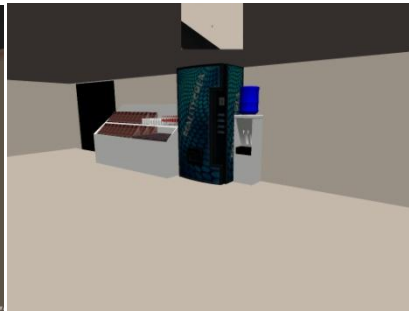


Fig 11: Canteen Vending Machines

The school with the students that had higher functioning abilities had ideas for the design that mirrored their experience of console games such as the types of menus they would expect to see, reward systems and the ability to purchase items. The autistic students that had greater communication difficulties and abilities needed a lot of support and were more focussed on the sensory aspects of the scenario and completion of the task rather than environmental concerns. This is consistent with the disparity between LFA and HFA as described in Chapter 2 and the levels of ability that they display.

In aiming to meet their expectations, I looked at the most common comments from the two schools and made changes to the menus, reduced the tables in the classrooms, added windows and incorporated a reward system. As the layout and interior of the two schools I was working with was not identical, this meant aiming to achieve an environment that included as many incidental items as possible that had caused a distraction so that the focus became more on completing the scenario.

4.2.3 Implementation

Taking the above comments into consideration, a number of elements were integrated into the interior of the school environment. The types of components changed were concerned with the size of the classrooms as class sizes were significantly smaller in the school with the autistic students with the lower functioning abilities. Also, as a few of the students had struggled with navigating their way through the school with the signs that were in place, I added more signs to make it clearer.

There had been a few comments made about the realism of the alarm sound and the colour and brightness of the light. In order to resolve these issues I altered the tone of the alarm and incorporated two different coloured lights so that during the next cycle the best choice of light colour could be determined.

With regard to the reward system, the aim of the study was to be able to enhance the abilities of the person to cope with situations that arise in everyday life. The reward structures that are offered in general game play such as artefacts and life restorers were not appropriate in meeting this objective. Therefore, at the completion of the scenario the reward that was given was a set of headphones that could be used to muffle the sound of the alarm. This coping mechanism is an everyday item that is commonly used and would not be seen as unusual if it were used inside or outside for example in a shopping centre.

The reason for the headphones is that it is an item that can be carried around and used if noise becomes a problem. It is not intended to block any sound completely but muffle it enough that the person can continue with what they were doing without the sound provoking adverse reactions.

4.2.4 Evaluation

Looking at the comments given and from observing the game play, the students understood the objective of the exercise. There were expectations of achieving a reasonable standard of specification through previous game play experience from the students with the higher functioning levels. However, the autistic students that displayed higher difficulties were more

focussed on the completion of the task. Overall, the response was positive and attention was given more to the purpose of the scenario.

What was particularly noticeable was the fact that, in typical autistic trait, they got caught up in the details of the school environment and wanting the surroundings to be familiar to them. With the alterations that I made to the interior layout, this matter should not arise during the third cycle.

In respect of the scenario, the majority of students, as determined in cycle 1, had issues with the noise and the light. However, as shown in Chapter 2, they were able to adapt and the level of psychological tolerance they were exposed to was minimal and whilst some found it distracting it did not detract them from the purpose of completing the exercise.

4.3 Third Cycle

The third cycle was the final part of the iteration. Having integrated the information gathered from the previous cycles and updated the evacuation scenario this last cycle determined what final adjustments were needed and whether a coping strategy for everyday life can be successful through a game-based tool.

4.3.1 Research

The students were now familiar with the evacuation scenario and knew what they were expected to do. The final part of the research was to gain views from the students regarding the overall scenario now that the internal environment had been updated with the features the students had noted that were either distracting them or hindering them in completing the task. Opinions were also sought on the volume and tone of the alarm and the brightness and colour of the light as the alarm needed to be as realistic as possible and the light was the main support feature for those that were hard of hearing. This component was an important element to take into consideration as some of the students had additional disabilities alongside their Autistic Spectrum Disorder and it takes into account accessibility guidelines as discussed earlier in the Chapter.

With the reward structure now in place with the sensory specific trophy that is to be awarded on completion of the mission, viewpoints were sought on whether this was something that could be a successful application if used in their daily lives. Unfortunately, a number of the students that had been seen previously were unavailable and, therefore, the continuity of the cyclic process from the students' perspective was hampered because they had not seen the progression of the intervention. However, other pupils were asked to participate and were able to give their opinion of the final product and the comments on the completed development from the students and the teaching staff and assistants are given below.

School C Student Comments

CO2M thought that the headphones were different to the usual trophies that are given and said that they were something that he wore at home when it was noisy. With regard to the alarm sound and the light he would have preferred to have just the sound even though he found it hard to concentrate. He liked the fact that he could look round the whole school aside from carrying out the task.

CO5M was happy with the headphones as a reward and wanted to wear some while playing the scenario. Thought the alarm sound was annoying but it reminded you that you needed to leave the building and overall thought it was better with light and sound. He would change the colour of the light to orange and make it brighter.

CO7M had not seen the intervention before and worked his way through the task on instinct and did not follow the exit signs. He used one finger keying to execute the movement of the character and communication was difficult. However, he still managed to complete the exercise. Would have preferred to have the light only as he did not like the fire alarm but once the headphones had been rewarded thought that it would help when the alarm sounded in school.

CO8M had also not been part of the development process and had no difficulties in completing the scenario. Whilst neither the sound nor light bothered him, he would have preferred to have just the alarm element used rather than both as he found it confusing and did not see the purpose of the light. He said that it is difficult to think when the fire alarm goes off in school and thought having some headphones available was a good idea.

School S Student Comments

SO1M had stated in cycle 1 that he found noise very upsetting; however, this did not prevent him from completing the task but as he had a preference for brighter lights he would have favoured the light on its own. Overall said he enjoyed the experience, was able to complete the scenario in the timeframe and liked the idea of receiving a trophy that helped with the noise.

SO2M had the benefit of participating in the whole process and whilst he panics and is unable to concentrate when the fire alarm sounds he had said that the alarm needed to be more life-like. This had not prevented him from completing the scenario previously and as adjustments had been made to the tone of the alarm he was still able to accomplish the task even though it was now more realistic. He was pleased with the headphones at the end but said that he would like to have other items to pick up along the way to the exit point. He stated that the game had improved and had enjoyed it.

SO8M said that he thought the environment was much better than the previous time now some changes had been made. He believed it would be better with more objectives but thought that something to muffle the sound was a good idea as it would help him think better. Thought the scenario was better with alarm on its own without the lights but if a light was included would have preferred it to be green.

SO10F found the combination of light and sound confusing but said as long as she stops and focuses it is fine. As she does not like the sound of the alarm because it ‘messes with her brain’ she had developed her own plan when leaving the building called PEEP – Personal Evacuation Escape Plan for anxiety. When completing the scenario she very quickly picked up the most obvious exit point and reached the destination in record time. As this was her first time in working with the development, she commented that there could be a gathering point rather than a beacon and to be following people to make it more realistic. She would make an alteration to the keys programmed and would exchange the ‘n’ for an ‘e’ because she thought it would make it easier. She did enjoy playing the intervention and thought it could help students in school and teach them what to do when the alarm sounds.

SO11M had played a lot of computer games and thought he had played something similar before. He completed the scenario without any difficulties by following the exit signs and was able to manipulate the keys with dexterity. He appeared oblivious to the fire alarm and was entirely focussed on achieving the objective. When asked his opinion about the alarm and the light he said that the alarm helped to give a sense of urgency in getting outside but it had not bothered him and he felt that the light was unnecessary. In respect of the reward of the headphones he could see why it would be helpful to some people but he did not feel that it was something that he would need to use.

SO12M was completely distracted by the label on the laptop and was unable to concentrate on completing the evacuation through his desire to remove the label. In addition, he wanted to run a scan and examine the software and as a result of this the endeavour was abandoned.

There were clear differences in abilities between the students with LFA and those with HFA. Those with HFA were more dexterous and had no problems with manipulating the controls. They were able to complete the task with few problems and in a timely manner whilst those with LFA were slower and struggled to complete the task in the allotted time. With regard to the sensory stimuli, the students with LFA were more aware of it than those with HFA and seemed more receptive of the reward, even though those with HFA were able to see the benefits. The students from both schools made insightful comments such as the use of keys that could make the task easier and the idea of testing different coping strategies whilst playing the intervention which is discussed further in Chapter 5.

School C: Teaching Staff and Assistant Comments

The class teacher said that the game was good and could be helpful as a learning tool. The teacher said that they were trained to deal with the difficulties that their students portray where mainstream schools are not and as a result they are more willing to try something different that could be of benefit to the students.

The idea of the headphones as a reward on completing the scenario was something that they could use in the school and have a selection on offer near the door in the classrooms and in the event that the fire alarm sounded and the students could pick them up on their way out of the room.

School S: Teaching Staff and Assistant Comments

The class teacher believed that the intervention would be beneficial for some students because it was more real life and something that could happen and by practicing what to do it would be clear in their head that if the situation occurred they know what they need to do. It is a useful tool because it's a real situation and it puts them into a real situation and when the fire alarm does sound it can be reassuring to know what their objectives are.

With regard to the sensory issues of the sound and the light one teacher said "I like the combination of sound and light because it gives the pupils guidance and the ability to concentrate on something that isn't wholly related to the sound of the alarm. Their focus is more on the objective of evacuating the building in the optimum time". In respect of the sound of the alarm she said "the intervention will enable them to get used to the noise and they will not be as shocked as they might have been when the alarm goes off in real time".

4.3.2 Design

The changes to the internal layout of the environment had been noted by the students had been input into the development. The classrooms were an important item to change because the size of the classrooms that they were used to were much smaller than those found in a traditional secondary school where the students have less support needs. There had been a lack of windows and the interior was quite dark and the inclusion of some windows and natural light brightened the inside of the school making it feel much more welcoming.

In deference to the difficulties that had been experienced by some of the students when navigating their way around the school environment, extra signage had been added to make the route to the meeting point clearer. The colour and brightness of the lights was also adjusted as this was intended to be a support mechanism and not a hindrance. Similarly the tone of the alarm was changed to a more realistic sound.



Fig 12: Fire Alarm light

The reward system had now been applied to the design of the intervention with a trophy being awarded once the person playing the game had reached their destination in the evacuation scenario. The reward that was chosen was done so through information from the students and parents concerning their reactions to noise and how they immediately aim to minimise the volume by putting their hands over their ears and the trophy was used to replicate this action.



Fig 13: Reward

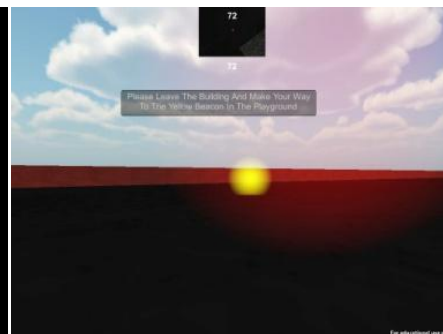


Fig 14: End Goal Beacon

4.3.3 Implementation

All the students who participated in cycle three appeared to be content with the changes that had been made to the school environment and their comments were now directed to the purpose of the study which was the sensory aspects of the evacuation scenario. From the nature of the comments made it was possible to detect those that had an interest in computer games as they requested items for inclusion that would be found in a professionally generated product but were unnecessary for determining whether the study was successful or not.

As described above, all the data that had been ascertained through the interviews, questionnaires and observations from the game playing was now populated into the intervention. As the purpose of the study is to ascertain whether a game based tool can be successful as an intervention for sensory difficulties for those with autism, it was not intended to implement the normal trophies that are given in computer games for the reward structure. Instead, the purpose was to offer something related to the study by way of a coping strategy for a way to minimise the effects of the sensory area and in the scenario developed, headphones were offered as an item that could be used in this way.

With all the information received from the participants implemented into the development, the intervention was now complete. Whilst there were cosmetic changes that could be made, these were on a minor scale and they would have no bearing on the outcome of the investigation which is discussed in Chapter 5.

4.3.4 Evaluation

The students that had difficulties with communication and motor skills were able to complete the task which fit the criteria for meeting the needs of differing abilities. Only one person did not complete the task and this was due to being distracted by a laptop label and had nothing to do with the scenario. Given the opportunity to play the scenario on another day, a different outcome may have been observed.

The people that were experienced in computer games were not concerned with the specification of the development, only the realism, and the fact that they could relate it to games that are on the market supported the idea that they felt it was credible. As well as the cosmetic changes and personal preferences that were voiced there were also some constructive responses given including use of the keyboard to replicate familiarity with game console devices.

Whilst I had always intended to add a reward structure as being an integral part of the development, particularly as they have a positive impact on the player as discussed in Chapter 2, it seemed that such schemes are something that game players expect to see and was the most common request prior to its implementation. There was a positive response for

the unexpected reward and indications that it was something that could be useful when noise was at intolerable levels.

4.4 Discussion

As discussed in chapter 3 regarding using design based research methodology, the development of the intervention required the implementation of a cyclic approach built from the compilation of the data received from interviews and questionnaires to determine the common areas of sensory difficulties that could be used for a sensory intervention. The initial interviews with the students concerned asking a set question format but with flexibility to adapt to responses or lack of responses taking into account each person's individual autistic traits as discussed in Chapter 2 in order to obtain as much data as possible regarding difficulties experienced over the core sensory areas.

Interviews also took place with teaching staff to give a viewing of the initial development of the school environment to seek their thoughts on how appropriate the setting was, if they foresaw any potential complications that the students may experience. I was also seeking ideas of any improvements that that could be implemented that may make game-play a better experience for the users and the results of this information will be deliberated further in chapter 5.

All the students that participated had numerous sensory difficulties in the categories that were being observed. However, the purpose of the study was to look at the most common elements that could more easily be translated into an everyday scenario that suggested coping strategies that could be taken into their daily lives. The areas that more easily fit that requirement were in the Auditory and Opticgroups.

On completion of the cycle process the response from the teaching staff and the students was positive but for different reasons. The students considered the purpose of the scenario in terms of being able to complete it and gain the trophy. They were all clear about what the task was and whilst it took some several attempts, and some with assistance depending upon their learning needs, success proved to be attainable.

Once it was accomplished they reflected on the level of difficulty and the concept of the reward. All of the students enjoyed playing the intervention as it was something different from the normal learning tools used in school. A number of students acknowledged that it was something that they thought would be useful in school for learning about evacuation when the alarm sounded. In respect of the reward structure surprise was expressed followed by an encouraging reaction in terms of something that could be used to lessen the effects of the sensory difficulties they experienced.

The teaching staff and assistants looked at the intervention in a much wider way. They considered the scope for being able to teach the students at the beginning of each year what to do when the fire alarm sounds as this is something that they cannot teach. In the school with the students displaying greater difficulties with communication and motor skills the scenario was able to be used in geography lessons as part of navigating their way around places from A to B and in mathematics lessons for learning and practicing movements in different directions. In addition, they believe that practising the scenario helps with dexterity in respect of fine motor skills and manipulation of the keyboard.

Noise is one of the biggest difficulties that are faced by the students and the reward given at the end of the scenario gives the staff options to have items available in the classrooms and dispense them if required and which does not eliminate noise but diffuses it so that the students can concentrate more on what they are doing.

4.5 Summary

The students that were participating were from schools that showed a contrasting perspective of their needs during the development process. The students at the specialist school with the more severe difficulties suggested simple changes that may have been related to their individual needs whereas the ones with the greater abilities delved into the detail of the intervention's environment. This is not an unexpected outcome bearing in mind the diverse characteristics displayed by those on the autistic spectrum as discussed in Chapter 2 (Dunn et al, (2002)).

With regard to the areas of sensory difficulties experienced, the data that was obtained from the different parties participating showed that they are all aware of the overriding problems and the results from the information gathered did agree in terms of the most common issues found. The difficulty arose when trying to calculate the percentages of difficulty experienced in each category as had been done in the Wendt et al (2005) study. This is because the schools invoked data protection on the parental data and it was impossible to know who had returned the information and if it related to any of the students that had been seen or if they were an entirely separate entity. However, as in the Wendt study, the tactile category was revealed as the one that the students had the most sensory difficulties with but in such different ways that it was discounted as a scenario prospect as discussed earlier in the Chapter.

In the way that Sutton-Smith (1997) researched development and adaption through play, comments received during the cycle process suggest that the intervention does achieve this as the learning tool is a game but is simultaneously teaching a number of different areas related to the sensory difficulty. Firstly, it presents the sensory problem so that it cannot be avoided within the scenario and at the same time poses a task that has potential risks involved in everyday life which has to be concentrated on to achieve the goal. Secondly, in order to minimise the effects of the difficulty it offers an item that can be used in everyday situations when the problem arises so that the problems that are normally experienced are reduced.

The students saw the avatar within the game as an extension of them and intrinsically understood that they were moving their character to attain an objective. None of the students suggested that they wanted to see the character in third person which supports my decision to use the first person for the reasons discussed in Chapter 2.

The exposure to psychological tolerance as discussed during Chapter 2 (e.g. Rapp et al 2005, Love et al 1990) and the level of sensory stimuli that was employed during the cycle process showed that by using graduated exposure it can be applied successfully with no damaging effects to the children involved. In addition, by using a measure of psychological tolerance in a game environment, this adds to the view of Whitton (2012) regarding players being able to control their own actions which makes it a safe place to fail. Therefore, the input of sensory stimuli in a game setting is not seen as a threatening element and this is something that was felt by the teaching staff as discussed earlier.

The study by Garris et al (2002) found that game-based learning can be instructional and enlightening and the feedback from the participants as discussed earlier in the chapter suggests that as a learning tool it holds some merit and this is examined further in Chapter 5. With regard to the link between games based learning and autism as stated by Roxby (2012) the students did find the scenario motivating. They wanted to complete the task and were willing to keep trying until they reached the destination and gained the trophy.

Feedback by the students and teaching staff suggest that the balance of risk and reward that studies deem are an essential element of gaming (e.g. Adams 2010 and Williams et al 2011) was achieved in that the risk was the exposure to sensory stimuli and the reward suggested a way to minimise that risk. These elements were a key factor in the development of the intervention and the successful features as well as the challenges encountered are discussed further in Chapter 5.

Chapter 5

Discussion, Conclusions and Further Research

5.0 Introduction

The investigation undertaken was to ascertain whether a game based learning tool was able to promote self awareness in school children with an Autistic Spectrum condition combined with social phobias. Before I give the answer to whether the study elicited a successful outcome, I will discuss the occurrences throughout the cycle process that lead to satisfying the answer to the research question. Firstly I will look at the responses that indicated that the intervention could be a useful educational tool followed by a discussion of the barriers that were encountered. I will then consider the answer to the research question, reflect on the research and methodology and discuss any further research that could be undertaken as a result of the final analysis.

5.1 Intervention as a Useful Learning Tool

Out of the participating bodies of school staff, students and parents, only the school staff and students were asked for their thoughts on the viability of the intervention. This is because the parents were only asked to complete a questionnaire for the purposes of defining the common sensory areas, coping mechanisms and trigger points. As they did not have the benefit of seeing the progression of the development at any stage or input into how it evolved their views of the intervention were not sought.

As discussed in Chapter 4, the teaching staff at School S were of the opinion that the intervention would be beneficial for some students because it represented real life, was something that could happen and would help to cement a clear process in the student's head of what they would need to do when the fire evacuation situation arose within school.

The teaching staff and assistants from School C were working with children with far more severe learning difficulties. From my discussions with them, whilst they have a curriculum to follow, they were much more flexible in their attitude and willing to try new approaches that

may have even the smallest benefit to the students. One person said “they’re trained to deal with their difficulties but mainstream schools aren’t”.

From my observations in both schools, there was a clear difference between the two establishments in terms of what they wished to achieve. There was no doubt that both wished to improve the lives of the students but in school S, because of the greater abilities of the students, they looked at the intervention as something only to be used for the purpose identified.

In contrast, school C were able to break down each part of the intervention and pick out separate elements that would be of benefit to the students and use it in different ways. As described in Chapter 4 there were elements that could be used in mathematics and geography lessons which had a benefit that was not part of my investigation and which was concerned with movement and the ability to successfully navigate around the environment.

Both schools agreed that underpinning the intervention was an exercise that could not be taught in school as they were limited to the number of times that they could implement a fire drill. From that perspective they believed it was useful as a learning tool for teaching the purpose of what to do when the fire alarm sounds and being able to achieve that objective by overcoming their immediate reaction to the noise.

As discussed in chapter 2 with regard to reward structures, the study found that people do find it motivating to work towards achieving an incentive. Whilst artefacts such as health pickups or power-ups that would be found in normal game play would not work in the intervention as it would detract from being able to answer the research question, I have aimed to include a reward type that offers a solution to minimising the problem and one that can be used in everyday life.

The feedback from the students concerning the reward was limited by difference in the level of communication skills displayed from the two participating schools. From the school where the abilities were greater there was a general consensus that it was a good idea and some students already utilised something similar as part of their own coping strategies. They expressed surprise to find such an unusual reward within a game environment and indicated that they would like the opportunity to have something available within school.

The students from the school who displayed more severe communication and learning difficulties were not expansive with their comments. However, through observing their behaviour whilst undertaking the intervention, they were motivated to complete the task and did learn from their mistakes so that they improved on each attempt.

Whilst comments were offered from the students about finding the noise and light distracting and not liking them, it did not prevent them completing the task. No adverse reactions were observed from the psychological tolerance perspective which reflects previous research discussed in Chapter 2. In fact the students appeared to be immersed in the undertaking so that their discomfort with the auditory and optical sensory areas gave the impression of becoming secondary to the mission.

5.2 Challenges Faced in Answering the Research Question

Whilst conducting the investigation with the aim of improving the ability of autistic people to manage their sensory difficulties in everyday life, and taking into account my own personal experiences, I had originally anticipated that the intervention would be able to be used at any time. However, this proved not to be the case and was an unexpected eventuality that I had not considered as it was not a detail that had arisen during the literature review. Contrary to expectations it appear that people with autism compartmentalise areas of their lives and develop coping mechanisms for each different part. Therefore, by considering that the intervention could only be used within the school environment, the research question could not be answered in its entirety and could only reflect the element of the school environment.

In addition to this, as stated earlier in the Chapter and as shown in Chapter 4, in several of the sensory areas the individual problems displayed were so expansive that it would have required several scenarios to be created to take account of each social phobia. With the number of students that were participating and the number of different experiences uncovered, particularly in the gustatory and olfactory areas, this went against the investigatory goal of addressing common sensory areas. Therefore, taking the limitations of the compartmentalisation and the breadth of different occurrences into consideration, the scope of the project had to be restricted to take account of the most common difficulties experienced that could generate sufficient data to enable a conclusion to be drawn.

Another area that impeded the analysis of the data was that of the parental questionnaires. This is because in the majority of cases there was no information given other than the basic awareness that their child experienced a problem in a particular area. The lack of detail restricted the ability to derive common circumstances where the children experienced difficulties.

This led to the question of whether they pandered to the sensory difficulties or tried in any way to affect a resolution. It also begged the question of whether the difficulties expounded by the students were the same problems that the parents were aware of or if they were different issues. Due to the inability to interact with the parents, the answers remain unknown. However, if the opportunity to liaise with the parents had been possible, more detail may have been able to be extracted and then cross referenced against the children's information to enable the intervention to be more detailed.

The communication difficulties of the students made it difficult to determine whether the information they gave was complete. Undoubtedly, given more time and personal familiarity with the participating group, greater depth of data could have been drawn out which would have aided the content of the intervention. Also not being able to interact with the same students each time meant that the ongoing cyclic process of evaluation and analysis was encumbered by repeated explanations and this did slightly interrupted the flow of the development. Nevertheless, I have no reason to believe that this limited the validity of the findings as the information they gave was consistent with that of students who were seen throughout.

Drawing out the information from the students was a lengthy process. As someone on the autistic spectrum myself, I am aware that I am generally not very verbose when communicating with other people, particularly strangers. I am also aware that I can sometimes be asked the same question in 20 different ways before I give a valid response, as the way a question is asked does not always have an obvious answer due to issues such as literalism or a general inability to grasp the point of the question as discussed in Chapter 2. Therefore, as someone on the spectrum and having the same problems as the students being questioned, my own communication skills and the ability to adapt to draw out a response may

not have facilitated as much data as might have been available if someone with ‘normal’ skills had been conducting the interviews.

The level of function of the students also detracted from the ability to gain accurate and detailed information with regard to the sensory difficulties experienced and in gathering evaluation data. This is because the autistic traits displayed were significantly more pronounced in the school catering for those with lower functioning abilities and this caused difficulties in asking the same questions whilst deferring to the levels of ability and meeting the needs of each person’s autistic traits.

Similarly, I did not see the same members of staff each time and they were not all aware of the content of the study and my requirements on each visit. Consequently, this contributed to the fact that the same students were not made available. In addition, the allocation of space to work in was not always a confidential area and the possibility that discussions could be overheard at times may have contaminated some of the data. Therefore, it is possible that some of the responses were given because they had been overheard by another person and not something that was their own personal experience. However, I do not believe that this is applicable to the auditory and optic sensory areas which were the key components of the intervention.

As the intervention was concerned with the evacuation of a school after the fire alarm sounds, in order to be able to fully answer the research question, I needed to be able to see this occur in reality. During the limited time for the project to be completed there was not an occasion when the fire alarm sounded and was, therefore, unable to see whether the intervention had improved their ability to focus on the objective of exiting the building as quickly as possible and securing the meeting point.

5.3 Research Outcomes

In addressing the research question the positive results and impediments described above need to be balanced. The idea of being able to enhance everyday life through using a game-based learning tool was embraced by the schools that participated. As mentioned above, at the beginning of the study I had anticipated that the intervention could be used at any time. However, it became clear that separate scenarios would have to be developed for different

environments such as home, school, work and social activities. This is because they were not likely to automatically think of the tools that were available as a coping mechanism as interchangeable outside of a particular environment.

The difference in functioning levels also had an outcome that I had not anticipated. After my familiarisation visits to the schools I believed that the students with the greater learning difficulties would struggle with the concept of having more social phobias and being able to implement strategies for their own benefit. However, whilst they needed a lot of support in navigating their way through the intervention, the level of improvement was far greater than with those who had the higher functioning abilities which was measured on the basis of observation throughout the cycle process. Therefore, the implications that could be drawn are that the students with LFA derived the most benefit from the intervention.

The major difference between the lower and higher functioning students was that the students displaying the greater abilities had already begun to develop their own coping mechanisms. Whilst they displayed negative behaviours towards the sensory input their tolerance levels were greater and they were more able to manage this. The students with the lower functioning abilities took longer to acclimatise themselves to the sensory environment within the intervention. They had trouble focussing against the backdrop of the alarm and were distracted by the light but, as stated above, over time their level of improvement was significantly higher.

Due to the reasons given above, it is difficult to say whether the research question can be answered conclusively. However, overall, I believe that potentially the answer to the research question is that it is possible for a game-based learning tool to help children with an autistic spectrum condition identify coping strategies in response to sensory difficulties.

5.4 Contribution of the Research

The investigation affirmed the findings of the literature review which was that the autistic community have been experiencing sensory difficulties for decades (e.g. Delcato, (1974);, Ayres and Tickle, (1980);, Grandin (1996). What has changed over time, particularly more recently, is the recognition of the effect that these problems have on their daily lives and is

now an integral part of the diagnostic process as discussed in Chapter 2 (Schopler et al., (2010);, APA, 2013).

The literature review confirmed that whilst considerable investigations are being undertaken concerning the prevalence of sensory dysfunction (e.g. Wendt et al (2005);, Nadon et al (2011)), solutions to the problem are, largely, not being sought. The literature review, therefore, exposed an area where there was a need for a remedy to be developed that offered practical strategies and learning opportunities for those with an autistic spectrum disorder.

As discussed previously, the studies undertaken are either concerned with individual circumstances (e.g. Love et al (1990); Rapp et al (2005)), related to the amount of people affected by sensory areas or reactions to the sensory stimuli. Their findings show that high numbers are involved but the recommendations only indicate that further research should be carried out (O'Neill & Jones (1997); Marco et al (2011)).

In addition, the areas where technology is being used as an educational learning tool mainly surround the area of facial expression and the understanding of what is being conveyed by another person (UAB, 2007). However, this is not related to sensory behaviours and is more concerned with a social interaction area of the triad of impairment (Wing and Gould (1979)).

From an educational perspective, the research highlighted that game-based learning has properties that aids motivation and knowledge (e.g. Whitehall & McDonald (1993);, Sutton Smith (1997);, Wang & Sun (2011);, Roxby (2012). It also showed that the specification of the game does not have to be at a high level to be successful (Whitton, 2012). This enabled the development of the intervention to proceed with the emphasis on the sensory coping mechanism.

What the literature review did not reveal was that people with autism commonly compartmentalise areas of their lives. This became evident through comments from the teaching staff from both schools when showing the template for the school environment prior to the first cycle commencing. The discovery of this fact immediately limited that ability to be able to answer the research question as I had originally planned to use a variety of environments during the intervention development process.

Whilst the question remained relevant, the environment in which the study was focussed became solely around the school environment because that was where the participants were situated to pre-empt any compartmentalising issues that could potentially affect the investigation. This corroborated the findings of Sehaba (2005) concerning the incorporation of flexibility within the game to take account of autistic characteristics.

5.5 Implications for Theory, Practice and Policy

Research concerning sensory dysfunction has become more widespread as awareness has grown of the impact that it has on the autistic community. Whilst potential sensory experiences have been documented from the time that Kanner (1943) and Asperger (1944) studied behaviours that are now recognised as autistic spectrum disorders, as discussed in Chapters 1 and 2, sensory behaviours were not included in the diagnostic process as a key component of the condition until 2013.

The numerous recordings of people's sensory experiences and the effect it has on individuals are widespread. From the number of students participating in the study, the findings corroborate the scope of the problem as every participant displayed a sensory problem in at least one of the areas being examined. The parent questionnaires also revealed that they were aware that their child experienced sensory difficulties, despite the fact that many of their children had severe learning difficulties and were unable to express themselves.

As discussed in Chapter 2 concerning the latest edition of the Diagnostic and Statistical Manual (APA, 2013), America has now included sensory behaviours in its diagnostic criteria for autism and is an important step forward for those who it affects. However, in the United Kingdom, this manual is not part of the main set used as part of the diagnostic process. This is an issue that needs to be addressed if children in the UK are to have their needs fully met.

Currently, once diagnosis has been achieved, the next step is to implement support and strategies throughout the medical, educational and family units that can benefit them in areas such as speech, movement, comprehension and interaction with other people. If sensory behaviours were included in the UK's diagnostic process, strategies would need to be employed by the professional multi-disciplinary team in order to manage and improve the problem areas.

There are many agencies currently utilised by the educational establishment that come into schools and offer support for children with a myriad of learning difficulties. As a strategy for managing sensory behaviours, a game-based learning intervention, such as that developed in this study, could be used as a tool for enabling children to overcome social phobias in schools such as those that I visited during the development process.

The development of the intervention was limited by time and the small sample group but with further enhancement the game could be adopted for use within the school establishment and made adaptable to reflect the different sensory areas and propose strategies to meet individual circumstances. Educational institutions are legally obliged to ensure that disadvantages arising due to learning difficulties are minimised (HMSO, 2010). Similarly, with regard to the design of the intervention, accessibility guidelines should be observed so that it does not discriminate against anyone with a disability (WCAG, 2008). If this can be improved by the adoption of game based learning within schools then those responsible for writing the policies have a duty of care to consider how they could accommodate children with autism within the education system.

If sensory behaviours were included in the diagnostic criteria, the educational establishment would, by default, have to give due consideration to the management of the problem. This is an opportunity for flexible game-based learning to be implemented as part of the Individual Education Plan (IEP) developed for each person displaying special needs. This could be achieved by the allocation of a small amount of time with a teaching assistant to explore strategies used within the game and how they can be utilised in daily life.

5.6 Reflections on the Research Methodology

I feel that using the design-based research methodology was the appropriate and correct choice for the study. The methods used to collect and analyse the data and the evaluation from the participants during the cyclical process enable the design of the intervention to progress and fitted the requirements of the investigation. However, the volume of data that was collected and analysed could have been greater and enabled further refinement to take place if the parents had been involved on a more collaborative basis.

Unfortunately, the level of confidentiality invoked by the schools made it impossible to match the data collected from the students with the parent responses. While the replies were consistent with the information supplied by the students in terms of applying a positive or negative response to the questions, there was no depth of answer given by way of explanation. In the majority of cases, the severe communication and learning difficulties of their child were cited as the reason for the lack of data and this meant that the data collected was of a basic quality.

The responses ascertained from the students who participated, whilst displaying different levels of abilities, were able to supply sufficient data to establish a variety of difficulties experienced in each sensory area. In the short time that I spent with them they felt comfortable enough in my presence to give specific details of the problems that they experienced and how it manifested itself and in some cases how they managed the problem.

The one area where the data exceeded that given by the students was in the gustatory category, presumably derived from the fact that they have to feed their children and the difficulties are more pronounced at this time. In all other areas the students were more expansive with their information. Therefore, the sparseness of the data supplied from the parental questionnaires poses some questions to discover why there was such a contrast in the detail. These questions are unable to be answered with any certainty but it is possible that none of the replies from the parents or guardians were related to those of any of the students and also that extensive learning difficulty was a factor.

Another point to note is that the responses to the questionnaires were very subjective from the point of view that people could only give their own perspective. People with autism have an awareness that other people cannot have because it is something that is happening to them. Their ability to communicate this to others is restricted by their level of ability and their trust and confidence in other people. They are also unlikely to be forthcoming in dispensing information without someone asking the question. As discussed earlier in section 5.2, I know from my own experience that the question needs to be asked in the right way in order to garner a response that the questioner is looking for. It is possible to ask a question in many different ways and generate no response at all.

Taking the above into consideration and the communication between parent and child it is possible that any questions regarding sensory difficulties may not have arisen and, therefore, the parent or guardian may not be aware of the problems experienced. Their responses to the questionnaires may have been provided entirely from observation.

This does not mean that the data was distorted in any way, or that the action based methodology was the wrong approach, but it does mean that the findings could have been strengthened if names had been used and the parental data could have been matched to that of the students. It would have enabled any differences in perceived sensory difficulties to be highlighted and recorded as part of the qualitative data. In addition to this, if collaboration had been possible, both parties could have learned something that could have enriched their understanding of themselves and each other.

Overall, I believe that the information received from the questionnaires and interviews showed that the qualitative and quantitative data retrieved throughout the cyclic process enabled the development of the intervention to progress to a successful outcome. Therefore, the choice of design based research methodology was a justified and correct choice.

5.7 Aspects Relevant to Practitioners

Even using a small sample population, the study highlighted the extent of the problem that sensory dysfunction has on the autistic community. The inclusion of sensory behaviours in the latest edition of the DSM (APA, (2013)) as discussed in Chapter 2 reflects the recognition of how debilitating sensory problems are for those affected.

Sensory dysfunction is something that has not previously been included as part of the diagnostic process as practitioners have only considered elements incorporated in the Triad of Impairment discussed in Chapter 2. However, the inclusion of sensory behaviours in the DSM has stretched the boundaries of perceived areas of difficulty so that clarification of individual circumstances can be sought and strategies and coping mechanisms can be offered to their clients in liaison with the family unit.

As discussed in Chapter 2, game based learning can be a motivational medium for learning and improved performance. It is also carried out in an environment that is safe from external consequences (Whitton, 2012) so that players have the flexibility to make their own choices and decisions. However, despite the benefits that it may have, my research suggests that its use by practitioners is currently limited.

The development of the intervention is a safe learning environment where the user is exposed to some sensory stimuli. My background research suggests that there is no product currently available where the central component is concerned with sensory behaviours. The findings from the study indicate that the intervention as a game-based learning tool could have a positive benefit in the management of sensory distress and is something that practitioners could utilise and recommend.

5.8 Suggestions for Further Research

Throughout the term of the investigation, whilst some questions were answered, it also raised significantly more. The answers to these questions were precluded from being answered by time-span of the study and limited number of participants and are discussed in further detail below. The challenges that are discussed above are also examined in terms of how they would benefit from further research.

In essence, the study was unable to be completed to the fullest extent because the brevity of its duration precluded the opportunity to monitor performance over an extended period of time. This monitoring includes evaluating multi-disciplinary input in areas concerning actions when the fire alarm sounds in real time and positive or negative sensory behaviours that are observed or related over an extended period of time.

As discussed earlier in the Chapter, in order to answer the research question in its entirety the intervention would need to be developed within a series of different environments such as home, school, work or social activities. This had an impact on the ability to look at all the sensory areas as several of the issues raised were something that would be in the 'home' box as opposed to being within the school environment.

As mentioned earlier, the data was restricted by the numbers of participants, the inconsistency of having different students evaluating the intervention during each cycle and the lack of cohesion between the student, teacher and parental information. It is apparent from the findings from the cyclic process that the study only skimmed the surface of its potential and was limited by virtue of it being a one year investigation.

The information given by the students evidenced the diversity of individual problems which, as discussed earlier in the Chapter, precluded them from further development in the limited time available. However, with the benefit of further research and refinement, the intervention could be customised by the users in terms of environment, colour, sound or other sensory areas to meet their individual circumstances in a more complete manner.

Therefore, the investigation would benefit from being undertaken over a 3-5 year period with a larger and dedicated group of participants. Additionally, as discussed above, a more collaborative examination of data extracted from each group may enable a greater knowledge base of individual circumstances which could be used in the wider community and for personal improvement and also within the family unit.

Within the design it would have been better if I had time to undertake a further cycle and been able to monitor reactions to different types of hearing protection into the schools such as headphones, ear plugs or cotton wool so that the students could wear them whilst playing the scenario to see if it made a difference to their ability to concentrate on the task. This is something that could be undertaken with further study and allows the individual to manage their choice of coping mechanism.

An extended investigation would also enable the research to be cascaded through the other sensory areas and for different scenarios to be examined and developed. In this way the research question would remain the same but the answer would be more complete. It would also be possible to explore the compartmentalisation issue and look at the possibility of either merging that divide or developing separate interventions for assorted environments.

Whilst it appeared that those with lower functioning autism derived the greater benefit from the intervention, this does not mean that those with higher functioning abilities did not benefit. What is not determined, and should be examined in further research, is whether

someone who has a higher functioning ability and appears to be able to manage without an intervention for their sensory behaviours mean that their difficulties are less or just that they have the greater ability to manage more for themselves and are able to develop their own coping strategies.

5.9 Conclusions

In conclusion, I will reiterate the research question and the aims of the investigation and discuss how the aims were addressed followed by the achievements of the study.

The research question was to discover whether a game-based learning tool would be effective in assisting school children with an Autistic Spectrum condition overcome their sensory difficulties.

As stated in Chapter 3, the aims of the investigation were to:

- a. Investigate whether a game-based intervention could be of benefit to people on the autistic spectrum with regard to sensory dysfunction.
- b. Examine whether, and the extent to which, such an intervention might impact on the autistic person's self awareness of their sensory problems.
- c. Explore the use of the intervention as a tool to develop coping mechanisms that could minimise the effects of a particular sensory difficulty.

In respect of the first aim, this was addressed from several different perspectives. Firstly by gaining data and feedback from the students on the autistic spectrum who displayed sensory difficulties and who were instrumental in the development process of the intervention.

Secondly, from information given by the teaching and support staff within the schools who were able to see the intervention's potential beyond that of its original purpose. Thirdly, the observational particulars provided by parents which supplemented the data gained from the other parties and which helped to direct the focus of the study. The feedback given from

students, teaching and support staff during the cycle process was analysed for the purpose of discovering the potential efficacy of the intervention.

The second aim was to discern if people on the Autistic Spectrum who display sensory difficulties, not only have an awareness of their problems but through playing the intervention, can be individually proactive in understanding that there are actions they can take to minimise the effects. Through the questionnaire and interview process it was apparent that the students were aware that within the sensory categories there were elements that affected them negatively and in some cases were quite debilitating. The objective of this was to observe during game-play if the students themselves could realise that there was a way to minimise the effects using the reward structure as an example and consider alternative ways that they could potentially help themselves. As discussed in Chapter 4, this was more successful with the students with higher functioning abilities.

The final aim was concerned with coping mechanisms and how the intervention could be used as a tool to offer ideas for coping mechanisms that could be readily used during everyday life when a sensory problem occurred. For reasons described in Chapter 4, the focus was given to auditory and optic sensory difficulties which took account of those with additional disabilities and the aim was addressed in two ways.

Firstly, in normal game-play with ongoing sensory input where the student was required to reach a destination. This required the ability to concentrate on a task that would normally cause them some distress and be able to achieve the goal in a timely manner. Therefore, understanding what was required and having a goal to achieve, assisted in being able to overcome the sensory input.

Secondly, with the incorporation of a game reward structure designed to offer a strategy that could be used to minimise the effects of sensory distress. In contrast to the second objective, which was aimed at the person, this goal addressed the idea of the use of coping mechanisms in general and adaptation to individual need through the use of support networks in place such as family, educational and medical practitioners.

Throughout the conclusions, I have considered what the research brought to the study and how the methodology supported the outcomes that were reached. There were a number of encouraging findings from the investigation in terms of ways that that schools' would be able to use the intervention for the benefit of the students as shown below.

The ability of the participants to execute the fire evacuation requirements whilst under sensory duress during game play was successful. However, the greatest challenge to reaching a conclusive result was the inability to evaluate the students' reactions to the sensory stimuli when it occurred outside of the game environment. This was the final component that the study needed to be able to evaluate in order to have been able to give an estimation of the advantages that could be derived by the use of the intervention.

Other accomplishments were that the participants were able to immerse themselves in the task and were motivated to complete the mission and collect the reward. At the end of the cyclical process their focus was entirely on the game and the peripheral distractions had been eradicated.

Another positive aspect and an unexpected deviation of the intended purpose of the intervention was the potential for it to be used in lessons as a learning tool for understanding direction for personal movement and navigation around buildings. It could also be used as a tool to meet the health and safety requirements of explaining fire evacuation procedures in a visual way which makes it a versatile product.

Finally, while the conclusions of the investigation have some merit, the ability to fully answer the research question is unable to be realised without the benefit of further and more detailed research in order to enable the development of the intervention to become a comprehensive game-based learning tool.

Appendix 1

Letter from Mainstream School



TRINITY ACADEMY

The Emmanuel Schools Foundation

Mr Robert Kean
12 Travis Grove
Thorne
Doncaster
DN8 5PL

3 December 2012

Dear Robert

Thank you for your letter, dated 23 November 2012, in regards to potential research here at Trinity. Regrettably I cannot see that we have students suitable for this work, nor could we fit it in to our curriculum, so I will have to decline your request.

I wish you well with your work.

Yours sincerely

Mr I Brew
Principal

Ian T Brew BA (Hons) Principal

Trinity Academy, Church Bate Thorne, Doncaster, DN8 5BY Tel: 01405 813 000 Fax: 01405 818 382
Email: enquiries@trinityacademy.org.uk www.trinityacademy.org.uk

Registered Office: Venture House, Aykley Heads, Durham, DH1 5TS Company Registration No. 4916397



Appendix 2

Parent Letter

Dear Parent / Guardian / Carer

My name is Robert Kean and I am undertaking a post-graduate research master's degree into the use of computer games as an intervention for people on the autistic spectrum who have sensory difficulties. My aim is to encourage the use of game-based solutions to enable the person to be more adaptable in their environment.

I am currently working at your child's school to identify information that I can use both to identify the problems and form a solution.

In order to complete my research I require the assistance of a range of people on the autistic spectrum who display a range of sensory difficulties. These sensory difficulties are aimed at problems with colours, numbers, textures, sounds, smell and touch but will also take account of other unusual cases that arise.

The information I am looking to acquire are the sensory difficulties each person has, why it is a problem to them, how it makes them feel and if they try to avoid coming into contact with these sensory problems and what happens when they come across them unexpectedly.

In addition, I would like to be able to take into account the perspective of parents in terms of what sensory issues they notice, how these problems identify themselves and the mechanisms that they have put in place as a solution.

What I want to discover is if the mechanisms used in a computer game environment can then be carried forward into real life situations.

I, myself, have a diagnosis of Asperger Syndrome and have a number of sensory difficulties that have given me problems in education and everyday living. I am hoping that by providing an 'out of the box' intervention I can create an awareness or understanding of certain difficulties and that solutions can be put in place to eradicate or minimise the effect of the problem.

I would be grateful if you could complete the attached checklist and return it to your child's school so that I can use the information to get a fuller picture of what I can put into the design of my game to be of the most help to your child.

I can assure you that confidentiality will be maintained in the final thesis and no names will be given.

Thank you for your support.

Robert Kean

Appendix 3

Student Questionnaire Part 1

STUDENT DETAILS

School:

Name:

Age:

AUDITORY	OPTIC
TEXTURE	OLFACTORY
GUSTATORY	OTHER

Student Questionnaire Part 2

1. What sounds don't you like?
2. When you hear that sound, how does it make you feel?
3. What do you do when you hear it?
4. Do you not like the sound at all or just when you don't expect it?
5. Have you had a bad experience (time) when you've heard that sound?
6. Do you avoid foods because of the colour or texture (feel of the food)?
7. Are there any classrooms you don't like to go in because of the colour or the number on the door?
8. Do labels bother you in clothing?
9. Are there clothes you don't like to wear? Why?
10. Do bright lights upset you?
11. Why do they upset you? What do you feel like?
12. Do you find some smells are really strong?
13. When any of these things happen, does it stop you from thinking properly? What do you feel like?
14. What things make you feel good?
15. Do you have any objects that make you feel better, eg silky material

Appendix 4

Parent Questionnaire

Please tick the appropriate answer to indicate the statement described as follows:

WT = was true at any time in the past – in brackets please specify the age of the child when the statement was true, eg (2-5 yrs)

T = true now (if it was true and is true now, tick both answers)

F = false

NS = not sure or don't know

Additional information is welcome: write it in the comments box or copy the question number on a blank sheet of paper and add the information there.

Name of Child:

Age:

No	Statement	WT	T	F	NS	Situation	Solutions you have Used	Comment
1	Gets easily frustrated/tired under fluorescent lights							
2	Squints or closes eyes in bright light							
3	Is frightened by sharp flashes of light, lightening etc							
4	Covers or closes eyes at bright lights							
5	Gets frustrated with certain colours (specify)							
6	Is fascinated with certain coloured and shining objects (specify)							
7	Reactions are triggered by lights or colours							
8	Will avoid or refuse to go to place/eat foods with certain colours (specify)							

9	Covers ears at many sounds (specify)							
10	Dislikes haircuts							
11	Avoids sounds and noises (specify)							
12	Is attracted to sounds (specify)							
13	Gets frustrated with certain sounds (specify)							
14	Becomes frozen or confused when certain sounds occur (specify)							
15	Will avoid places or situations where particular noises occur (specify)							
16	Tries to destroy/break objects producing sounds (clock, telephone etc)							
17	Sudden outbursts, tantrums or withdrawal in response to auditory stimuli (specify)							
18	Covers/hits ears in response to lights, colours/touch, texture/smell/taste							
19	Complains about (is frustrated) with a sound in response to colours, textures, touch, scent, flavour							
20	Cannot tolerate new clothes or certain materials (specify)							
21	Complains about parts of the clothes (specify)							

22	Dislikes food of certain textures (specify)							
23	Likes pressure, tight clothing							
24	Low reaction to pain, temperature							
25	Overreacts to heat, cold, pain							
26	Cannot tolerate certain textures (specify)							
27	Is fascinated with certain textures (specify)							
28	Seems to be absorbed with certain textures (specify)							
29	Complains about (is frustrated with) headache, etc/heat/cold in colourful/noisy/crowded places							
30	Reactions are triggered by textures (specify)							
31	Runs from smells (specify)							
32	Cannot tolerate certain smells (specify)							
33	Avoids direct smell (eg leaves the kitchen when one is cooking)							
34	Reactions are triggered by smells (specify)							
35	Gags/vomits easily in reaction to certain foods / textures (specify)							
36	Is distressed by certain							

	foods or textures (specify)							
37	Displays tantrums or withdrawal in response to taste (specify)							
38	Reactions are triggered by certain food (specify)							
39	Doesn't like certain numbers (specify)							
40	Is distressed/has a reaction to certain numbers (specify)							
41	Will avoid/refuse situations where certain numbers arise (specify)							

Appendix 5

Evaluation Form

1. What do you think about the design of the level?
2. Is there anything in the design that you think is missing or needs including?
3. How realistic do you think the noise of the fire alarm is?
4. What do you like / don't like about the fire alarms?
5. What do you think about the colour of the light?
6. If you could change the light colour to something else, what colour would it be and why?
7. Does light and sound bother you – in what way?
8. How do you think it could be improved?
9. Would changing the brightness make it better for you – in what way?
10. What do you think about the size of the light?
11. Would making the light size bigger or smaller make it better or worse? In what way?
12. What do you think of the reward?
13. Do you think the reward is something that you would use to lessen the effects of the noise?
14. What is your opinion of the scenario overall?
15. Do you have any further comments or questions?

Bibliography

Adams E. (2010). *Fundamentals of Game Design* (2nd ed.). New Riders, Berkley, CA, USA.

American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.). Washington DC: Author

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Aron, E.N., Aron A. (1997). *Sensory-Processing Sensitivity and its Relation to Introversion and Emotionality*. *Journal of Personality and Social Psychology*. 1997, vol.73 p.p. 345–368

Asperger, H. (1944/1991). *Die "Autistischen Psychopathen" in Kind Esalter*. *Archive für Psychaitrie und Nervenkrankheiten*. 117, 760136. Translated by U. Frith (Ed.), *Autism and Asperger syndrome* (1991, p.p. 37-92). Cambridge, UK: Cambridge University Press

Attwood, T. (2007). *The Complete Guide to Asperger Syndrome*. London, Jessica Kingsley Press

Attwood, T. (2007). *Asperger's Syndrome: a Guide for Parents and Professionals*. London: Jessica Kingsley Press

Attwood, T. (2003). *Is There a Difference Between Asperger's Syndrome and High Functioning Autism?* Available at http://www.sacramentoasis.com/docs/8-22-03/as_&_hfa.pdf [Accessed 5 January 2014]

Ayres, J. A. (1972). *Sensory Integration and Learning Disorders*. Los Angeles, CA: Western Psychological Services

Ayres, J. A., Robbins, J. (1979). *Sensory Integration and the Child*. Los Angeles, CA: Western Psychological Services

Ayres, J. A., Tickle, L. S., (1980). *Hyper-Responsivity to Touch and Vestibular Stimuli as a Predictor of Positive Response to Sensory Integration Procedures by Autistic Children*. *The American Journal of occupational Therapy*, June 1980, vol. 34, No 6

Ayres, A. (2005). *Sensory Integration and the Child*. Los Angeles, CA: Western Psychological Services.

Baxter, P., & Jack, S. (2008). *Qualitative case study methodology: Study design and implementation for novice researchers*. *The qualitative report*, 13(4), 544-559.

Berrios G E (2011) *Eugen Bleuler's Place in the History of Psychiatry*. *Schizophrenia Bulletin*, vol. 37(6) p.p. 1095-1098

Björk. S., & Holopainen, J. (2005). *Patterns in Game Design*. Massachusetts: Charles River Media.

Blake, A. (2010). *Welsh Sensory Study Aims to Improve Autism Treatments*. Western Mail, 4 August 2010

Boehm, B. (1988), "A Spiral Model of Software Development and Enhancement," *IEEE Computer* vol. 21(5) p.p. 61-72

Bogdashina, O. (2001). *A Reconstruction of the Sensory World of Autism*. Sheffield Hallam University Press.

Brown, A. L. (1992). *Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings*. The Journal of the Learning Sciences vol. 2(2) p.p. 141-178.

Cobb, P. (2001). *Supporting the Improvement of Learning and Teaching in Social and Institutional Context*. In S. Carver & D. Klahr (Eds.), *Cognition and instruction: Twenty-five years of progress* (p.p. 455–478). Cambridge, MA: Lawrence Erlbaum Associates

Collins, A. (1992). *Towards a Design Science of Education*. In E. Scanlon & T. O'Shea (Eds.), *New directions in educational technology* (p.p. 15-22). Berlin: Springer.

Crookall, D., Saunders, D. (1989). *Towards an Integration of Communication and Simulation*. In D Crookall & D Saunders (Eds.), *Communication and simulation: from two fields to one theme* (p.p. 3-29). Clevedon, UK: Multilingual Matters.

Delacato, C. (1974). *The Ultimate Stranger: the Autistic Child*. Noveto, CA: Academic Therapy Publications

DeMyer, M.K. (1976). *Motor, Perceptual-Motor, and Intellectual Disabilities of Autistic Children*. In: Wing L, editor. *Early Childhood Autism*. 2. Pergamon Press; Oxford: p.p. 169–196.

Design-Based Research Collective. (2003). *Design-Based Research: An Emerging Paradigm for Educational Enquiry*. Educational Research vol. 32(1), p.p. 5-8.

Dickerson Mayes, S., Calhoun, S. L., Murray, M. J., Morrow, J. D., Yurich, K. K. L., Mahr, F., Cothren, S., Purichia, H., Boudier, J. N., Petersen, C. (2009). *Comparison of Scores on the Checklist for Autism Spectrum Disorder, Childhood Autism Rating Scale, and Gilliam Asperger's Disorder Scale for Children with Low Functioning Autism, High Functioning Autism, Asperger's Disorder, ADHD, and Typical Development*. Available at http://www.thevistaschool.org/upload/The_Vista_School_checklist_study.pdf [Accessed 10 June 2013].

Dunn, W. (1997). *The Impact of Sensory Processing Abilities on the Daily Lives of Young Children and their Families. A Conceptual Model*. Infants and Young Children vol. 9(4) p.p. 23-25.

Dunn, W. (1999). *Sensory Profile Manual*. The Psychological Corporation, San Antonio.

Dunn, W. (2001). *The Sensations of Everyday Life: Empirical, Theoretical and Pragmatic Considerations*. The American Journal of Occupational Therapy vol. 55(6) p.p. 608-620

Dunn W., Saiter, J., Rinner, L. (2002). *Asperger Syndrome and Sensory Processing: A Conceptual Model and Guidance for Intervention Planning*. Focus on Autism & other Developmental Disabilities vol. 17(3) p.p. 172-185

Entertainment Software Association (n.d.). *Games: Improving Education*. Available at <http://www.theesa.com/games-improving-what-matters/education.asp> [Accessed 10 July 2013]

Frith, U. (1991). *Autism and Asperger Syndrome*. Cambridge University Press.

Garris, R., Ahlers, R., Driskell, J.E. (2002). *Games, Motivation and Learning: A Research and Practice Model*. Available at <http://www.thaisim.org/articles/Garris%20et%20al%20-%202002%20-%20Games,%20motivation,%20and%20learning%20-%20441.pdf> [Accessed 2 July 2013].

Gilliam, J. E. (2003). *Gilliam Asperger's Disorder Scale*. PRO-ED, Austin, Tx

Grandin, T. (1996). *My Experiences with Visual Thinking. Sensory Problems and Communication Difficulties*. Web based article from the Center for the Study of Autism.

Halford N. & Halford, J. (2001). *Swords and Circuitry: A Designer's Guide to Computer Role Playing Games*. Roseville, CA: Prime Publishing.

Hamilton, K. (2011). *High School Sucked. Can We Please Have More Games About It?* Available at <http://kotaku.com/5868250/high-school-sucked-can-we-please-have-more-games-about-it> [Accessed 3 July 2013]

HMSO (2010) *The Equality Act 2010*. The National Archives. Retrieved 1 February 2014.

Jackson, L. (2002). *Freaks, Geeks & Asperger Syndrome. A User Guide to Adolescence*. London: Jessica Kingsley Publishers

Jones, R. P., Quigney, C., Huws, J. C. (2003). *First Hand Accounts of Sensory Perceptual Experiences in Autism: A Qualitative Analysis*. Journal of Intellectual and Developmental Disability, vol. 28(2) p.p. 112-121

Kanner, L. (1943). *Autistic Disturbances of Affective Contact*. *Nervous Child* 2, p.p. 217-250

Kemmis, S. (2008). *Critical theory and participatory action research*. The SAGE handbook of action research: Participative inquiry and practice, (2), p.p. 121-138.

Kientz, M. A., Dunn, W. (1997). *A Comparison of the Performance of Children with and without Autism on the Sensory Profile*. American Journal of Occupational Therapy, 51, p.p. 530-537.

Krug, D. A., Arick J., Almond P. (1980). *Behaviour Checklist for Identifying Severely Handicapped Individuals with High Levels of Autistic Behaviour*. Journal of Child Psychology and Psychiatry. vol. 21, Issue 3 p.p. 221-229

- Lewin, K. (1946) *Action Research and Minority Problems*. J Soc. Issues 2(4) p.p. 34-46
- Li, K-H., Lou, S-J., Tsai, H-Y., Shih, R-C. (2012). *The Effects of Applying Game-Based Learning to Webcam Motion Sensor Games for Autistic Students' Sensory Integration Training*. The Turkish Online Journal of Educational Technology, vol. 11, Issue 4. Available at www.tojet.net/articles/v11i4/11446.pdf
- Love, S.R., Matson, J.L., & West, D. (1990). *Mothers as Effective Therapists for Children's Phobias*. Journal of Applied Behaviour Analysis, vol.23 p.p. 379-385.
- Marco, E. J., Hinkley, L. B. N., Hill, S. S., Nagarajan, S. S. (2011). *Sensory Processing in Autism: A Review of Neurophysiologic Findings*. Pediatric Research, vol. 69 p.p. 48-54
- Marita, (2008). *Going Out and About with Autism and Sensory Processing Disorder*. Available at <http://www.stuffwiththing.com/2008/12/going-out-and-about-with-autism-and-sensory-processing-disorder/> [Accessed 4 June 2013].
- MouseTrial (n.d.). *Autism Software*. Available at http://www.mousetrial.com/autism_software.html [Accessed 21 August 2013].
- Mugsy.org (n.d.). *Sensory and Motor Disorders*. Available at www.mugsy.org/asa_faq/definitions/sensory.shtml [Accessed 19 November 2012].
- Nadon, G., Feldman, D. E., Dunn, W., Gisell, E. (2011). *Association of Sensory Processing and Eating Problems in Children with Autistic Spectrum Disorders*. Autism Research and Treatment. vol. 2011, Article ID 541926
- National Autistic Society (n.d.). *Difference between Asperger's Syndrome and High Functioning Autism*. Internet data available at www.nationalautisticsociety.co.uk [accessed 30 June 2013].
- National Autistic Society (2009). *Representation of Triad of Impairment*. Internet data available at <http://www.ssc.education.ed.ac.uk/courses/deaf/dnov09ii> [accessed 13 October 2013].
- O'Neill, M., Jones, R. S. P. (1997). *Sensory-Perceptual Abnormalities in Autism: A case for More Research?* Journal of Autism and Developmental Disorders, vol. 27, Issue 3, p.p. 283-293.
- Ornitz, E.M., (1989). *Autism at the Interface Between Sensory Processing and Information Processing*. In Dawson G, editor. *Autism: Nature, Diagnosis, and Treatment*. New York: Guilford p.p. 174–207
- Rapp, J.T., Vollmer, T.R., & Hovanetz, A.N., (2005). *Evaluation and Treatment of Swimming Pool Avoidance Exhibited by an Adolescent Girl with Autism*. Behaviour Therapy, 36, p.p.101-105.
- Ricci, K., Salas, E., Cannon-Bowers, J.A. (1996). *Do Computer-Based Games Facilitate Knowledge Acquisition and Retention?* Military Psychology vol. 8(4) p.p. 295-307.

Ricciardi, J.N., Luiselli, J.K., & Camare, M. (2006). *Shaping Approach Responses as Intervention for Specific Phobia in a Child with Autism*. Journal of Applied Behaviour Analysis vol.39 p.p. 445-448.

Robbins, G. (2011). *UCSD Exploring why Robots Creep People Out*. U-T San Diego, 4 August 2011.

ROBOTA, (2008). Available at <http://kafee.wordpress.com/2008/01/06/robotas-doll-eyes/> [Accessed 2 June 2013]

Roxby, P. (2012). *Are Apps the Key to Revolutionising Autism Learning?* BBC News: Health, 15 January 2012.

Rutter, M., & Schopler, E. (1987). *Autism and Pervasive Development Disorders: Concepts and Diagnostic Issues*. Journal of autism and developmental disorders, vol. 17 p.p. 159-186

Schneider, E., Wang, Y., Yang, S. (2007). *Exploring the Uncanny Valley with Japanese Video Game Characters*. Available at <http://www.digra.org/wp-content/uploads/digital-library/07312.11004.pdf> [Accessed 10 July 2013].

Schopler, E., Van Bourgondien, M. E., Wellman, G. J., Love, S. R. (2010). *CARS2: Childhood Autism Rating Scale* (2nd ed.). Western Psychological Services (WPS), Torrance, CA

Sehaba, K., Estraillier, P., Lambert, D. (2005). *Interactive Educational Games for Autistic Children with Agent Based System*. Available at www.liris.cnrs.fr/ksehaba/ICEC'05_Sehaba.pdf [Accessed 2 July 2013]

Stake, R. (1995). *The Art of Case Research*. Newbury Park, CA: Sage Publications.

Sutton-Smith, B. (1997). *The Ambiguity of Play*. Cambridge, MA: Harvard University Press.

Susman, G. I. (1983). *Action Research: A Sociotechnical Systems Perspective*. (Ed.) G. Morton. London: Sage Publications p.p. 95-113

University of Alabama at Birmingham (23 June 2007). *Computer Game Helps Autistic Children Recognise Emotions*. Science Daily. Available from <http://www.sciencedaily.com/releases/2007/06/070622183516.htm> [Accessed 13 July 2013]

Vidosevic, T. (2009). *Using a Behavioural Treatment Package to Teach Tolerance to Sun Care Products to a Child with Autism: A Systematic Replication*. University of Texas

Walker, N., Cantello J. (Eds.) (1994). *You Don't Have to Have Words to Describe What I Experience*. Geneva Centre for Autism

Walker, N., Whelan M. (1994). *Geneva Symposium on Autism*, October 27, 1994, Toronto.

Wang, F., & Hannafin, M. J. (2005). *Design-Based Research and Technology-Enhanced Learning Environments*. Educational Technology Research and Development, vol.53(4) .p.p 5-23

Wang, H., Sun C-T. (2011), *Game Reward Systems: Gaming Experiences and Social Meanings*. Available at www.diagr.org/dl/db/11310.20247.pdf [Accessed 14 June 2013].

Web Content Accessibility Guidelines 2.0. Available from <http://www.w3.org/TR/2008/REC-WCAG20-20081211/> [Accessed 7 June 2014]

Wechsler, D. (1974). *Wechsler Intelligence Scale for Children – Revised*. New York: The Psychological Corporation.

Wechsler, D. (1981). *Wechsler Adult Intelligence Scale – Revised*. New York: The Psychological Corporation.

Wendt, T., Paavonen, J. E., Ylisaukko-Oja, T., Sarenius, S, Källman, T., Järvelä, I., von Wendt., L. (2005). *Subjective Face Recognition Difficulties, Aberrant Sensibility, Sleeping Disturbances and Aberrant Eating Habits in Families with Asperger Syndrome*. BMC Psychiatry, 5:20

Whitehall, B., McDonald, B. (1993). *Improving Learning Persistence of Military Personnel by Enhancing Motivation in a Technical Training Programme*. Simulation and Gaming, vol. 24 p.p. 294-313.

Whitton, N. (2012). *The Place of Game-Based Learning in an Age of Austerity*. Electronic Journal & e-learning vol. 10, Issue 2, 2012 (pp249-256) available online at www.ejel.org [Accessed 27 June 2013]

Williams, D. L., Goldstein, G., Minshew, N. J. (2006). *The Profile of Memory Function in Children with Autism*. Neuropsychology. vol. 20, No 1, p.p. 21-29

Williams, P., Nesbitt, K.V., Eidels, A., Elliot, D. (2011). *Balancing Risk and Reward to Develop an Optimal Hot-Hand Game*. The international journal of computer game research, vol. 11, Issue 1.

Williamson, B. (2009). *Computer Games, Schools and Young People*. A report for educators on using games for learning. Available at www.futurelab.org.uk/projects/games-and-learning [Accessed 2 July 2013]

Wing, L. (1969). *The Handicaps of Autistic Children – A Comparative Study*. Journal of Child Psychology and Psychiatry. 1996 vol. 10 p.p.1-40

Wing, L. (1976). *Diagnosis, Clinical Description and Prognosis*. Early Childhood Autism. Pergamon; Oxford

Wing L., Gould J. (1979). *Severe Impairments of Social Interaction and Associated Abnormalities in Children: Epidemiology and Classification*. Journal of Autism and Developmental Disorders, vol. 9, p.p. 11-29

Wing, L. (1981). *Asperger's Syndrome: A Clinical Account*. Psychological Medicine vol.11, p.p. 115-130

WHO (World Health Organisation). (1993). *The ICD-10 Classification of Mental and Behavioural Disorders*. Diagnostic Criteria for Research. Geneva: Author

Yin, R. K. (2003). *Case Study Research, Design and Methods*, (3rd ed.) Newbury Park: Sage Publications.