Designing an Educational Game for Children with Autism Spectrum Conditions to Encourage Nonverbal Communication

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Abstract

All people with Autism Spectrum Conditions (ASC) have a difficulty communicating with those around them in one form or another; nonverbal communication is one such difficulty for many with this condition. While analysis of the literature shows that nonverbal skills can be crucial in social life, very few interventions are available to help promote and develop such skills for this population. This dissertation therefore explores the possibility of a technology-based game to encourage nonverbal communication. An initial concept framework is proposed - a Charades-style, narrative-based roleplaying game - along with a number of design objectives relevant to making games for children with autism. This framework is then tested with neurotypical children during workshops, and feedback is sought from relevant experts, before the full game is designed and implemented for a touchscreen tablet interface.

The implemented system is then evaluated with respect to child workshops and expert interviews once again. It was found that such a roleplaying game is received well by children and that in the majority of cases, players were willing and eager to perform actions in front of their peers. Experts also provided positive input to the framework and generally expected the outcomes to be similar for children with ASC. It is concluded that the game and accompanying features proposed in this research do have potential to succeed in encouraging nonverbal communication; however more research is required to examine the limits of what can be achieved with this system.
"I want to prove that people with autism are not broken computers, we are different operating systems”

- ALAN GARDNER, The Autistic Gardener

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1 Introduction

Around 1% of people are described as having Autism Spectrum Conditions (ASC), which is classified by the American Psychiatric Association (2013) as a group of neurodevelopmental disorders that cause impairments in three main social domains: communication, interaction and imagination. The nature of the spectrum causes ASC to manifest in vastly different ways, resulting in varying levels of severity particular to the individual child. This results in difficulties when managing and treating the condition. Numerous intervention techniques have been researched, developed and put into practice over the past 50 years, and the topic is still an active area of exploration both in the academic world and - in more recent years - the commercial. The recent trend has been towards technological interventions with an apparent ‘explosion’ of ideas and products based on computers and tech in order to better tackle such issues (Hourcade, et al., 2013). The change in approach has proved successful in a number of contexts and research has been done to establish the significance that such developments may hold on interventions now and in the future (Fletcher-Watson, 2014; Hourcade, et al., 2013; Mineo, et al., 2011).

All people with ASC have an impairment with communication in some form or another. One such area of communication that has proved problematic is nonverbal communication (Wing, 1996). Nonverbal communication and the ability to express oneself through the nonverbal is a vital part of social life, and lacking skills in such areas can result in difficulties when conveying meaning, appearing natural and making relationships (Burgoon, et al., 2011). Yet there have been relatively few interventions that target this area, let alone technology based ones. This gives us scope to speculate what such a technological intervention may look like and thus the leading question underlying this project is:

What form might a technology-based game for encouraging nonverbal communication in children with autism take?

A number of steps are required in order to attempt to answer this question:

1. Review current literature on the topic
2. Devise a structured idea for a game that could tackle the problem
3. Have a number of sources inform on such a design
4. Build the system
5. Evaluate the success of the idea in terms of the research questions proposed
6. Discuss the implications of the findings and attempt to speculate how the idea can be taken further based on what has been learned during the project.

Investigating the potential of a system based on technological means in order to encourage children with ASC to express themselves nonverbally is therefore the main subject of this dissertation.
1.1 Project Roadmap

The remaining 6 chapters of this work mirror the steps described above and are structured as follows:

**Chapter 2** - The statistics, diagnostic criteria and most importantly the effects of ASC are evaluated with reference to research literature on the topic. Additionally the area of nonverbal communication and technology’s role in educating those with ASC are also covered.

**Chapter 3** - Here the literature is considered in context with the problem. A gap in the research is identified and research questions are proposed that form the basis for the work. Additionally a number of game design requirements are set out along with a corresponding initial game idea based on such requirements.

**Chapter 4** - Prior to implementing the initial idea, it is important to inform the design of the game to ensure it caters to the audience, allowing the research questions to be adequately answered. Gathering such information is the purpose of this chapter. Informing sources include the reviewed literature, neurotypical children, and relevant field experts.

**Chapter 5** - A description of the implementation process is given, including information about the development platform and game features. Implementation decisions are also justified here in reference to Chapter 4.

**Chapter 6** - Summative evaluation of the game and its potential effects on nonverbal communication for children with ASC will be described in this chapter. Success of the system will be evaluated with reference to design requirements and goals. The main objective of the chapter will be to assess and answer the research questions with reference to the evaluation methods.

**Chapter 7** - Here the project is put in a larger context as the main contributions are summarised and the overarching themes are addressed. There is also discussion of future work to verify the effectiveness of the system and propose ideas of where the system could be developed further.

These chapters are followed by the bibliography and appendices.
2 Literature Review

Autism is a condition that has been studied for only tens of years, back to the mid-20th Century. While previous cases - dating back hundreds of years - have been retrospectively thought of as autism (Frith, 2003), it was not until the early 1940s that Leo Kanner and Hans Asperger began using the term autism and in particular *early infantile autism* that the condition became more recognised and researched to the point it was identified as a medical condition. Although the field is relatively new, due to the high number of cases and severity of the condition, research and treatments have progressed quickly and there is a large body of work trying to address the issues inherent in Autism Spectrum Conditions.

2.1 Autism Spectrum Conditions (ASC)

Under the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) (2013) from the American Psychiatric Association, autism is classified as a lifelong *Neurodevelopmental Disorder*. There are 5 main diagnostic criteria set out under the DSM-5:

- **Criterion A** - A persistent impairment in reciprocal social communication and social interaction
- **Criterion B** – Restricted patterns of behaviour, interests or activities
- **Criterion C** – The symptoms are present from early childhood even if those symptoms are not recognized until later
- **Criterion D** – The symptoms limit or impair everyday functioning
- **Criterion E** – The social communication deficits are not in line with the individual

It should also be noted that autism is a spectrum condition, which means it can affect people in different ways and in varying levels of severity. The DSM-5 states “the symptoms of people with ASD will fall on a continuum” and “This spectrum will allow clinicians to account for the variations in symptoms and behaviours from person to person”. This issue is of paramount importance in understanding the limits and capabilities of those with ASC. Despite the complexity of a spectrum of conditions, there is a general consensus among experts on diagnostic criteria (Frith, 2003).

Prevalence rates of the condition can vary based on alternative diagnostic standards, procedures and where and when the diagnoses took place. For example the DSM-4 (1994) suggested from epidemiological studies that around 2-5 individuals in 10,000 have ASC. Meanwhile in 2014, the Centres for Disease Control identified 1 in 68 children as having ASC. The DSM-5 has been updated in line with the revised diagnostic criteria and a general figure of 1.1% prevalence rate - along with other sources (Brugha, et al., 2012) - has been calculated. It is agreed though that boys are more frequently affected than girls, however the exact ratio is unclear with various studies arriving at
men/women ratios ranging from 2:1 to 16:1 (National Autistic Society, 2015) - the cause for this is unknown. The issue here is that ASC is a complex disorder and the full range of the spectrum makes comprehensive treatment difficult.

There is currently no cure for ASC, however it is generally agreed that targeted education can vastly improve the outcomes for children with ASC and their later lives. Also under consideration are Early Intensive (Behavioural) Interventions, which are now seen as well-established treatments. Evidence shows that these highly focused interventions early in life can have noticeable positive effects with many children (Howlin, et al., 2009; Warren, et al., 2011; Lovaas, 1987).

2.1.1 The Triad of Impairments

Although a set of criteria under the DSM-5 was covered, a different system can be used to describe the effects of ASC, known as the Triad of Impairments. The majority of difficulties associated with ASC can be categorised under these 3 following categories:

1. Difficulties with Social Communication
2. Difficulties with Social Interaction
3. Difficulties with Social Imagination

This system is very common in literature and so it is more appropriate to use the Triad of Impairments to describe the issues and effects of ASC in greater detail.

2.1.1.1 Difficulties in Social Communication

People with ASC have difficulty producing and understanding both verbal and nonverbal communication; once again the spectrum aspect of the condition should be considered carefully. Some are completely nonverbal and do not speak while others have a good grasp of typical language (i.e. the grammar and definition of words) and can ‘speak’ competently, however have issues with the understanding and use of language. All people with autism suffer from communication issues though and the problems lie with whatever form of language they do use (Wing, 1996).

It was once estimated that between one-third and one-half of children with autism have no speech at all, however this proportion is much smaller among those who have received early intervention (Charman & Stone, 2006). Should the child not develop speech, then they may use alternative methods of communication such as gesture or even primitive sign language, this can be effective in some cases but still suffers from the same problems inherent in verbal communication (Wing, 1996). Most children do develop some speech, though it is most often delayed. The initial step for many is echolalia; this is a stage where the child repeats the words of others, often the first or last few words of a sentence. Some children stay in this stage for the remainder of their lives, perfectly able to pronounce words and phrases but will remain unable to produce spontaneous speech (Wing, 1996).
Some children go beyond the echolalic stage and are able to produce speech of their own to express themselves, however the understanding of language may still be impaired. Those with ASC take expressions very literally and this leads to issues with comprehending jokes or idioms. Even expressions such as ‘That film was cool’ may be understood as the film being cold. This can lead to problems integrating with others naturally and great offense can be taken by any jokes involving the individual (Wing, 1996). If the child reaches the stage of producing spontaneous speech then in the majority of cases they often have trouble controlling their voice, perhaps being too loud, monotonous or having a strange intonation (Wing, 1996).

2.1.1.2 Difficulties in Social Interaction

Impairments in social interaction can manifest in a number of ways but can be described as a difficulty in suitably interacting with those around them, be it lacking an understanding of social norms or simply not being able to realise others’ emotions and express their own. Some children may abstain completely from social interactions and instead will be content to play alone.

Lorna Wing (1996) described the impairments associated with social interaction by placing them into 4 different groups.

1. *Aloof Group* - manifests itself in early childhood and those who are socially aloof behave as though those around them do not exist. They do not answer to any calls and will seem distant in facial expression.

2. *Passive Group* - passive children may be happy to play with others but will take a passive role in the situation. This can be acceptable in early years but becomes more problematic in adolescence.

3. *Active but odd Group* - Different to the previous groups, these children will take an active role will those around them, however may act in peculiar ways and become difficult or aggressive without attention.

4. *Over-formal, stilted group* - A common pattern that is not seen until adolescence. This behaviour will come across as very polite and formal but sometimes excessively so.

The issue of holding joint attention is also apparent. Joint attention is described as a triadic relationship between two people and an object (Charman & Stone, 2006). This lack of joint attention can have implications with social interaction as seen when the individual fails to participate in the shared enjoyment of others (Howlin, 1997). Often there is little issue with what the individual does or says, more that the setting or context is simply inappropriate. The lack of understanding and recognition of others’ emotions can often cause the individual to say something that can cause offense. Additionally, they often have trouble expressing *themselves* nonverbally, with wooden facial expressions and rigid movement (Frith, 2003). This can have negative impacts on the way others perceive them. This deficit in social interaction can result in those with ASC struggling to integrate into society and form friendships.
2.1.1.3 **Difficulties in Social Imagination**

Social Imagination should not be taken in the sense that people with ASC do not have an imagination or are not creative, instead it has to do with their inability to adapt to new situations and behaviours. It is commonly referred to as a *rigidity of thought*.

Again this can appear in a number of different ways. In early life it can most prominently be seen in the way the child plays. Their involvement in pretend play and imaginative activities does not develop in the traditional way. Although they may use toys and objects in functional manners and in complex ways, they will not act out imaginative stories. At times they may be able to act out their favourite television/film characters but the enactment will be more repetitive (copying) as opposed to spontaneous (Wing, 1996). This lack of spontaneity will be apparent in later life, most commonly in their repetitive behaviour and need for routine and consistency.

As the individual grows older they may be able to enjoy a greater level of variation in their routines, however will continue to resist certain changes in aspects of their lives - unpredictable changes in particular can cause considerable distress (Howlin, 1997) when the individual does not have the mental flexibility to deal with it. Even for those without ASC, routines and consistency are essential in one’s daily life, but problems arise when the situation changes and the individual cannot, or the level of routine becomes so strict that it disrupts other aspects of their life (Howlin, 1997).

2.1.1.4 **Related Difficulties**

Beyond the triad of impairments there are a number of external issues that are commonly associated with ASC; these are not prevalent in every case and are not essential under the diagnostic criteria however they are important to consider. Learning difficulties are common with ASC and although a figure is not available for prevalence of those with autism that also have learning disabilities, it has been estimated that in the England, between 20 and 33 percent of those with learning disabilities, also have autism (Emerson & Baines, 2010). Such disabilities include ADHD, dyslexia, dyspraxia, and visual/hearing impairments.

Also to be considered is oversensitivity to sensory stimulation. It is often the case that loud or unexpected noises can cause increased stress to those with ASC over those without ASC. This is the same with visual stimuli, too much can provoke distress (e.g. the flashing of cameras), however these responses can fade as the individual grows older (Wing, 1996).

2.1.2 **Common Interventions**

Interventions for ASC take many forms and use various different techniques, however due to the variability of ASC there is little evidence supporting one intervention over another (Parsons, et al., 2009). There are a number of standardised educational programmes/tools that have proved effective. The following sections show examples of such tools.
2.1.2.1 TEACCH

TEACCH (Treatment and Education of Autistic and Communication Handicapped Children) is less of a single educational method and more of a system that finds appropriate methods for the individual. Specific emphasis is placed on improving the lives of the individual and their family by reducing the effects of disruptive behaviours. Among other techniques, this can involve creating unique educational programmes or working closely with parents to ensure treatment is being continued outside the education environment. The TEACCH system is well researched and has proved effective in many areas of autism education (Warren, et al., 2011; Trevarthen, et al., 1998).

2.1.2.2 PECS

Although PECS (Picture Exchange Communication System) is not designed exclusively for autism, it is most commonly used by those with ASC. The purpose of the system is to provide an alternative communication medium (beyond speech) and to encourage spontaneous communication. Since a significant number of those with ASC remain mute for all (or large portions of childhood) it is important that they can express their needs and wants to others. The PECS exchanges words for pictures and allows an association to build up between the two; the system also allows the individual to learn about sentence structure early on, without the need for speech. Although some think this will inhibit the development of speech there has been no evidence to support this and instead it has been seen in cases to facilitate spoken interaction (Tincani & Davis, 2010).

2.1.2.3 Narrative and Social Stories

It has long been recognised that story-telling has educational value, and it is generally agreed that they act as a powerful tool for organizing and transmitting information (Green, 2004). Narrative and stories have been used to teach a large range of people from primary school pupils to those in higher education while whole textbooks have been written on the topic (McDrury & Alterio, 2003). The discovery of this educational value has transferred onto the digital platform in recent years with the creation of Narrative Learning Environments (NLEs) where educational material is matched alongside a story - often learning gains and improvement in motivation are seen with these resources (McQuiggan, et al., 2008).

In the context of ASC, the creation of a narrative structure known as the Social Story has evolved. Social stories are relatively short stories that present a certain situation to the learner. Accompanying the story is a description of what one might expect to happen and why. For example - a character goes to the post office to send a letter; a description of the process of a queue may be described with an explanation that waiting in the queue is the fair way for everyone to send their letter. The underlying idea is that this will help teach certain social situations to those with ASC. Many studies have been conducted on the effectiveness of social stories and they are generally seen as positive tools in the process of educating those with ASC (Qi, et al., 2015).
2.2 Autism and Technology

Children with ASC have an affinity with computers and technology (Fletcher-Watson, 2014; Hourcade, et al., 2013) and these individuals spend considerable time with such devices (Mineo, et al., 2011). It has even been observed that individuals participated in higher quality communications with a virtual agent over their peers (Tartaro & Cassell, 2008). This realisation has resulted in an ‘explosion’ of technologies for supporting children and young adults with ASC while computer-assisted learning (CAL) has become a widely used technique by teachers and parents (Bhattachayra, et al., 2015). Further studies conducted to assess the effectiveness of these technology-based tools has shown that they have been well received (Ramdoss, et al., 2012; Bartoli, et al., 2014).

2.2.1 Benefits and Attraction of Technology

There appears to be a number of reasons why those with ASC are drawn to technology. It is thought that technology can provide a safe space for the children to explore in. Given their rigidity of thought, exploration within the real world can be a daunting task, meanwhile computer games or virtual worlds can provide an environment where they feel secure yet able to explore (Hourcade, et al., 2013). The real world can also be a confusing place where multi-sensory distractions may cause anxiety and stress, this can be mitigated and controlled with the introduction of digital tools. Additionally, processes and environments can be made very predictable and replicable within a computer and will often appeal to the behavioural aspects of the child (Bartoli, et al., 2014).

An additional benefit of technological interventions is the portability of digital tools. Given that devices capable of running widely distributable software can now be carried in your pocket, this provides the opportunity for these tools to be used at any time, be it at home or on holidays, not just in the classroom. This can give families the chance to do additional learning and play with their child without the expertise or material found in the specified learning environment.

2.2.2 Common Methodology

Mainstream technological interventions are fairly recent however there are some guidelines that can be followed when designing a tool like this.

- The ease with which customisation can be implemented within a game is a big benefit of technological solutions. As mentioned, ASC can affect people in vastly different ways and not adhering to a child’s unique issues may cause distress. There is therefore an incentive to provide a level of customisation to the games (Bhattachayra, et al., 2015; Fletcher-Watson, 2014), for example this could incorporate a choice of backgrounds or themes most suited to the individual (Bhattachayra, et al., 2015).
• Providing avatars for the individual is also seen as useful (Bartoli, et al., 2014). In a study by Bhattacharya et al. (2015) where children were represented on screen as they moved showed positive results for avatar representation. The response from teachers was – “allowing the children to see themselves on screen provides an inherent motivation and reward stemming from the ability to control the avatar” (pg. 75).

• There is a need to provide good quality multimedia when creating CAL for children. Being able to present attractive, engaging, audio content with animation is considered an advantage over traditional teaching methods (Fletcher-Watson, 2014). This multimedia should be able to provide dynamic stimuli for the entire game session, as so to ensure the child does not lose concentration – a prolonged static situation may trigger abnormal behaviours. Audio is particularly important and a balance should be found such that the sound is cheerful and engaging, while too much audio stimuli can be perceived as a mass of noise and may cause stress (Bartoli, et al., 2014).

• A suitable reward system should be found for children with ASC. With typically developing children a normal reward system may include accumulating trophies or points – this is not as valued by (medium-low functioning) children with autism. What is preferred is perhaps a short animation or audio effect that creates a sense of fun (Bartoli, et al., 2014). The joy of technological solutions is that we can give immediate rewards and a level of customisation of such rewards (Fletcher-Watson, 2014).

2.2.3 Technological Intervention Examples

There are hundreds of different apps, games and programs that have been designed to provide support for those with ASC. Below are some examples.

2.2.3.1 AACORN

This is an example of an Augmented and Alternative Communication (AAC) application. The purpose of the app is to provide children an alternative way to express themselves through a tablet as opposed to speaking. It is essentially a digital version of PECS. The child can navigate through graphical menus arranged as trees to reach the intended meaning and build sentences or phrases (see Figure 1) – once the sentence is finished it can be synthesised and ‘spoken’ by the tablet. Figure 1 shows the tree like interface of AACORN. The app is primarily for use by those in early age who have not developed speech yet, but can also works as a means of communication for those who are completely nonverbal. This app takes from the research described above and allows the app to be customised by adding new words or graphics specific to the individual.
2.2.3.2 Multitouch Tablet Games for Children with ASD

This is a suite of games made for a research project by Hourcade et al. (2013) as a means to enhance the social skills of children with ASD. A number of games were created with different purposes:

1. A freehand drawing game to be used with a pen, that also had a collaborative story telling option available
2. A musical game that turns the tablet into a harp-like device that can be used by multiple users at the same time
3. A visual puzzle that involves moving circles on the screen so that none overlap. This can be made into a team game by letting players only touch a subset of circles
4. A photo manipulation program that allows the child to upload photos and distort the image

The games were received well by the children and Hourcade et al. concluded that such technologies help learn more about children with ASC and how their minds work. They hypothesise that technology alone may be enough of an incentive to improve the quality of social interactions.

2.2.3.3 JeStimule – Teaching Children with ASC emotions

Again this is the result of a research project undertaken (Serret, et al., 2014) with the purpose of developing a serious game to teach the facial expressions associated with certain emotions. The game is a highly developed 3D virtual world and the intention is to allow the child to independently explore various situations and see different emotions in action. The game can be customised for the player’s skill and competence level throughout and is intended to be available for low and high functioning children up to the age of 18.

The game also has a level of data collection in the background that can collect statistics for further analysis by the research team. Results from the study were positive with children able to recall the
knowledge they had learned over a year later. They also noted – along with above research – that the use of child avatars in the virtual world was successful.

So it is clear that a wide range of games and applications can be made to focus on different aspects of autism and that when these games are produced in accordance with the research and guidelines, they are successful.

2.3 Nonverbal Communication and Gesture Use

2.3.1 Autism and Nonverbal Communication

It was seen in the above literature that those with ASC show difficulties in communication and expressing themselves. Deaf people may use nonverbal communication techniques such as sign language and lip reading, while children with a language disorder, but without autism, can communication in gesture, facial expressions and mime. Those with ASC however have an impairment in using even these alternative methods (Wing, 1996).

This deficit may be noticed quite early in life prior to any expected language use. As with a typically developing child you may see them reach with their arms to be picked up. This behaviour is not typically seen from children with ASC (Ricks & Wing, 1975; Wing, 1971). Some simple gestures will become used later in life, however this may never get beyond the point of nodding or shaking of head and complex gestures are rarely seen (Wing, 1996; Bartak, et al., 1975). Should the person be able to produce gestures, there is often confusion and a lack of proper execution as gestures become either too stiff and rigid, or oppositely too exaggerated and dramatic (Howlin, 1997).

Attwood et al. (1988) produced a study to examine the capacity of gesture use between typically developing children, children with Down’s syndrome and children with autism. Attwood split types of gestures into 2 categories; instrumental gestures that are used for a purpose (e.g. pointing to desired objects) and expressive gestures to convey a state of mind (e.g. thumbs up for ‘well done’). The results showed that the autistic children were capable of recognising instrumental gestures at a similar level as the two other groups. However when it came to producing instrumental gestures, or recognising and producing expressive gestures, those with ASC performed much more poorly than the other populations. While this research focused on conscious purposeful gestures, other work has been done to examine the effect on spontaneous gestures, such as those that implicitly accompany speech. The Autism Diagnostic Observation Schedule (ADOS) was developed (Lord, et al., 1989) as the ‘gold standard’ of diagnostic tests; a section of the test requires a child to read out a story while their nonverbal expressions are monitored – certain gestural traits can point to a diagnosis. It was observed through tests with the ADOS that while the frequency of gestures was similar to that of TD children, the quality and lack of synchronisation with speech exhibited by
those with ASC, contributed to lower quality story-telling that was harder to understand (de Marchena & Eigsti, 2010).

Targeted interventions in this area appear to be less common compared to speech development. The general approach is to encourage the child to learn through games, tasks, activities and situations (such as employed in social stories) and any sign of willingness from the child to express nonverbally should be greeted with pleasure and appreciation (Trevarthen, et al., 1998). Nonverbal communication is important in social life and the lack of such skills (or if skills are developed, the awkwardness associated with the expression) can still cause teasing from peers (Ricks & Wing, 1975).

2.3.2 Different types of nonverbal communication

It is particularly hard to pin down what is and is not classed as nonverbal communication. Determining what counts as a message is more difficult than it seems, but that decision is key to deciding how different scholars choose to define what is and is not nonverbal communication (Burgoon, et al., 2011).

The SAGE Handbook of Interpersonal Communication (2011) defines 8 different types of nonverbal communication:

1. Kinesics
2. Vocalics
3. Physical Appearance
4. Proxemics
5. Haptics
6. Chronemics
7. Environment and artifacts
8. Olfactics

These are referred to as communication coding systems. For the purposes of this project we will only be considering Kinesics and Haptics; this is because the remaining 6 coding systems are more closely related to unintentional or subconscious communication and this is beyond the scope of teaching children with ASC. Kinesics refers to the movement (and interpretation of movement) of the body, including posture, gestures, facial expressions, head movements and eye gaze. Meanwhile Haptics is concerned more with forms of touch such as hugs, pats and kicks.

Beyond this there are also 5 levels of communication exchange when considering nonverbal communication (Guerrero & Floyd, 2006). These can be thought of a messages sent from a sender to a receiver but encrypted and decrypted with coding systems.
Literature Review

1. Successful communication – A message is successfully encoded and decoded
2. Miscommunication – A message is successfully encoded but inaccurately decoded
3. Accidental Communication – An unintended message is decoded successfully
4. Attempted Communication – A message is encoded successfully but not received
5. Misinterpretation - An unintended message is decoded inaccurately.

2.3.3 The importance of nonverbal communication

There is no doubt that nonverbal communication is important in getting our message across (whether intentional or not) and often holds more clues to true meaning than verbal communication. This is emphasised by Mary Ritchie Key (1982) as she states that “Language is accompanied, modified, reinforced, enhanced and nullified by nonverbal concomitants. It seems probable that nonverbal modalities carry the heavier weight of expressive and emotive messages” (pg. 9).

There have been numerous studies on the importance of nonverbal communication. Carton et al. (1999) conducted a study with college students; those who were better at decoding nonverbal cues reported having better personal relationships. Meanwhile those who showed decoding issues had relationships that were less well off. A review of such studies was carried out by Burgoon (1985), it revealed a number of matters

- Adults generally rely more on nonverbal than verbal cues in determining meaning
- Children rely more heavily on verbal cues when growing up but prior to adolescence they find greater belief in nonverbal signals
- As verbal and nonverbal cues become more contradictory, adults tend to rely more heavily on the nonverbal.

Producing nonverbal communication is also important in making a good impression and developing new relationships and friendships (Burgoon, et al., 2011). Imada et al. (1977) produced a study that found clear evidence that job interview impressions and decisions are susceptible to the applicant’s nonverbal behaviour and even suggested that training applicants in nonverbal communication would be useful. It is well summed up by Burgoon et al. (2011) who states,

“Nonverbal messages constitute a large part of the communication system, and skill in encoding and decoding nonverbal messages is indeed one key to building and maintaining a satisfying life” (pg. 242)
2.3.4 Nonverbal Communication Training

Most of our ability to both send and receive nonverbal signals are gained through processes that are inherent in daily living; we learn our nonverbal skills (not necessarily consciously) from imitating and modelling others, while adjusting our skills based on the interactions and feedback we receive from those around us (Knapp, et al., 2012). The fact that we pick up the majority of nonverbal skills without explicit teaching may explain why little research has been done into the area of nonverbal communication training.

However attempts have been made into providing solutions to the issue, many of which employ techniques based on roleplaying to encourage the participants to practice such nonverbal signals and receive direct feedback on their performance (Serber, 1972; Belleck, et al., 1979; Minskoff, 1980). More in-depth roleplaying situations have been used to teach communication skills in business. In a particular piece of research (Sigmar, et al., 2012), games such as the ‘Corporate Blindfold’ or ‘Emotion Charades’ were created as teambuilding exercises to develop self-awareness, verbal and nonverbal communication among colleagues within a single business.

2.3.5 Gesture, Autism and Technology

Relatively few technological interventions can be found that teach gesture use to children with ASC. There are however some examples of games that require full body interaction between children and technology. One research project that provided this level of interaction was by Bartoli et al. (2014). A series of games were created for children with ASC to play. Interaction with the technology was facilitated by a Microsoft Kinect vision system and children were involved in games that required them to move an avatar on screen and avoid objects or pop bubbles. Another suite of games created separately by Bhattacharya et al. (2015) worked on similar principles as Bartoli’s work. One of these games did require the children to perform gestures at times during an interactive story; the gestures were then to be recognised by a Kinect system and encouragement given for correct gestures. The vision system was unfortunately unable to competently detect gestures and that particular game had to be abandoned.

2.4 Conclusion

The literature here shows that there exists a large body of research, spanning tens of years, in the individual areas of Autism Spectrum Conditions and Nonverbal Communication. It was seen that ASC is a recognised medical condition under the American Psychiatric Association and that although prevalence figures often vary based on certain criteria, a general figure of 1% of people are directly affected. It was also noted that the majority of difficulties faced by those with ASC are categorised under deficits in Social Communication, Social Interaction and Social Imagination.
Meanwhile Nonverbal Communication is a well-documented topic spanning many fields. It is generally seen that skills in nonverbal communication are essential to the socialising process and the fact that people with ASC have difficulties expressing themselves by such means suggests that this will contribute heavily to how they can integrate in life.

There have been many approaches to the challenge of teaching skills to people with ASC and recently this factor has made the jump to modern technology (affordable computers and mobile technology). The recent rush of tech-based interventions has seen games to teach emotions, collaboration and verbal communication. There does however appear to be a gap in the area of nonverbal communication – the field appears void of any system specifically designed for this purpose – knowledge of non-technical teaching methods suggests this is an area worth exploring.
3 Concept Development

3.1 Project Development Methodology

The following methodology used for design and evaluation of the project was adapted from the Scaife and Rogers (2001) framework for informing design of virtual environments for children. The adapted framework consists of 6 stages as described below.

Stage 1 – Specifying the Research Questions and Requirements

The initial stage of the process defines many of the themes and ideas that will be prominent throughout the project. In this stage we decide the what and why we are building. This enables us to have a clear picture of the problem space before committing ourselves to a particular design solution (Scaife & Rogers, 2001). This stage will be fuelled by existing theory and literature, such that gaps in research can be identified as areas to explore – this should allow the researcher to establish research questions. Based on the literature, a set of requirements suitable for the subject should also be generated such that the design, implementation and evaluation can be based on these. An initial idea for the project should be the outcome of this stage.

Stage 2 – Prototyping and Mock-Ups

This stage involves developing the initial idea from Stage 1. This development can be in different forms from simple descriptions of the system, to non-technological mock-ups, to implemented prototypes. The purpose of this stage is to have the system in a basic format that can be understood by potential users or experts so they can provide adequate feedback.

Stage 3 – Informing the Design

This stage allows a level of feedback on what was developed in Stage 2. In this stage we consider our developed mock-ups and assess whether an implemented version of this framework can be an effective tool for answering the research questions and meeting the requirements. This is done through two exercises – testing the framework with children, and getting feedback from experts. The extracted data will inform the design of the implementation and allow changes to be made if needed. A set of Design Objectives should also be generated during this stage to provide design goals to aim for.
**Stage 4 – Implementation**

Based on the mock-ups from Stage 2 (and revised version from Stage 3) the system is generated for the chosen development platform. An iterative process will be applied to the development where different versions of the system are implemented before their suitability is assessed against the requirements, design objectives and Stage 3 feedback. Changes are made to the system to attempt to bring them in line these criteria.

**Stage 5 – Evaluation**

In this stage we test the system that has been built in Stage 4, and most importantly, using the system as a tool, attempt to answer the research questions set out in Stage 1. A number of evaluation techniques such as interviews and observation will be used to provide summative evaluation. Similar to Stage 3 the project will be tested with child users and field experts.

**Stage 6 – Future Directions**

It is likely the case that not all the research questions will be addressed comprehensively, so this stage allows the researcher to speculate on future directions and adaptations to the project that would allow further research to be conducted to better answer such questions or even propose follow up development.

### 3.2 Research Question

Given the literature that was reviewed in the previous section a few things were apparent when considering potential designs of a new game for children with ASC.

- All children with ASC have difficulties in communication regardless of what form of communication they are using. One particular area of communication that causes problems across many areas of an individual’s life is nonverbal communication.
- Nonverbal communication is an essential and natural part of social interactions. A difficulties in encoding and decoding nonverbal messages can have significant effects on people’s ability to make way in life, including making relationships and friendships and finding jobs.
- There have been numerous different technology based interventions created (both commercially and academically) for this population and this has resulted in certain guidelines becoming available when making games for children with ASC. Evidence suggests that games that follow these guidelines prove successful.
- There is a lack of specific interventions available to teach children with ASC gesture use and in particular very few technology based interventions for this purpose.
These conclusions give the project scope to investigate the possibility of creating a technology based game to teach and encourage children with ASC to express themselves with nonverbal communication and gesture use. Given that evidence of teaching nonverbal communication (technological or not) was limited, it poses further questions about the effective limits of teaching such skills to those with ASC, however this is beyond the scope of the research. A different question however can become the basis of this project:

**What form might a technology-based game for encouraging nonverbal communication in children with autism take?**

This overarching question can be split into a number of sub questions to refine the design and evaluation processes.

**Sub Question A:**  What format of game may be suitable for this task?

**Sub Question B:**  Does the chosen game format support the expression of nonverbal communication?

**Sub Question C:**  What level of customisation and personalisation is suitable and effective in a game for this task?

**Sub Question D:**  Does the chosen game format promote any additional skills beyond just nonverbal communication?

To adequately answer these questions, the design methodology will be followed.

### 3.3 Game Framework Proposal

#### 3.3.1 Design Requirements

The following requirements for the game correspond to Stage 1 of the Design Methodology

**Requirement 1:** The game will be roleplay based.

Immediately from the literature we can gain some insight into answering Sub Question A. It was seen that many of the skills involved in nonverbal communication are gained through the processes inherent in regular human interaction (Knapp, et al., 2012) and while explicit training in these skills is relatively rare, it appears that roleplaying based exercises have been used for this task previously with good effect. It therefore seems like a natural step to incorporate some form of roleplaying as the main contributor to encouraging nonverbal expression.

**Requirement 2:** The game will be multiplayer, and allow the child with ASC to play with anyone from a friend (with or without ASC) to a parent.
There are a number of reasons to make the game multiplayer. Firstly it is desirable to ensure collaboration between the players. Many previous games have used collaboration as a technique to encourage social interaction with positive effects (Bhattachayra, et al., 2015), so it seems suitable to incorporate this into the game. Also apparent from Bhattachayra et al. work was gesture recognition by a computer was not yet effective. They used a highly developed vision platform (Microsoft Kinect) and still that particular game had to be abandoned due to recognition inaccuracies. It therefore seems appropriate to have a human recognising gestures instead, as we are much better at it. This is how collaborative multiplayer will be incorporated into the game.

**Requirement 3:** The game will provide a framework to include a social story or set of social stories.

Social stories are a tried and tested technique of teaching children to act in appropriate ways in certain situations. The premise involves a story, presented to the child, to emphasise what is expected in that situation and why. Often the child can be incorporated into the social story as one of the characters - studies have shown this can be very effective (Qi, et al., 2015). Although creating a social story is beyond the scope of the project, the game will allow a framework for others (professional in the field) to create one for the format of the game.

**Requirement 4:** The game will allow the children to incorporate themselves into the game using avatars or profiles.

There has been convincing evidence promoting the use of avatars and customisation in these game (Bhattachayra, et al., 2015; Serret, et al., 2014; Bartoli, et al., 2014; Fletcher-Watson, 2014) and so it seems like this would be a desirable design choice. The roleplaying element described in Requirement 1 may raise questions about the ability of a child with ASC to roleplay, however this will be balanced by the fact that they can roleplay as themselves.

**Requirement 5:** The game shall be developed for a touchscreen tablet interface.

The explosion of tablet-use has brought new levels of interactivity with computers to a wide variety of populations, including children and adults with ASC. Hourcade et al. (2013) describes in their paper the success of tablets in this field:

“Multitouch tablets have also brought hope to people with autism spectrum disorders (ASDs) and their families. The simplicity of touch interactions and the portability of these devices have lowered the barriers for interacting with computers. The preference of many children with ASDs for touchscreens has long been documented. The arrival of iPads has brought with it a veritable downpour of excitement about their use primarily from children with ASDs. This excitement has produced hundreds of apps that purportedly help children with ASDs...” (pg. 3197).
Hourcade admits that the sheer number of apps available makes choosing one difficult, but the point here is that consistent success is apparent with the use of tablets and so there is substance in the choice of this development platform.

### 3.3.2 The Game Idea

Given the above requirements the development of the following game idea can be examined:

- A variation on *Charades* with a narrative or story, with scope for the story to be a *Social Story*
- Where Charades is relevant is in the sense that players will act out meaning using their bodies and they are not allowed to speak – there is no emphasis on guessing films, books or songs.
- Players will assume characters in the story or will be placed into the story via their avatars/profiles
- At instances in the story one player must convey meaning to the other player using his/her bodies only. The opposite player must guess the meaning. The story progresses after a correct guess is made.
- Although the players perform outside technology, it is most certainly facilitated by the tablet which provides the story context and options to incorporate avatars.

This raises an additional requirement that we must consider

**Requirement 6:** Different views of the game must be displayed on a single device at different times.

The game will involve 2 different players at the same time – one must perform, while the other guesses. This means the players have different viewpoints of the game from their different characters. This would suit the use of multiple tablets connected over a network. Unfortunately this is not feasible to implement in the timescale of the project. This limits the game to a single tablet and so a suitable user interface must be developed to display each viewpoint separately without crossover.

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1 Details about the game *Charades* can be found at the following website - https://en.wikipedia.org/wiki/Charades
3.4 Design Issues

The game proposed above raises questions about its purpose and what it looks to achieve. Generally we are looking to encourage nonverbal communication so it may be assumed that it will only tackle the impairment of social communication. The game however will also look to mitigate the issues of social interaction and social imagination as well. We saw from the literature that expressing yourself nonverbally has many benefits with social interaction and can make one appear more natural among company. The inclusion of a story element allows the individual to experience unfamiliar situations in a safe environment, and helps with the issue of rigidity of thought.

Although a framework has been developed already, there are still a number of issues that need to be resolved during the following stages of informing the design.

1. Is the game format enjoyable for the specific audience?
2. Will the audience find the game too easy/difficult?
3. Although avatars will be used in some sense during the game, it is not clear whether players will actually be placed in the stories. From an interactive point of view this would be preferable, however this would cause problems for making pleasant graphics/animations to accompany the stories – which is also important for this audience. For example if we want the children to play themselves in the story and we want animations to tell the story, this means the graphics have to be created on the fly in order to create customised animations, this poses an implementation issue. It is more likely that only 1 of these aspects can be included; i.e. animations without avatars OR avatars without animations. It should be established which method is more important for this game.

3.4.1 The 2 Frameworks

Two different frameworks have been developed for the game. Although they are very similar they differ in the way that the idea for the gesture is created. The first framework (referred to as Framework 1 from now on) provides a gesture for the player to act, while the opposite player gets multiple choice answers to guess from. For example, the context of the story might have player 1 telling player 2 that their favourite musical instrument is a trumpet:

Player 1 could be told - “Without talking, tell your friend your favourite musical instrument is a trumpet”

Player 2 will be asked - “What is your friend’s favourite musical instrument. Choose from PIANO, TRUMPET or GUITAR.”

Meanwhile the other framework (referred to as Framework 2 from now on) allows the individual to make up his/her idea for gesture based on the context of the story alone and the opposite player must be able to guess from the action alone and no multiple choice is given:
3 Concept Development

Player 1 could be told - “Without talking, think of a musical instrument and act it out to your friend.”

Player 2 will be asked - “What is your friend’s favourite musical instrument. Keep guessing until they say you are correct.”

A final design issue is determining which one of these formats is preferable or if there is scope to include both.

3.5 Conclusion

To summarise, the area of nonverbal communication has been identified as a gap in research and it is worth developing a game to explore this area. A game framework has been developed that looks to answer a number of research questions and to meet a set of requirements derived from the reviewed literature. These requirements are as follows:

1. The nonverbal expression will be facilitated by roleplay
2. The game should be multiplayer
3. The game will provide a framework for social stories
4. The game will use some form of avatars and customisation
5. It will be developed for a touchscreen tablet interface
6. The interface should allow multiple players to see their individual viewpoint of the game.

The game will take the players through a story where the players assume characters and at various points must perform (and correctly guess) gestures to progress. There are still some design issues that require attention and this is the purpose of the following section where workshops and expert interviews are conducted to resolve such issues and assess the potential of the idea.

The overarching research question asks what a game for encouraging nonverbal expression in children with ASC might look like, and a design methodology has been developed to attempt to answer a series of sub questions relating to that overarching question.
4 Informing the Design

4.1 Methodology

A certain approach must be taken to design such that the appropriate amount of research is carried out. We must be able to inform the design and have the evidence to show that the decisions that are made can be validated. The main reason for carrying out such research is to ensure the requirements set out in the concept proposal are met sufficiently and the research question is answered.

There are a number of techniques and methodologies to employ when informing the design and the following will be used:

- Examination of the reviewed literature
- Design Workshops with Children
- Expert Interviews

Some examination of the literature has already been described and has been documented in Chapter 3. The information extracted in Chapter 3 contributed to the concept development, however more can be extracted to inform the design and ensure the game is effective for the audience. The workshops will involve presenting the concept framework to typically developing (TD) children to act as proxies for children with ASC. Their interaction with the framework will be observed and their feedback recorded. Finally, interviews with experts will be conducted; these will be a selection of experts from relevant fields of study who will provide feedback on the initial design framework and suggest changes or potential problems. These 3 techniques and the results will be described in the sections below.

4.2 Reviewed Literature

From the literature, a concept was designed and requirements thought out, however a number of additional design objectives could be inferred from such literature.

**Design Objective 1 –** *Appropriate sensory stimuli should be generated for the game.*

It was shown that good quality multimedia is important for this audience (Fletcher-Watson, 2014). Attractive and engaging media content has proved more effective than traditional teaching methods and so effort will be made to ensure that this is provided, as moments of inactivity on screen can cause distress. This may include animations to display the stories, a voice over telling the stories aloud, or background music on menus. Care must be taken with this objective though as too much
informing the design

visual or audio content at the same time may be overwhelming and cause distress (Bartoli, et al., 2014). So an appropriate balance should be found.

Design Objective 2 – A suitable reward system is required

Children with ASC do not value conventional reward systems such as gathering points or trophies as much as TD children (Bartoli, et al., 2014). They tend to respond more positively to the initiation of a short animation and sound, effort will be made to ensure this reward system is respected. One of the requirements set out in the previous section was to provide a level of customisation to the game, this can be merged with the reward system and children could have a particular favourite sound play when they get an answer correct.

Design Objective 3 – Different levels of difficulty should be available for the vast range of players.

By now it should be obvious that the spectrum element of autism describes how each person can be affected in different ways and levels of severity. This means some may find the game too difficult and some may find the game too easy. To mitigate this problem, different levels of difficulty should be provided throughout the game. These differences can manifest in multiple ways, for example more ambiguous gestures can be demanded so that greater precision is required in its execution. The possibility of 2 versions of the game have also been discussed – one where the gestures are provided with multiple choice answers, and one where the players must think of and produce their own – one of these approaches may be more difficult than the other.

Design Objective 4 – Transitions between screens, menus, and stories should be fast and if not, appropriate audio-visual stimuli should be presented in such idle times.

This is related to design objective 1. Should a screen lie static for too long this may cause distress due to a build-up of anticipation not knowing what is coming next. On the other hand, a static screen may cause the child to lose interest quickly (Bartoli, et al., 2014). So effort will be made to ensure the game runs smoothly between transitions, and if a static screen is required (loading a story for example), appropriate stimuli should be provided instead.

Design Objective 5 – The language used during the telling of the story should be appropriate for children with autism.

The stories included in the game will have to be portrayed to the children through text or spoken audio. This raises a number of issues with the difficulty in social communication and language understanding. Again different reading levels will be apparent and so the story must be written in language appropriate for many different children. Another important issue may be how those with autism take language very literally – this leads to misunderstanding of jokes and the simplest of
phrases and idioms (Wing, 1996). So care must be taken to ensure ambiguities in language can be reduced. Of course there may be scope to teach the child about language use as well as nonverbal communication, but appropriate research has not been done in this area and so this will not be covered in the dissertation.

4.3 Design Workshops

As part of the game design process, suitable research must be done to find out how children play games and what value they take from them. It is important to find out what makes a game fun, interesting and engaging so that these principles can be incorporated into the design. On the flip side it is also important to establish what may be boring, disengaging or difficult in games so that appropriate measures can be taken to avoid these aspects. The best way to conduct this research is to get involved with children themselves and see directly what they think. This was the purpose of the design workshops. Data was gathered in 3 different ways – group interviews, observation and informative worksheets the children completed. Each method was facilitated by an activity.

1. A group chat about what the children do or do not enjoy about games
2. A game session where the concept framework is played with non-technological means (i.e. mock-ups)
3. A worksheet activity

4.3.1 Workshop Goals

A number of goals were set out to be achieved during the workshop. Goal 2 is the most important at this stage of development as it is crucial to have the format of the game determined before implementation begins. Other issues can be worked upon at a later stage when the base system has been built.

- **Goal 1**: Establish what is currently popular for children of that age group, be it games, films, characters, toys, etc. This knowledge may inform the themes of the stories – for example a Sci-Fi story.
- **Goal 2**: Assess the current game frameworks.
  - Is it too easy/difficult?
  - Which gestures are well received among the group, which gestures are less well received or result in breaking the flow the game?
  - Is the format and time frame of the game suitable and engaging to the audience?
  - Does working in teams help or hinder the players?
• **Goal 3:** Gather ideas for new gestures and movements that can be incorporated into the game.

### 4.3.2 The Participants

The participants were made up of a selection of males and females in the age range of 7-10. All participants were typically developing children and acted as proxies for the target audience – children with ASC. It should be noted that those selected were children (and friends) of Informatics staff and many had been involved in games testing for children before. The participants got the chance to involve themselves in all 3 activities across 3 different workshop sessions, the breakdown of participants can be seen in Table 1.

**First Session** – P1 was in this session alone, however data was still extracted from the session with the help of an adult who played the game with P1

**Second Session** – The second session contained 5 participants (P2-P6) and for the purposes of playing the game, were split in two groups – P3, P4 & P6 with P2 & P5 (girls and boys).

**Third Session** – The final session contained P7 and P8. For the purpose of reducing anxiety or shyness they were placed in a team with an adult helper, so that performing was not done alone.

<table>
<thead>
<tr>
<th>Session</th>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>Participant 1 (P1)</td>
<td>Female</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Participant 2 (P2)</td>
<td>Male</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Participant 3 (P3)</td>
<td>Female</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Participant 4 (P4)</td>
<td>Female</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Participant 5 (P5)</td>
<td>Male</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Participant 6 (P6)</td>
<td>Female</td>
<td>8</td>
</tr>
<tr>
<td>Session 2</td>
<td>Participant 7 (P7)</td>
<td>Female</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Participant 8 (P8)</td>
<td>Male</td>
<td>8</td>
</tr>
</tbody>
</table>

*Table 1 - Breakdown of Child Participants*

### 4.3.3 Setup and Materials

Prior to the session, individual information sheets were sent to both the parents and children explaining the project and what would be expected of them. Accompanying the information sheets was individual consent forms for the children and parents to ensure there exists confirmation of the participants agreeing to the workshops. Examples of the information sheets and consent forms...
can be found in Appendix A. In order to capture valuable data, a video camera was used to record the gestures used by the children for future analysis; explicit confirmation was required to video record the children so this was an option on the consent forms. The children were first taken into the room where the upcoming activities were explained and what would be expected of them. If any consent forms had not been signed by any child or their corresponding parent/guardian then this was addressed. The children were given the opportunity to ask any questions prior to starting to allow any problems (such as needing the toilet) to arise and be solved. The children were also reminded that they could leave at any time without giving a reason. When ready, the video camera was set up and the first activity began.

For the workshop the following materials were used for different stages of the session

1. A flip chart and pen for taking notes on during group discussion
2. A video camera for filming the session
3. Coloured pens and pencils for the worksheets
4. Tables and chairs for children to do worksheets

### 4.3.4 Group Discussion Activity

**Procedure**

There were 2 purposes of this activity, firstly it is a good activity to do as a warm up. Some of the children had never met the researchers or other participants and so it was expected they may be shy or anxious, alternatively the children could have been over excited. This activity acted as a means of alleviating such issues before the game started. Secondly, this activity could have informed the design of the game by highlighting common interests among the children. It may be apparent that a certain story theme or type of game is very popular and so there would be scope to incorporate these ideas into the final game. This would make the game more appealing and relevant to the age group it is designed for.

The children were openly asked about their favourite games (at school and home), movies, or characters while the researcher wrote down suggestions on the flip chart. The researcher kept the conversation loose and allowed for deviation if it seemed useful. The discussion did not exceed 10 minutes so that the children did not lose interest.

**Results**

It was suspected prior to the workshops that this activity may not provide a great deal of valuable data, however a number of things became apparent about the games that children play:
• Tig\(^2\) (or variations of tig) were very popular, with the term cropping up during every session and being mentioned by 5 of the participants. There was also an emphasis on being active in the playground and the enjoyment gained from that.

• Games that involved some strategy and learning such as Risk and Monopoly were also popular. P5 mentioned he enjoyed Hangman due to how it improves his spelling. While 4 of the 8 participants had played Charades before.

• Technological games also proved popular with interaction with iPads the most common. Minecraft was another popular platform for their play.

Unfortunately due to time constraints, questions about the children’s favourite films and characters could not be asked in session 2 and 3 and so no common grounds were found in this respect.

### 4.3.5 Playing the Game

**Procedure**

The purpose of this activity is to directly test the game framework that had been designed, assessing a number of different issues outlined in workshop goal 2.

The children were asked to split into groups and play the game as outlined in the framework, where each group assumes characters in the story. There are 2 different stories; Story 1 – James and Sarah visit the park, Story 2 – Jessica’s Day with Grandad, each story has a slightly different format. Story 1 (Framework 1) provided actions for one group to perform, and multiple choice answers for the other group to guess from. Meanwhile Story 2 (Framework 2) did not provide any actions to perform and also gave no multiple choice answers, instead the children were given time to think of an action appropriate to the story context. Since no technological interface had been made for the game, children were instead given cards that explain what they had to do (see Figure 2).

![Figure 2](https://en.wikipedia.org/wiki/Tag_(game))

*Figure 2 - Example of Cards given to children for Story 1. Sarah’s blue card describes the action to perform, while James’ red card gives multiple choice options.*

\(^2\) https://en.wikipedia.org/wiki/Tag_(game)
Results

The questions that are to be answered with this activity are outlined under workshop goal 2. It should be noted that due to time constraints session 2 were not asked on their thoughts of the game.

Is the game too easy/difficult? Assessing this was done by both observing the children play but also asking them directly. After playing Story 1 it was noted as being too easy, even for the youngest of participants (P1). Meanwhile P7 requested the game to be more difficult, however there was an expectation among P1, P7 & P8 that the game may get harder as it progressed. Child responses were different when commenting on the second story. While P1 said she found it easier because she could act her own ideas, while both P7 & P8 found the second game harder, but not too hard. In terms of observation, there was only one instance of specific problems decoding/encoding gestures during Story 1 across all 3 sessions, and almost all gestures were guessed correctly immediately - this suggests the first story is too easy. The second story however had 6 instances where there were noticeable delays and clues were required to reach the correct answer, however only 1 instance occurred when the correct answer had to be revealed. A careful approach must be taken when assessing this question though as the ability of TD children may be vastly different to those with ASC. This will be clarified during the expert interviews.

Is the game format and timeframe suitable and engaging to the audience? This is also a question of whether the game is fun and entertaining enough for the children. When asked, all participants said that they enjoyed the game, however there was a unanimous consensus that Story 2 was more fun and enjoyable than Story 1. When observational results are considered, a number of factors were looked into in order to gauge the affect and engagement of the children. Facial expressions and body language were analysed to assess such affect; smiling and inability to remain still (while still focused on the game) were seen as signs of positive affect, while certain facial expressions (e.g. grumpy, bored) and lack of movement were seen as signs of negative affect. Beyond this a number of specific instances for each category were looked for:

Specific examples of enjoyment or excitement were shown by instances of

- Out-loud laughter
- Raised voices when guessing the action
- Eagerness to progress through game (e.g. Jumping out of seat to collect information card)

Meanwhile specific examples of boredom or distraction were shown by instances of

- Staring out the window, or anything in the room not associated with the game
- Reluctance to perform or guess actions
- Lack of collaboration with other group members

Based on the above measures a count of the number of times the children looked distinctly bored or distracted against the number of times they showed enjoyment and excitement was taken. The accumulated results for the 3 sessions are below in Table 2.
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The table shows encouraging results that the children were entertained, and certainly that the level of enjoyment outweighed the level of boredom during the play time. Generally though based on facial expressions and body language, children appeared well engaged and motivated to play this game and in this respect suggests it would also be suitable for an audience with ASC.

Story 1 provoked more expression of emotion, and therefore appears to be the more engaging, but this is probably attributable to the fact that Story 1 was new to the children, meanwhile by the time Story 2 was reached, the format had already been established. At times there were exclamations of enjoyment from the children – “This a really fun game actually” & “Can we do one more” after we had finished. On only one occasion was there confusion about the game format and all children picked the game rules up quickly. The time frame for a single story also seemed reasonable and at no time did the children want to stop a game prematurely. The “Can we do one more” remark actually suggests that play could have continued for longer. This could be facilitated by longer stories or more stories - it is not apparent from this workshop which would be preferable.

What gestures worked and did not work so well? The two stories will have to be assessed separately. The majority of all gestures for Story 1 were performed as expected, occasionally a slightly abstract representation of the gesture was performed – P8’s performance of a bird tried to represent the it as something flying through the air as opposed to the expected flapping of arms – but given time was guessed correctly. A particular action of interest was having the children try to represent blue. Everyone pointed at something blue in the end, however there was an extra level of thought and interest apparent from both the acting and guessing groups. Story 2 provided a different level of thought process and brought up some interesting issues. Generally the gestures were well encoded and decoded and brought enjoyment with the greater level of creativity that could be afforded to the children. Some gestures proved problematic for decoding and this was most prominent in session 2 where no adults were present in either group. For the group of girls some of their ideas were quite complicated (Granddad’s dead flowers, ordering a pizza) and even though well-acted, could not be guessed by the guessing group without clues. Meanwhile the variation with the boys’ performances caused confusion for the girls on occasions – they performed the same action for remote control car and toy. Additionally it was noticeable that certain sound effects were used when performing actions.
Does working in teams help or hinder the players? For all sessions, the children were placed in a group with either peers or an adult. The evidence during the sessions showed that being in a group works very well when it came to both producing actions and thinking of ideas for Framework 2. It was suspected that having multiple players on a team may lead to arguments or perhaps contradictory actions but this was not the case. Instead, across the sessions we saw many examples of teamwork most notably when the children performed different parts in the action. Notable uses of teamwork were as follows:

- **P2 & P5** – One acted as a remote control car while the other pretended to play with the remote
- **P3, P4 & P6** – 2 acted like lifeless dolls while the other played with them
- **P8 and his adult partner** – The adult acted as a clock while **P8** tried to wind him up
- **P7 and her adult partner** – they pretended to play a board game together.

This level of collaboration and teamwork is encouraging considering the game requirements.

### 4.3.6 Gestures Worksheet

**Procedure**

As a final warm-down activity the children were asked to fill in a worksheet. The purpose of this worksheet was to give the children a chance to put their own gesture ideas into the game. The worksheet asks them to draw their representation of a gesture in a box and describe below what it is. There are 3 different types of gesture that they were asked them to complete (all on the same sheet):

1. A hobby/activity
2. An emotion
3. Any additional ideas they have

Given the variability and imagination that was expected from the suggestions, no guarantee was given that their ideas would be placed in the game however it was hoped that some suggestions (or ideas and themes derived from the suggestions) could be incorporated, and that because the ideas are from children, would be more appealing to the audience.

**Results**

Some good ideas were extracted from the worksheets (see Figure 3), however there were a few issues that would present problems when trying to incorporate them into the game.

- Some suggested actions/gestures were ideas that had already been seen in the stories that had just been played.
• Some ideas were too ambitious to be translated into gestures (e.g. “Climbing up Mount Everest” - climbing could be extracted from this).

• One participant had connected the idea of using a tablet with the request for gestures too closely and so tried to provide ideas for tablet gestures such as swiping.

A number of good ideas were also proposed though such as watching television, being hungry/thirsty or playing Tig. These ideas have good scope for generating actions and gestures associated with them and so it is feasible to place them into a story.

4.4 Expert Interviews

4.4.1 Expert Interview Goals

While the design workshop was valuable in informing the framework, themes and structure of a game for children, it did little to inform the design of other crucial aspects such as autism specific features or how the children would interact with the system. The purpose of the expert interviews was to inform us on these crucial aspects as well as back up any assumptions that were inferred from the literature. The goals of the expert interviews were more open than that of the design workshop, and were about gathering general feedback and advice on the game framework from a
number of experts relevant to education, technology and autism. There were however a number of questions that the interview sessions were attempting to answer:

- How suitable is the game framework for children with ASC?
  - What level of participation is expected from children with ASC?
  - Are the level of gestures suitable for children with ASC, is there a type of gesture that is received better than others?
- What design implications should be considered during implementation - e.g. what aspects of customisation and personalisation should be aimed for?
- Of the two frameworks proposed, which one is more suitable, or is there scope to include both structures in the implementation?
- What effect on nonverbal communication is expected with the proposed game?

### 4.4.2 The Interview Setup

The interviews were to be semi-structured and fairly open in the direction that the conversation would go in. This was moderated by the interviewer such that if a particular topic arose that could provide particular value then time could be spent on discussing these topics in greater detail. Each interview had questions that were based on the same structure:

1. Interviewer would explain the project brief and research area that was to be focused on - nonverbal communication.
2. Expert was asked about their relevant experience in their field.
3. Interviewer provided more detail on the project and gave a quick demonstration of how the game was to be played using the same resources as the design workshop.
4. Expert is invited to comment or ask questions about any part of the system they want.
5. Expert is asked general questions about proposed game
6. Expert is asked more specific questions about the game related to their expertise.

An example of an expert interview question structure can be found in appendix B1.

There were 4 sessions in total and each took place as face-to-face interviews while the dialogue was recorded for later analysis - all experts agreed to this prior to recording beginning. The experts’ experience is detailed in the Table 3 below.
4.4.3 The Results

All experts responded positively to the idea of the game and gave suitable feedback on different aspects of the design, implementation and future directions of the project. The design questions are considered first.

**How suitable is the game framework for those with ASC?** A few experts commented on how well the idea of this roleplaying gesture game would be received by those with autism. E1 expected that those with ASC would be open to playing and would have the capabilities to play such a game, providing a teacher or parent figure was present at the beginning to help and providing there is the option to revise the rules/structure at a later time. Similarly E3 mentioned that as long as the
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Learners are in a comfortable environment with trusted peers, then a similar level of engagement and participation would likely be seen as TD children. E2 however said it would be hard to estimate how well the game would be received and attributed this to variation in the spectrum, however emphasised that placing the child into the stories as themselves is particularly important because taking the role of a stranger is too complex a task for those with ASC; E4 backed up this point.

In terms of choice of gestures to place into the story, E4 warned that the examples used for the design workshop would require further development and focus in order to work effectively. Consideration between the choice of 1st and 3rd person actions or dynamic and static gestures is important because switching between the two forms too often may cause issues or confusion. E4 praised the framework saying a very open game has been scaffolded into an easy to understand format that can be easily distributed, but reiterated that more focus was required on that scaffolding. For example in Framework 2, hints for an item include a book and a toy. E4 explained that the difficulty and thought process involved in gesturing these 2 ideas is quite different and this may result in the child always choosing the easy option, reducing the learning effect.

**What design implications should be considered during implementation?** A vast number of ideas, suggestions and considerations were made by all experts with respect to potential implementations of the game. E3 commented on the 'slightly clunky' nature of having two players share a tablet with hidden content that somehow had to be navigated around. It was instead suggested that the system be ported onto multiple devices such that the game could be played remotely between players. E2 focused on the issue of how the system will react when a child simply cannot think of an action to perform or continually gets the guessing part wrong. It was stressed that inability to progress through the game can cause frustration to build and so there must be a way to mitigate this possible situation; it was suggested that a skip or hint function be added, this was also made apparent by E1 and E3. The issue of how to present the story was also a common topic for discussion with E2 describing the stories as “quite wordy, which will cause problems to some learners”, but as long as the issue is made apparent such that only competent readers would use the system, then it should not be a problem. The idea of having the story read out by a computer generated voice received positive feedback from E1, E2 and E3, providing the voice could be turned off as this may cause annoyance. E1 and E2 both emphasised the need for instructions to be clear, and although graphical means of telling a story may look nice, E2 explained there is scope for graphics to cause too much distraction away from such clear instructions.

The level of customisation and personalisation was also covered among the experts. The suggestions covered were: Allowing a change of interface colours, changing the font size, allowing sounds to be switched on/off, and allowing the child to choose their own individual reward sound (with the ability to upload a tailored sound for the individual receiving positive responses).

**What is the suitability of the 2 different game frameworks?** A lot of feedback was received in this area and the general consensus was that there is definitely space for both frameworks to be in the
game, however the reasons for this differed among experts. E1 liked the idea of having the two frameworks as stepping stones of progression for the child (Framework 1 is easier than Framework 2), and as a practitioner in a secondary school found that Framework 1 would be more suitable for primary school children, however when the child transfers to secondary school they would progress to Framework 2 yet still be familiar with the basic format. E3 and E4 also appreciated that an extra level of difficulty would be valuable. E3 explained that Framework 1 can provide a nice level of scaffolding to the process while Framework 2 allows more creative ideas (or special interest items) to be included and that Framework 2 worked better in the context of using a shared tablet because there is no hidden content. E3 also warned of the problem of generativity apparent in Framework 2 where a child may have trouble actually thinking of new ideas. E2 also explained that this may be a problem as children with ASC have trouble filtering out all the possible ideas and having such open ended questions can become quite overwhelming. To counter this though, E2 explained the importance of providing choice and the abilities of an individual may actually be higher than expected, so recommends including both frameworks in the game.

**What effect on nonverbal communication may be expected?** The position of the experts on this aspect was not as clear cut as the previous questions. This may be attributable to scarce amount of research done on the topic. It was assumed by the experts that the game would indeed have positive effects on nonverbal communication, and in principle the ideas behind the game ‘make sense’. E1 used an anecdote of child who would watch all the actions this expert did and try mimic them, thus improving the child’s ability in attempting to express themselves nonverbally. E3 proposed that the game would be useful for children who do not express themselves nonverbally at all and sees it as a good way to begin the process of teaching such skills. E4 warned of the transfer problem that may arise with a system that is not backed by a strong theoretical model, and although agrees that the game’s methods make sense, could not guarantee it would have significant results; E4 however did envision the game being used as research tool to explore such ideas and provide such evidence.

### 4.5 Conclusion

The design process, and decisions taken during that process, should be informed by a number of varied sources to identify issues that may not be immediately apparent otherwise (Scaife & Rogers, 2001). During this process 3 main sources have been consulted to better define the design of the game: reviewed literature, workshops with TD children as proxies for children with ASC and interviews with experts relevant to the field.

The outcome of reviewing the literature was a set of design objectives, these are goals that the game attempts to fulfil in order to best cater for the audience:

- **Objective 1** - Appropriate sensory stimuli should be generated for the game.
- **Objective 2** - A suitable reward system is required
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- **Objective 3** - Different levels of difficulty should be available for the vast range of players.
- **Objective 4** – Transitions between screens, menus, and stories should be fast and if not, appropriate audio-visual stimuli should be presented in such idle times.
- **Objective 5** – The language used during the telling of the story should be appropriate for children with autism.

The workshops provided some insight into designing entertaining games for children, the key results were:

- The basic game format was enjoyable to children and suitably held their attention for the duration of the session.
- Framework 2 appeared to be more engaging to the children than Framework 1. This could be because Framework 1 was deemed too easy for the audience.
- Working in a team not only alleviated shyness but in many cases provided a better basis for performing complex gestures.

After the workshops a number of experts were consulted about the game design in order to better assess its suitability for children with ASC, these are the key results:

- The game was well received by experts who believe a comparable level of participation would be seen among those with ASC as TD children, providing help is available from a parent of teacher figure.
- Further enhancements to customisation, scaffolding and gesture choice should be made in order to increase the usability of the game and reduce the risk of building up stress in the individual.
- Both frameworks should be included in the final implementation
- In principle the idea should have positive effects on nonverbal communication in children with autism.

Going forward these results will prove valuable in the next stage as the game is developed for a touch screen tablet interface.
5 Game Implementation

The final developed game is in much the same format as was provided to the children in the workshop and presented to experts during interviews. The basic format of the game is as follows:

- 2 children are placed into a story as characters while they interact with each other.
- At certain instances during the story, the game will stop and one player must convey some meaning to the opposite player without talking.
- Meanwhile the opposite player must correctly guess what meaning is trying to be conveyed.
- The story progresses when the meaning is guessed correctly and the player roles (Actor and Guesser) are swapped on alternating action instances.
- The actions are based on the context of the story, and may be explicitly told to the actor or depending on the story will allow the actor to think of an idea relating to the story on their own.

This chapter will explain how a game made for a tablet was developed in order to contain this structure and make it suitable for this particular audience.

5.1 System Structure and Features

Perhaps the best way to describe the game in its implemented form is to provide a demonstration of how the game may be played by 2 children (ChildA and ChildB). The below flow diagram (Figure 4) exhibits how a child may navigate and proceed through the game structure. Appendix C gives screenshots of the process involved in the final two orange blocks.

![Figure 4 - Expected sequence of play for a new player]
5.1.1 Opening Home Screen

When the players open the app they are greeted with the Home screen (see Figure 5). This screen provides a number of navigation options. The user can chose to Play, go to the Characters screen, go to the Settings screen or go to the Tutorial screen.

![Home Screen Image]

Figure 5 - The Home Screen and opening screen of the app

5.1.2 Tutorial Screen

The first thing the child may do is consult the Tutorial screen (see Figure 6) in order to find out how to play. The Tutorial screen allows the user to choose from 3 tutorials - how to create a character, how to play Framework 1, how to play Framework 2. Selecting one of these options brings up a screen that can be swiped through, giving step-by-step guidance on how to play the game - after the tutorial is finished the option to try a dummy version of the game is provided. The tutorials are not interactive and contain a lot of text so in its current form would be more

![Tutorial Image]

Figure 6 - Example of one section of a tutorial
appropriate for an adult to use before passing on such guidance to the child. Appendix C contains screenshots of a whole tutorial.

5.1.3 Character Screen

Once the format and rules of the game are established, it is expected that the children will create a profile/character for themselves by navigating to the *Characters* screen (see Figure 7). Here the characters that have already been created are displayed. Selecting a character allows the user to change any aspects of that profile - characters can also be deleted. For new players - ChildA and ChildB - they will have to create a new character each by pressing the ‘Create New Character’ Button. This brings up a new screen (see Figure 8) that allows the user to adapt the customisable aspects and save their character. The children can choose their name (or any name of their choice) along with their gender, reward sound and take a profile picture with the device camera (see section 5.2.4 for more details of character customisation). Once the characters have been made, the children can navigate back to the *Home* screen by pressing the ‘Back’ buttons.

![Figure 7 - Left: Screen to create a new Character, Right: Screen to edit an existing Character](image)

![Figure 8 - The Characters Screen. Players are selectable and scrolling is enabled for showing many characters down the screen.](image)
5.1.4 Setting up the Game

When the children are ready and have created characters, they can select the ‘Play’ button on the Home screen. This will open a choice of different stories to play through.

1. Going to the Park - A Framework 1 story that was also used during the design workshop.
2. The Sleepover - A Framework 1 story.
3. To the Shops - A Framework 2 story.

Once a story is selected, a new screen will open allowing ChildA to select their own character to play as and following this, ChildB can perform the same process on an almost identical screen. Once both players have selected their characters, a final confirmation screen is displayed to ensure all settings are correct - should anything require changing then the back buttons can be used to navigate back to the relevant screen. When the children are happy with the settings, the ‘Begin Story’ button can be pressed. Figure 9 shows the user interface for this process.

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Figure 9 - Progression from Story Choice to Confirmation Screen. TopLeft: Choosing a Story, TopRight: Choosing First Character, BottomLeft: Choosing Second Character, BottomRight: Confirming the Choices
5.1.5 Playing the Game

When the game has begun the children will be faced with the *Game* screen which has 3 distinct sections - Centre, Left and Right - only one section is displayed at a time - see Figure 12.

- **Left Section** - This is ChildA’s section and ChildB should not be able to see it. This section gives instructions to ChildA (i.e. perform an action OR guess an action)
- **Right Section** - This is ChildB’s section and ChildA should not be able to see it. This section gives instructions to ChildB (i.e. perform an action OR guess an action)
- **Centre Section** - Displays the story text, an exit button and buttons to navigate to the player’s individual section.

The default section is the Centre section, both players can look at this section and read the story, while the left and right sections are private to that player. Once the story text has been read, one player must perform some form of action - the player to do this is indicated by a green border around their button. That player can navigate to their screen (by pressing their button or swiping) where they will be told what action to perform. When the child is ready they should navigate back to the centre screen before showing the opposite player, who can subsequently navigate to their own screen for guessing instructions (depending on which framework is being used).

By a certain point the guessing child will guess correctly and will be greeted by their reward sound and a *Congratulations* Screen (see Figure 10) and the story will progress with a different action to perform. The role of the actor and guesser are swapped on alternating turns such that if ChildA is acting on one story instance, ChildA will be guessing on the next story instance (and vice-versa for ChildB). This process continues until the story is complete and the *Home* screen is automatically navigated back to.

![Figure 10 - Congratulations on a Correct Answer](image1)

![Figure 11 - Congratulations on completing a Story](image2)
The Story Screen features 3 sections:

- The LEFT screen is dedicated to the player.
  - Allows the story to be global.
  - Acting in the top right section, the adjacent button is pressed with each action.
  - After completing all actions, the player can navigate to the next screen.

- The CENTER screen contains the story.

- The RIGHT screen is dedicated to the player.
  - The right screen helps to play back the story.
  - The player can select the next screen.

Figure 12 - The Story Screen features 3 Sections
Figure 13 - Complete Navigation Map of Interface. Double ended arrows indicate an area/screen that a player can explicitly go back from (to the parent). Single headed arrows indicate an area/screen that cannot be navigated back from. Blocks that feature a thick green border indicate areas where some form of decision or choice is given.
5.1.6 The 2 Frameworks

The format displayed in Figure 12 is an implementation of Framework 1. Should the chosen story be a Framework 2 story then the basic interface will remain exactly the same. The centre section is identical and the changes are more apparent in the left and right sections. A section telling the player to perform an action will be much the same except the question will be phrased such that the user must think of their own idea. Meanwhile on a guessing section, since the system does not know what the actor is going to do, it cannot provide any multiple choice options. Instead it features a button that says “Click Here when you guess Correctly” The idea is that the guesser continually guesses until the actor confirms the guesser is correct - a level of self-moderation is required for this such that the guessing child does not press the button without reaching a correct guess.

5.2 Designing for the Audience

As explained in Chapter 4, a range of sources should inform the design of the game in order to best cater for the audience. In this section we describe how such information was acted upon and how these additions have been implemented in the game.

5.2.1 Reducing Frustration

It was established by the experts that those with ASC can be easily stressed and frustrated and that the inability to play the game well enough or progress through a story may provoke such frustration. It was made evident that some effort should be made to try and alleviate this effect - hints, clues and skip buttons were suggested as ways around this. The solution opted for in the final game is video and text hints. In Framework 1, should the acting player not be able to translate the given action into an effective movement then they can press the ‘Help?’ button - this will make a
video hint pop up showing a possible interpretation of the action (see Figure 16). On the other side the problem is less apparent for the guesser because they can simply continue guessing from the three options until they get it correct. On incorrect guesses, a short message (known as an Android Toast) pops up encouraging the child to continue guessing or try another option (see Figure 15).

Meanwhile for Framework 2 the problem is more apparent for the guesser because the context of the story is up for interpretation by the players. It is not until the actor looks at their screen that they will know the range of actions they could perform. This level of understanding should also be given to the guesser, so that if the guesser has got the complete wrong idea about what the actor is conveying, then they can press the 'Need a Hint' button to receive some further context (see Figure 17). As an example, assume that the actor must perform some sport and so chooses to perform football by kicking the air. The guesser may not interpret this correctly and continually try to guess actions like ‘kicking’ or ‘swinging leg’. Should the guesser press the hint button, a popup saying “The actor is going to act out a sport like tennis or golf” will appear and this should hopefully be enough context for the guesser to suggest sports instead.

5.2.2 The Problem of Generativity

Two of the experts suggested there may be a problem with Framework 2 in that allowing the child to come up with their own ideas opens up too many possibilities and a child with ASC’s difficulty in filtering all the possible options or ability to come up with a single idea could seriously hamper
this framework. The solution instead was to provide 4 options to the child at every action instance (see Figure 18). In the same way as the acting hints in Framework 1, these options are then linked to a video clip showing an interpretation of that idea. These options are not compulsory to look at (a button must be pressed) and are only there when the child needs them.

\[\text{Figure 18 - Additional ideas for the child to choose from. Each option is linked to video a interpretation of the idea.}\]

### 5.2.3 Gesture Choice

One expert raised the issue that the choice of gestures that are being asked of the children are too varied across different types of gesture (1st person, 3rd person, dynamic, static) and level of difficulty. It was recommended that further development on the scaffolding and more focus on the wording of questions was required to solve this issue. The stories created for the design workshop would therefore not be the focus of the game and two new stories were created to try bring some consistency into the gestures. This was most apparent in 'To the Shops' - a Framework 2 story. The Framework 2 story used in the design workshop asked very open questions that could relate to many different types of gesture, meanwhile the new story tried to keep this under control by limiting the possible forms of gesture (i.e. 'Perform a Sport', 'Perform a musical instrument'). This also contributed to alleviating the generativity issues.

### 5.2.4 Customisation and Personalisation

It has been established on multiple occasions throughout the paper that being able to customise and personalise the system for an individual child is particularly important in this context - a major benefit of technological interventions is the ease with which customisation features can be implemented. A number of measures have been taken during implementation to fulfil this
requirement. The main aspect of personalisation is the ability for the child to create their own character unique to them and have that character placed in the story. The importance of this aspect was stressed by the experts who said it meant the child did not to have to take on the role of someone unfamiliar, which can cause discomfort and confusion. As mentioned previously the player can choose the name, gender, profile picture and reward sound of their character. The profile picture is chosen by using the device’s camera; once the 'Take Photo' button is pressed this launches the camera app with which the player can take a photo of themselves or an object if preferred. This image will then be used throughout the game to identify (along with the name) the player. The gender field is only relevant when placing the character into the story. The underlying story text contains placeholders that are replaced with names of characters, however there also exists placeholders for pronouns and since pronouns are gendered, a gender field is required. The reward sound is a prominent part of the personalisation effect, it was seen in the literature that children can be oversensitive to audio and visual stimuli however this could vary between individuals. Therefore the individual is given the choice of sounds (see Figure 19) to choose from and a button to hear the sounds immediately, while choosing. This reward sound is then played when the player guesses correctly, therefore creating a tailored reward system. Ideally the child would be able to upload their own sound (or image for the profile picture) further enhancing the effect of personalisation but has not been implemented in this version.

Figure 19 - The sound options to choose a reward from.

Beyond this, further customisation options may be found when visiting the Settings screen where the background colour and text size can be altered (see Figure 20). These are application wide alterations that further allow customisation for a specific child. The possibility of having a voice over accompanying the text for those who are less able to read was suggested by multiple experts however this was not implemented in this version (see section 6.4 for more details)
5.2.5 Other Additions based on Workshop Observations

A number of observations were collected during the design workshop that were able to influence the design in small ways. Firstly it was apparent from when the children were playing the game with prompt cards for Framework 1, that on a number of occasions, once the guessers had chosen the correct option from the multiple choices, the acting players were then interested in seeing what options their playing partners had to choose from. So this information was added to the congratulations screen for both groups to view (see Figure 21).
During the first task of the design workshop, the group discussion, there little was said about favourite films and TV shows and so no common ground could be found between the children. However one film - *Big Hero 6* - was mentioned by a child and so in a bid to keep the stories relevant, appears during 'The Sleepover' story.

The final task involved the children trying to provide ideas for gestures by drawing them on provided worksheets. Some ideas were appropriate enough to feature in the game and derivations of such ideas appear across the stories. The ideas were *playing tig*, *watching TV* and *feeling hungry/thirsty*.

### 5.3 Development Platform

It has already been established in the design requirements that the game was to be developed for a touchscreen tablet and such a decision was taken with reference to literature. Beyond this, a number of different development platforms are available for building the game (or application in the context of tablets) on this device. These are based on the 3 main operating systems available for such devices:

- Android (by Google)
- iOS (by Apple)
- Windows (by Microsoft)

Almost immediately a Windows app was ruled out for a number of reasons. Firstly the development environment is very large and distinction between a Windows App and a Windows Program would have to be made, requiring additional time to investigate the implications of such a choice. Apps for Windows would also require a tablet that can run Windows, these are less common than both Android and iOS devices and so would narrow the audience that could use it; Windows tablets also tend to be significantly more expensive as well.

The choice between Android and iOS was also made relatively early in the process. Android has a very open source nature to its development and this is mirrored in the creation of apps as well. This results in a wide community of online users that can provide help with writing code, this is particularly important when considering no prior app development had been attempted by the researcher; this advantage is not as apparent in iOS development. Coding language was also taken into consideration - Android uses a version of Java while iOS uses a version of Objective C. Given that the researcher has considerably more experience with Java and that Google provides an extensive IDE for free, this contributes significantly to the final decision.

Given the popularity of the OS, the experience of the researcher and the accessible nature (for both the developer and the end user) of the ecosystem, Android was chosen as the development platform.
5.4 Conclusion

In this chapter the measures taken to transfer the proposed game onto a technological device were described. Firstly, a walkthrough of the game with screenshots and diagrams was given in order to describe the structure and navigation of the system. The process of creating a character, setting up a story and actually playing the game was covered here, as well as the differences between the 2 story frameworks and how they manifest in the game.

A number of design features were included with an accompanying range of design decisions. These decisions and features were justified with reference to the conclusions that were gathered from the Informing the Design chapter. A number of issues became apparent in the design and so solutions to such problems were proposed. In the next section the effectiveness of such solutions is evaluated as well as the research questions proposed during the Concept Development.

Finally the development platform was discussed with justification for the choice of an Android app. Because of its open source nature, vast availability and with consideration of the researcher’s experience, Android was the most appropriate for the task.
6 Evaluation

In this chapter we provide evidence of an evaluation process conducted to assess the effectiveness of the developed game and answer the research questions set out in Chapter 3. In order to complete such evaluation, two main techniques were used to gather feedback - observation and interview of children through workshops, and expert interviews.

The chapter first evaluates the effectiveness of the system - this is in reference to both the Design Requirements and the Design Objectives, with additional analysis of the features of the game described in Chapter 5. Once the system has been validated as an effective game suitable for the audience, it is justified to be used as a tool for trying to answer the research questions. Following this, based on observations and results, a number of small-scale system improvements will be suggested as ways to further enhance the game.

6.1 Evaluation Methodology

The two evaluation methods used are workshops with children and expert interviews. Here we explain the procedure taken during these methods and in the following section the results are jointly presented with reference to each design goal and research question.

6.1.1 Evaluation Workshops

The workshops work on the same basis as the design workshops did, where children were asked to play the game and act as proxies for children with ASC. This will allow the processes involved in playing the game to become more apparent, and therefore easier to analyse. For example, the way in which a child interacts with the user interface may well be different from how an adult may use the UI, and so assessment of this feature is more accurate when it can be shown that children can or cannot use it effectively.

Data will be gathered from analysing video of the children playing the game and also from subsequent group interviews to get their immediate thoughts on the experience.

6.1.1.1 The Participants

Seven participants were used during the workshops across 4 different sessions. The age range of the children were 6-11 and were a mix of males and females; in a number of sessions the children were siblings. Like the design workshops, the majority were children of Informatics staff and had been involved in such workshops before. This meant they had a relatively good idea of the process and
were perhaps more proficient with technology than non-Informatics staff children. The breakdown of participants and sessions is described below (see Table).

**First Session** - Contained P9 & P10 who were siblings. The game was to be played in the expected way with each participant playing a single character in the story.

**Second Session** - P11 was the only participant featured in this session and so played the game with a present adult. P11 explained prior to play that she has a number of friends who have autism and so would be able to advise from that perspective.

**Third Session** - P2 and P3 were present during the design workshops and were invited back to test the game in its implemented form and so will have experience with the game format. Also present was P12 who was not at the design workshops. Given the odd numbers in this session, P2 and P12 played together for the first story, followed by P3 and P12 in the second story and finally P2 and P3 in the final story, such that all participants played the same number of stories.

**Fourth Session** - This featured P13 and P14 who played the game in the expected way - one player for a single character.

<table>
<thead>
<tr>
<th>Session</th>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
<th>Design Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>Participant 9 (P9)</td>
<td>Male</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Participant 10 (P10)</td>
<td>Female</td>
<td>8</td>
<td>No</td>
</tr>
<tr>
<td>Session 2</td>
<td>Participant 11 (P11)</td>
<td>Female</td>
<td>11</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Participant 2 (P2)</td>
<td>Male</td>
<td>7</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Participant 3 (P3)</td>
<td>Female</td>
<td>10</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Participant 12 (P12)</td>
<td>Female</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>Session 4</td>
<td>Participant 13 (P13)</td>
<td>Male</td>
<td>10</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Participant 14 (P14)</td>
<td>Male</td>
<td>8</td>
<td>No</td>
</tr>
</tbody>
</table>

*Table 4 - Breakdown of Child Participants*

**6.1.1.2 Workshop Setup**

Prior to the session, individual information sheets were sent to both the parents and children explaining the project and what would be expected of them. Accompanying the information sheets were individual consent forms to ensure there exists confirmation of the participants and parent agreeing to the workshops (see Appendix A for information and consent forms). Like the design workshops, a video camera was used to capture the interactions of the children with the game and each other - explicit permission was gained for this.
The children were first taken into the activity room where initial setup procedures were completed; the children were given the opportunity to ask any questions before they began and if any consent forms had not been signed by any child or their corresponding parent/guardian then this was addressed here. The children were also reminded that they could leave at any time without giving a reason. When ready, the video camera was set up and the procedure began.

6.1.1.3 Workshop Procedure

The premise of the game was explained to the child (“Attempting to make children better at expressing themselves with their body”) and the basic outline of the game made clear. In the case of P2 and P3 they were reminded of the format they played during the design workshop. Following this, the game tablet interface was described with a quick demonstration using dummy characters. Once the game had been established, the children were given the chance to create their own characters and the game could begin. “The Sleepover” (Framework 1) was the first story to be played, followed by “To the Shops” (Framework 2), while session 3 and 4 participants also played “To the Park” (Framework 1). The above procedure was led and moderated by the researcher and help with the interface was allowed because this was not the focus of the workshops.

Following play time, the children were asked some questions about their experience with the game in an open group discussion format. Discussion topics included:

- What were their initial reaction to the game
  - Did they enjoy playing? Or did not enjoy playing?
  - Did they find the game easy to understand?
  - What were their favourite parts
- Any suggestions that they had for improvements?
- They were asked for their opinions on using the game with multiple devices and being able to create their own stories.

6.1.2 Expert Interviews

Although the evaluation workshops provided material for evaluating the system’s use with children, it does not always provide adequate data on how the system may be received by those with ASC. The insight provided by the experts will be particularly good for assessing the system in this way, as well as looking at the game in a wider context with respect to overall contribution the game can make and where future work may push the ideas and design.
6.1.2.1 The Interview Setup and Procedure

Again, the interviews were conducted in a semi-structured manner and conversation was open, with experts allowed to talk about specific parts of the system if valuable data relevant to the research questions could be extracted. In total, 5 experts were consulted, 3 of which were involved in informing the design and 2 had not previously seen the game. In one case the expert E1 was met informally for a demonstration of the game - this encounter was not recorded. A formal face-to-face interview could not be arranged so an open questionnaire was sent to E1 with a subsequent phone call exchange to clarify any questions E1 had. In all other cases the interview was conducted face-to-face and the dialogue was recorded with the expert agreeing to this. Table 4 details the relevant experience each expert had. See Appendix B for interview materials and questionnaire.

<table>
<thead>
<tr>
<th>Expert</th>
<th>Experience</th>
<th>Involved in Design?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert 1 (E1)</td>
<td>Pupil support assistant working in a secondary school for over 15 years. Has professional experience working with children with learning difficulties and mid-high functioning pupils with autism while has recently seen technology and software become a prominent part in school education.</td>
<td>Yes</td>
</tr>
<tr>
<td>Expert 3 (E3)</td>
<td>A research psychologist with extensive academic experience in autism research. Body of work focuses on the potential of technology as an educational support specifically for children with autism.</td>
<td>Yes</td>
</tr>
<tr>
<td>Expert 4 (E4)</td>
<td>Researcher focusing on tangible technology. Recently looking into the relationship between physical interaction and the way that children think, through work with gesture analysis and nonverbal communication. Prior to research, was a teacher in special education and has experience working with children with autism.</td>
<td>Yes</td>
</tr>
<tr>
<td>Expert 5 (E5)</td>
<td>PHD student and research assistance with background in Informatics, looking at HCI within applications relating to pretend play. From an academic context also has previous experience creating games and applications for children with autism.</td>
<td>No</td>
</tr>
<tr>
<td>Expert 6 (E6)</td>
<td>Researcher with a background in cognitive science and psychology focusing on the area of HCI and the Human Factor. Has done extensive work in interface design for a number of audiences from children to the elderly and has been involved in numerous external technology-based projects.</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 4 - Evaluation Expert profiles
A similar discussion structure was adopted for all interviews.

1. Interviewer would explain the project brief and progress made so far, this was a recap for those who had previously seen the project.

2. Interviewer provided a demonstration of the game and both frameworks. It was made explicit that should the expert have any questions or comments, they would be welcome to interrupt the demo or if preferred wait until the demo was complete.

3. Expert is invited to comment or ask questions about any part of the system.

4. Expert is asked general questions about the implemented game.

5. Expert is asked more specific questions about the game, related to their expertise.

6. If the expert had not been seen during the design phase then details about their experience in relation to the project was requested.

6.2 Evaluating Design Objectives and Requirements

6.2.1 The Design Requirements

In Chapter 3 a number of design requirements were set out as definitive goals that were necessary for the project to become a success. Here it is assessed whether those requirements were met.

**Requirement 1:** The game will be roleplay based.

The players are placed into the story and are expected to take a role as one of the characters while acting out situations relevant to the story context. It was important to have the child play the role of themselves, however this can still be described as roleplaying.

**Requirement 2:** The game will be multiplayer, and allow the child with ASC to play with anyone from a friend (with or without ASC) to a parent.

It is a requirement that the game is multiplayer, the game cannot be played by a single person. Although the game is designed for children for ASC it is not restricted to that audience as evident by the evaluation workshop with typically developing children. Given that the game’s goal is to simply encourage nonverbal communication, it does not matter who the opposite player is, so long as that opposite player can participate in the guessing and acting roles to help encourage the child
- there is no reason that cannot be an adult. This was tested in the second session with no apparent drawbacks or disadvantages.

**Requirement 3:** The game will provide a framework to include a social story or set of social stories.

There is scope with what has been designed for an expert to incorporate such a social story into this game. This will relate to certain authoring functions that will be described in the next chapter (see Section 7.2.2). E5 backed up the idea and thought the structure was suitable for doing this. E3 also commented on the idea, believing it was a suitable framework, however stressed the value of the game in its current form and suggested social stories would not be necessary in the context of teaching nonverbal communication.

**Requirement 4:** The game will allow the children to incorporate themselves into the game using avatars or profiles.

This has been achieved by allowing players to create their own character profile and then that character can be placed into the story text and any other text that is relevant (e.g. prompts and questions). The profile image of the child is also used as a button on the game screen to navigate to that player’s own view - the child simply presses their own profile picture.

**Requirement 5:** The game shall be developed for a touchscreen tablet interface.

The justification for this platform has been evident from early on in development, and the game has indeed been developed for this interface. E6 warned of the issues with shared tablet use and advised being aware that accidental button presses would be common when passing the device between players.

**Requirement 6:** Different views of the game must be displayed on a single device at different times.

Given the restrictions of a single device, effort has been made to ensure two players can keep hidden information private to them without hampering the usability too heavily. This has been achieved by creating a screen with 3 separate sections where only 1 section can be displayed at a time (see Figure 12). There is a common centre screen and individual screens for each player - navigating between screens can be done easily through swiping or button presses, and so it should be made clear to the players that they can only look at the common centre screen and their own individual screen.
6.2.2 The Design Objectives

In Chapter 4 a number of design objectives were set out to complement the design requirements. The design objectives were goals that were derived from the literature, and although they were not necessary for system success, they were important in creating a game that would be an effective tool for the audience. Here it is assessed if these goals were met.

**Design Objective 1 – Appropriate sensory stimuli should be generated for the game.**

It was made clear that the game should include good quality multimedia as engaging and attractive content can prove an effective means of teaching. It was suggested that audio, video, voice overs and animations could be used. Not all aspects were implemented, however audio content is apparent in the rewards system and video content is available through the video hints. The method of displaying the story was discussed in design phases with suggestions from E2 that too many graphics will distract away from the instructions. Meanwhile a number of sources suggested that a voice over accompanying the text would be the most appropriate solution, however this has not been implemented. E1 reacted positively to the colourful graphical nature of the interface and described it as child friendly, while E5 described it as “quite visual, which would work well”.

Meanwhile during workshops the sound multimedia was responded to well, often with the children laughing when they heard the possible sounds they could choose from, despite the fact that on two occasions some of the sounds were described as “Cheesy”. P13 and P14 explained it would be nice to see some pictures to accompany the story, while P11 liked the fact the interface contained colour, however thought this aspect could be taken further to ensure it was eye-catching enough for children with ASC.

**Design Objective 2 – A suitable reward system is required**

The reward system implemented allows the child to choose a sound for their character that is played when they get an answer correct. There was potential for this to be taken further with customised visual stimuli as well. E5 suggested moving stars or bubbles could be presented on the screen but to reduce the chance of over-stimulation suggested that either an image or audio or animation should be chosen by the child as opposed to all three. E1 explained that the reward system was good for younger children but as the child grows up and becomes more independent and competitive, a points system may be more appropriate. Meanwhile E3 felt the true reward for the child is being able to play with a friend and explains that a well-structured game can provide lots of enjoyment (this game allows that to happen) but added that “any reward system can be placed into a game but it will never compete with a real person saying well done”.

The reward system appeared to be well received by those playing the game especially with the younger children who would sometimes laugh when hearing their sounds played back on a correct answer. The reward sound also acted well as immediate feedback to the child when they got the
question correct. This was most evident when a story finished and the child’s sound did not play even when they got it correct (a deliberate implementation decision). On these instances - even though a Congratulations screen appeared - there was initial confusion over what had happened. As one story finished, P9 asked for confirmation that he had got the question right, and on another occasion P11 asked “Wait, what happened to the sound”. So it is clear that the reward sound was not only valuable as a means of encouragement but also a way of clearly indicating a correct answer. Although no participant in the first three sessions mentioned they would like a different reward system, when P13 and P14 were asked about a potential points system, they responded very positively to the idea.

**Design Objective 3** – *Different levels of difficulty should be available for the vast range of players.*

Effort has been made to cater for different learners’ abilities. The main manifestation of this is the differences in the two frameworks. Framework 2 in itself requires an added layer of ability to think of ideas but also within Framework 2, the actor has scope to choose an idea that suits their level of ability. For example if the child is asked to perform a sport they could choose an easy one like football, or if they are feeling motivated for a challenge may want to try water polo. This idea was established during the design stage where experts backed it up and on occasions the children in the workshop preferred the harder Framework 2 because they could choose their own ideas.

Again it was evident that the children during the evaluation workshop understood the step up in difficulty between Framework 1 and Framework 2. In all but the first session there was a general consensus was that Framework 2 was preferred over Framework 1 due the increase in difficulty. P11 stated that she wanted to try the hardest story while P9 and P10 also looked forward to the challenge that would be required in the next story. P3 explained she enjoyed the greater level of thought required in Framework 2 to “Freestyle” the game. Although it is hard to assess how well those with ASC would deal with this level of difficulty it is apparent that different levels of difficulty have been implemented.

**Design Objective 4** – *Transitions between screens, menus, and stories should be fast and if not, appropriate audio-visual stimuli should be presented in such idle times.*

Through the development process it was noted that the Android platform is designed to allow navigation and transitions between screens and menus to be fast and appealing, and given that the game was not performing any expensive computation this was not an issue - this was confirmed by E6 who described the navigation around screens as neat and should not cause problems. With this in mind, no audio-visual stimuli was created to counteract the problem.
Design Objective 5 – The language used during the telling of the story should be appropriate for children with autism.

It has already been established that the story would be materialized through text. This issue raised concerns from the experts about the reading level required of the child but in most cases balanced it out by explaining that as long as the required reading level is apparent before play then this would be okay - for example only allowing players who can read to play the game and if they cannot then make arrangements for an adult figure to provide help. Again the idea of having a voice over to read the story aloud was reiterated with respect to this issue. E4 admitted that there was value in the story text element but warned that since the story is not necessary to perform actions and progress that some children may skip the story entirely. E3 meanwhile praised the balance that had been struck between the reading level and difficulty of task. E3 explained that it is common for games to have a mismatch between the skills required to play the game (e.g. reading) and the skill level that is actually being taught (e.g. gesturing) and that in this case the balance between the two is well-matched.

During the workshops some children (P2 and P13) took charge of reading the story aloud. Although their reading level was as expected for their age, some sentences and phrases followed a more complex structure than perhaps what they had previously seen and so frequently stumbled while reading aloud. This suggests further care should be taken when writing the stories so that they are age appropriate - for example examining children’s books and assessing the level of language evident in them. P11 openly explained that she could not read and so this provided the opportunity to test the game with an illiterate child who requires help from an adult (in this case the researcher). It was clear that the game could still be played adequately and very little changed to the format of play - when the child was given a private instruction to perform an action, the opposing player simply placed their hands over their ears.

6.3 The Research Questions

Since the tool has been validated against the design requirements and objectives, it is reasonable to attempt to answer the set of research questions with the evaluation data that has been gathered with the application.

The purpose of this paper was to explore the possibility of creating a technology-based game to encourage children with autism to express themselves through their body. This includes speculating what form the game may take, exploring how best to tailor the game to the audience and assessing the ability of such a game to for this task.

A number of sub questions were developed to help tackle the prominent issues at the source of the main research question. Considering these sub questions with respect to the evaluation methods (with additional reference to the design process) is the purpose of this section.
6.3.1 Sub Question A

What format of game may be suitable for this task?

**Literature** A potential format for this game was established through the design requirements after assessing the literature. Some research was done into the process of teaching nonverbal communication to adults where it was found that roleplay based activities had been employed with success. Extending this, a number of roleplay team-building exercises had been described for developing interpersonal communication in businesses - this included nonverbal communication. It is on this basis that the format chosen was a roleplay based game that contained elements of *Charades*, where the children would play face-to-face with each other. This format would then be developed to work with a technological interface and be adapted for the audience of children with ASC.

**Evaluation Workshops** When asked about the game *Charades* there was a general familiarity with the game from the children. If the children from the design workshop are included as well then *Charades* was discussed with 11 of the 14 of the participants.

<table>
<thead>
<tr>
<th>Played Charades</th>
<th>Heard of Charades</th>
<th>No knowledge of Charades</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

*Table 5 - Breakdown of all Workshop Participants and their knowledge of Charades*

More than half of the children had at least heard of the game format before (*P11* described it as her favourite game) and this familiarity with *Charades* is encouraging from an initial participation point of view - children may be more inclined to play a game that is similar to something they have played before. When considering choice of format, perhaps the most important aspect is that the children enjoy playing. All children when asked what they felt about the game said they enjoyed it apart from *P9* who overall described it as “Ok”. A more reliable source might be the fact that the children showed eagerness to continue playing after the first story. *P11* asked to play another story before the first story had even finished and expressed disappointment when all stories were complete. During session 3, *P12* had to stand aside while *P2* and *P3* played the game, however still watched with interest, moving around the room in order to see the hidden content on *P2* and *P3*’s screen. Given the choice between leaving the session and playing a third story, *P13* and *P14* chose to continue playing.

**Expert Interviews** Experts generally reacted favourably to the format and there were no suggestions that a major overhaul was required in order for the game to be at least used as a research tool - both *E4* and *E6* saw the potential of the game to be used as research tool. *E5* suggested that instead of having the children play face-to-face it may be more appropriate to have multiple devices connected remotely as this could (in the first instance) reduce the stress inherent in social
interaction. Discussion of this idea is extended in the next chapter (see section 7.2.2) however as a major change to the game format, this appears like a suitable suggestion.

6.3.2 Sub Question B

*Does the chosen game format support the expression of nonverbal communication?*

**Evaluation Workshops** The most important result that arose from the evaluation workshops was that all children participated in performing actions/gestures one way or another. On only three occasions did a child not perform an action, two of which were due to confusion with the rules. Video hints were also used frequently by a number of participants to good use. When a more difficult action was required the child would spend a long time thinking about what they could perform, in some cases it was appearing that the child may give up and abandon that action until the researcher suggested using the video hint - on seeing the hint the child simply copied the video and a correct guess was made. This was the case with both P11 and P13 when attempting to act out *watching a movie*. At times there were misunderstandings about the story that resulted in a strange out of context action, however given the main goal is simply encouraging the nonverbal expression this should not be seen as a negative result.

An observation that was made showed a difference in the level of expression required for actions. Some actions were performed with a greater level of movement and eagerness to express. All observed actions across all sessions were separated into three types:

- **Type 1** - Those where the child performed the action sitting down
- **Type 2** - Those where the child performed the action standing up
- **Type 3** - Those that were performed with greater activity than just standing up - such as crawling under a table or moving to the centre of the room to allow more expression.

<table>
<thead>
<tr>
<th></th>
<th>No action</th>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>34</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

*Table 6 - Individual counts of types of action*

If the types were to be indicators of how confident and willing the child is to perform (Type3 > Type2 > Type 1 > No action) then effort can be made to increase the number of Type 2 and Type 3 actions.
An unexpected result came from the reward sounds. It was seen in a number of cases that the sound actually provoked nonverbal expression among some children. Examples of such are:

- **P9** (Cheering Reward Sound) stood up, waved his arms and clapped along with the sound when he correctly answered a question.

- **P11** (Tropical Reward Sound) stood up and started *Hula* dancing when she heard her reward sound.

- **P13** and **P14** (Guitar Reward Sound) **P13** pretended to play a guitar while **P14** ‘danced’ in his chair when they heard the sound.

Should more thought be placed into the selection of reward sounds then there may be more opportunities to prompt such spontaneous gesture.

**Expert Interviews** A number of comments were made about this aspect by the experts and it was the general view that yes, the game format will support the expression of nonverbal communication. **E1** noted positively that the game would certainly encourage such skills and the *Help* feature with video hints would be particularly effective for those with little experience in such roleplay game situations. **E4** extended the comments made during the design interviews about the different types of gesture appearing in the game and that switching between types of gestures may cause problems. The expert mentions it is important to provide all different types of gestures, however was unsure of which gestures would cause most problems (the expert suspects symbolic gestures). The potential of the system was still seen positively by this expert, but urged awareness of this issue so that the game can be designed more effectively - for example, increasing the level of difficulty. **E5** saw the game as a good way of structuring such nonverbal interactions by placing them into a story context. The expert went onto compare this idea to social stories however saw it as more than just a platform for social stories because the explicit task of performing actions requires a lot of representational skills.

**E3** gave promising feedback relating to this aspect and explained that while the game may not be effective in teaching ‘what gestures mean’ there was most definitely relevance in the way the game allows the child to see what they *can do* with their body. The expert gave reference to the ADOS test (Lord, et al., 1989) for gesture, where the child is asked to tell a story verbally while the their nonverbal expression is assessed. **E3** explained that a common trait during this diagnostic test is that the child simply does not move while telling the story, while it would be normal for at least some form of unconscious nonverbal gesturing to be visible. The expert explained that the ‘loosening up’ aspect of this proposed game taps into relevant areas from a diagnostic and practical point of view.
6.3.3 Sub Question C

What level of customisation and personalisation is suitable and effective in a game for this task?

In this game, customisation and personalisation is made apparent in a couple of ways – changing elements of the interface (background colour, text size) and allowing children to create their own character profile, adapting their name, profile picture and reward sound.

Evaluation Workshops The level of personalisation from allowing children to play as themselves proved to be very important. The participants enjoyed the fact they were a part of the story and some laughed when they first saw their name placed into the story text. From the design workshops it was clear that the children do not like assuming the role of a gender not their own. This was noticeable again during evaluation. The children were taken through a tutorial game with dummy characters, James and Sarah. The boys were reluctant to be Sarah and the girls were reluctant to be James. During session 3, P3 was asked if she could play together with her brother, P2, as a single character. P3 was not open to the idea and insisted on making her own character. Customisation was also evident within character creation, where children could take a profile picture and select their reward sound. The number of reward sounds (6 with the option of no sound) was appropriate. There were enough choices such that every child found a sound they liked yet not too many that listening to them all would cause long delays in progressing the game. Taking a profile picture was also received positively however P11 noted that some of her friends would with autism would not like to have their photograph taken and instead suggested allowing graphical avatar creation.

Expert Interviews All the experts found that allowing the child to create their own character profile was valuable. The importance of this element was stressed by E2 in the design expert interviews as children with ASC have a problem taking on the role of somebody unfamiliar. E3 was impressed with the way that the names and pronouns were automatically placed into the story text while E1 found the control that the individual has over their character is valuable in the sense that it can promote independence.

Again multiple experts gave positive input on the ability to change the background colour and text size, and should a voice over feature be implemented then an option to toggle on/off would be required, however it should be placed on the game screen as this is more accessible than was previously suggested – on the Settings screen. E1 praised the balance of customisation choices as there is a possibility of overloading the child with too many options, explaining that some children have difficulty in making choices and the fact that the game does not provide too many, avoids this problem.
6.3.4 Sub Question D

Does the chosen game format promote any additional skills beyond just nonverbal communication?

**Evaluation Workshops** Turn taking was inherent in the game format, one child performs while the other guesses, and subsequently those roles are switched. The level of turn taking between uses of the tablet was also evident, children did not fight over the tablet at any point and this may be due to how the each child was given their individual section. It appeared that the children understood well the fact that they could not look at their opponents section and their opponent could not look at theirs. It is believed that this separation of tablet content reduced the desire to have possession over the device because the child knew they had their own personal space that could not be shared. There was little chance during the workshops to evaluate the level of collaboration between players, especially when there were no instances of multiple children assuming a single role. During the design workshops, multiple children did assume single roles and this appeared to work very well so further research could explore such potential.

**Expert Interviews** A number of ideas came up during the interviews that expressed an interest in alternative ways the game could be beneficial. Discussion with E3 and E5 brought up the issue of social stories, and the fact that the game could provide a platform for this suggests by extension that it can also promote a number of skills provided by social stories. E4 was interested in the collaboration factor inherent in the gameplay. The ability to progress through the game is very much dependent on both players; they are working together in a joint process to get the answers correct. E4 states that the game does this very well. During the design phase E2 was asked about the possibility of 2 players working together as a single character. E2 explained that from a social cognition point of view, multiple people with ASC assuming a single role could cause problems but also allowing multiple children to discuss how they might make an action could hold valuable collaboration effects. E1 mentions that the game is actually good for any type of communication and interaction, not just nonverbal, and suggests the game could also be used to improve leadership by allowing one child to teach another how to play.

6.4 Game Improvements

After testing and feedback sessions were complete it was evident that there were a number of areas that the game could be extended upon in the larger context, this will be covered in the next chapter. However a number of small implementation issues were either pointed out or were obvious from observations. Here a set of improvements are suggested that will alleviate the effect of such issues.
Improvement 1 - Adding Voice Over: One point that was consistently brought up by the experts was the reading level required to read the text and understand the story was quite high for those with autism and the suggestion of having a voice over on the text was positively discussed. This was not implemented in this version however after speaking to E5 it was made clear that Google APIs were available just for the purpose of reading aloud text, this next logical step would be to implement these APIs as the task has been simplified. E5 went on to explain that the audience are actually fond of the synthesised voice used by such APIs.

Improvement 2 - Basic UI Updates: Some experts noted minor issues with the user interface that could be improved upon, these would be relatively simple to add/alter in a future iteration:

- Have the difference between the two player selection screens more obvious so that players do not accidentally press the same character twice.
- Some buttons were to be larger for visibility reasons
- Add a visual mechanism that distinguishes between a Framework 1 story and a Framework 2 story.

Improvement 3 - Offer Graphical Reward: It was suggested by E5 that visual stimuli could also constitute a reward. It would be relatively simple for a child-chosen static image to appear when a question is guessed correctly. Additional animations would be more difficult to implement but not beyond the scope of a project on this scale.

Improvement 4 - Restrict Number of Guesses: Framework 2 must rely on some form of self-moderation in the sense that the children must only press the Guessed Correctly? Button when they actually guess correctly. E6 explained that the guessing process might stagnate or go on indefinitely should a correct answer not be found. It was therefore suggested that a counter restricting the number of guesses a player is allowed may reduce this effect - the player simply taps a button that decrements a Number_Of_Guesses_Remaining counter. The number of guesses is also a variable than can be easily be adjusted to vary difficulty levels. This idea was also suggested by P11, because her opposing player continued to get her actions wrong yet was still allowed to hear the reward. P13 and P14 were told for Framework 2 that they could count the number of guesses their opponent had. This was enjoyable for the participants but did appear to bring a level of competitiveness to the game which could stifle collaboration.

Improvement 5 - Sound and Image Upload: It had been suggested by the workshop participants that greater personalisation would be available if they could choose their own profile images and reward
sounds from files on the device. P3 suggested that sounds could be downloaded from the web and mentioned a viral song she had heard on YouTube - this could be extended such that a video clip from YouTube could be streamed as a reward.

### 6.5 Conclusion

In this chapter evidence was provided of an evaluation process conducted through expert interviews and user testing with typically developing children. The processes involved in these evaluation methods were explained; 8 child participants were shown the game and observed across 4 distinct sessions, while 5 relevant experts were consulted in semi-structured interviews to assess the suitability for children with ASC.

The design requirements were assessed first and it was found that all were met sufficiently. The design objectives were set out as a way to ensure the game is effective, it was found that the majority of these objectives were met in most respects:

- Appropriate stimuli had been created for the game but there were suggestions that this aspect could be taken further with animations and pictures.
- The reward system provided a good level of immediate feedback and participants reacted well to the sounds. The experts also explained that such a reward system would be suitable for those with ASC.
- Varying levels of difficulty had been achieved through the 2 frameworks and the children responded well to the change in difficulty. It is less clear how those with ASC would react when faced with the same change in difficulty.
- Transitions and navigation were quick enough that no additional content had to be created to alleviate the issue.
- The level of language was just appropriate to be understood by the children, however some additional focus was required to make sentence structure more readable. An even more prominent issue to consider is children who cannot read. This was tested with such a child and with help from the researcher did not cause any major problems however it would be beneficial to add a voice over function.

Following this, the research sub questions were examined with reference to the evaluation data.

- The game format proved popular among the children and their familiarity with Charades suggests that getting the children to initially play the game would be easy. The experts also found the format valuable and did not suggest any major changes.
- The level of participation was encouraging with respect to nonverbal expression. Only on rare occasions were gestures not performed and even when there was confusion about the game or story, some form on nonverbal gesture was still the outcome. Experts showed
positivity to the idea and most envisioned it working while others saw it as a research tool to investigate certain aspects of nonverbal communication.

- The ability to create a character profile and place that profile in the story was well received by children and experts alike. Children enjoyed personalising their character’s reward sound and profile picture while the experts liked the fact it takes some difficulty out of the roleplaying aspect. The number of customisation options struck an appropriate balance between allowing enough choice and not causing long delays while a child decided on customisation options.

- While collaboration was envisioned by some experts as an additional area that could benefit from the game, there was little evidence to suggest this from the limited workshops. Turn-taking did appear to be encouraged through the passing of the tablet and swapping of roles between actor and guesser.

A number of small scale improvements were then suggested as ways to make the game more effective based on what had been observed and said during interviews.

Our overarching question looks to explore the possibility of a game to encourage nonverbal communication. The following chapter looks to answer this question by reflecting on the process described in the previous chapters with particular focus on the evaluation of the sub questions.
7 Discussion

In this chapter the process described during this dissertation is summarised and a number of conclusions are reached based on analysis of the results. The overarching question and themes of the paper are discussed with reference to the sub questions and evaluation process. This is followed by a section that describes where the work could be taken next by considerations of possible future research and development. The main contributions of the work are then described, and a final summary of the outcomes and results of the paper are given.

7.1 Research Question

The theme behind the dissertation was to explore the possibility of creating a new game to promote nonverbal expression in children with autism through the aid of technology. The main research question put forward as a basis for this was:

**What form might a technology-based game for encouraging nonverbal communication in children with autism take?**

To evaluate the overarching theme, the question was broken down into a number of sub questions. Attempting to answer such sub questions provided better insight when assessing the main question.

**Sub Question A** attempted to find out what format of game could try and tackle the problem. A concept was proposed for a tablet game that featured a *Charades-style* format within a roleplaying based narrative. During both the design and evaluation workshops the children responded positively to the game format, insisting they enjoyed playing, and in the majority of cases showed eagerness to continue beyond the first and second stories. Many were familiar with *Charades* and this appeared to be a contributing factor to their willingness to play.

Even if the game was enjoyable there was no guarantee that such a game would actually encourage nonverbal communication and so **Sub Question B** looked to assess the potential that this game would have for children with ASC. It was observed that in the vast majority of cases children were willing to perform the actions and only in a few instances were gestures not performed; even though there were occasional wrong answers given or confusion about the story, the child still performed some form of action. Another consideration was the value of video hints which on a number of occasions provided support and perhaps avoided situations where a child would have abandoned the action altogether. There were also some endorsements from the experts who expected that the game would provide nonverbal communication support for those with autism, and that it would be especially relevant to those who are uncomfortable showing any expression. It was unclear however as to what extent the game could be effective.
A general recommendation for developing games for those with autism is to allow scope to personalise and customise the game for individual children. What level of personalisation was the focus of **Sub Question C**. The idea of role-playing brought up the issue that those with ASC have difficulty assuming unfamiliar roles. To alleviate this, the game was implemented such that users could create a personal character profile and this profile would be placed into the story. This was responded to well by children and experts, both appearing to see it as a valuable aspect of the game. Within the profile there was room to customise a reward sound and take a profile picture. This level of choice was suitable, although it was suggested by the children that the option to upload (or download from the web) their own sounds and profile pictures would be preferable.

**Sub Question D** examined the potential to promote more than just nonverbal skills through the game. Experts expected that skills such as turn taking, leadership and collaboration would be apparent during play. During testing with children, an element of turn taking was evident as children each had their chance to use the tablet, however in four sessions with children, collaboration and leadership were less obvious and further study would need to be done to assess this.

To summarise, a possible form of game for encouraging nonverbal communication in children with ASC could be a *Charades-style* roleplaying game with a narrative. It was found that this format did indeed promote nonverbal communication in typically developing children and this would be expected to transfer over to those with ASC. Allowing children to create their own customisable character and placing that in the story adds an adequate and important level of personalisation, while the game also has the potential to promote other skills such as turn taking and collaboration.

### 7.2 Future Work

#### 7.2.1 Future Research

There were promising initial results in the level of participation and experts expected it could work, however no experiments were designed to test the effectiveness of the system. Designing and implementing such experiments is the next logical step for this research.

During the evaluation stage, all actions performed by the children were categorised into three types:

- **Type 1** - Those where the child performed the action sitting down
- **Type 2** - Those where the child performed the action standing up
- **Type 3** - Those that were performed with greater activity than just standing up - such as crawling under a table or moving to the centre of the room to allow more expression.

The three types loosely define levels of confidence and willingness to produce actions. The goal of this game would be to attempt to push children to be more expressive and aim for **Type 3** actions. If the participants’ actions were plotted then the results would be as the graph below (Figure 22).
Participants are represented by their own line. The x-axis represents the timeline of actions performed by the participant, for example the third increment on the timeline represents the third action performed by the participants, while the y-axis represents what type of action they used to perform. Since participants performed different stories in different orders, a single column of the graph does not represent the same instance of a story.

It can be imagined that longer term studies with more participants and more stories may result in trends appearing (hopefully upward trends towards Type 3 actions) and should this be the case then it could be claimed the game works as tool for encouraging nonverbal communication. Of course certain gestures may be more suited to certain types (watching a movie = sitting; playing football = standing) however once such gestures and their common action type can be identified then some logic could be applied to the stories such that a progression from Type 1 to Type 3 actions can be encouraged gradually.

### 7.2.2 Future System Adaptions and Additions

A number of problems, ideas and additions were made apparent during the evaluation stage and so a set of small-scale improvements were generated. However this section allows the game to be placed into a greater context and scope with two major game ideas.

Firstly is the idea of adding **authoring** functionality. This would allow parents, teachers, practitioners and even children to write their own stories for the game frameworks. This concept was discussed among experts very positively and all saw scope for the inclusion in the game. They felt the ability to tailor a story to a particular child was very valuable, however one expert explained...
that a teachers time is already limited and in this case full authoring is unlikely to be feasible, instead suggesting that a reduced authoring tool could allow different pathways through existing stories to be selected. The authoring idea was proposed to the children with mixed response. A number liked the idea of creating their own stories (two children were able to think of a story idea on the spot) while others were less motivated to write their own, but liked the idea of new stories being released on a regular basis.

The second development would incorporate remote play and support for multiple devices. The idea behind this would allow users to play with each other when they are not in the same room. Each player could have access to their own device (be it a smartphone or tablet interface - Android easily supports both) and would connect to each other through internet network protocols. Interaction could be facilitated through Skype-like video connections with use of the devices' cameras such that players could play with friends not located in the same room. A number of benefits are evident from this addition; the effort required to ensure private content remains hidden will be eliminated because each child will receive their own private view of the story on their individual device, while the interface can be adjusted on a device-wide scale for individual children. The experts again promoted this idea positively, with one suggesting that the format may be more appropriate for those with autism as it could reduce the stress of face-to-face social interaction. Another mentioned that a child's familiarity with their own device is something that can provide comfort in new situations.

On a grander scale it would be especially interesting to combine these two major game ideas. Services like Facebook, Twitter and Snapchat have added a different dimension to the way people interact on the internet. The focus is often on communities, friends and sharing content (often multimedia) and it seems reasonable to imagine a game like the one proposed in this dissertation to be adapted for an international social audience. Strangers from across the world could play with each other via their own device and an internet connection. Character profiles have already been implemented in this system however could be extended to a much greater depth where users have a network of friends that they could play with regularly. In terms of story content, a community of story writers could be founded where stories are published for everyone to play and rated on certain scales such as enjoyment or suitability for children with autism. The idea is on a large scale, far beyond what was discussed during this dissertation but feedback on the potential of the game with respect to these ideas was very positive from both the experts and children.

### 7.3 Significance and Conclusion

During this research, the goal was to explore the possibility of a new technology-based game to promote nonverbal communication in children with autism spectrum disorders. This process followed a structure that involved reviewing the literature, developing a concept, receiving feedback on the concept, developing a prototype and finally evaluating that prototype. Feedback
and evaluation data was gathered from testing the game with neurotypical children and interviews with field experts.

Considering that a game for encouraging or teaching nonverbal communication in children with autism could not be found, it could be claimed that the proposed game is one of very few systems purpose-built for the task. A number of valuable observations and results were found during the process that could be of use to future researchers:

- A *Charades-style* role-playing based game with narrative appears to be effective in eliciting nonverbal expression from children.
- Such a game also has the potential to promote other skills such as turn taking, sharing and collaboration.
- The inclusion of character profiles that are placed into a story is responded to well and can reduce the stresses of role-playing in children with ASC.
- Character customisation is received well by children and can provide a greater level of tailoring for individual children with ASC.
- Video hints are valuable in ensuring at least some nonverbal meaning is conveyed even if that gesture is not understood.

A set of small-scale improvements to the system design and interface will allow the game to be more appropriate for the audience while in the long term, possible support for remote play across multiple devices and authoring tools could provide a platform for a community of ASC children to flourish.

Further research is still required to assess how effective the system could be on children with ASC before the system could be described as a proof of concept, however the work shown here presents a potential solution for future work to be based upon.


Bibliography


Appendix A

Workshop Content

This features consent forms and information forms for both the children and the parents or guardians. The workshops sessions were shared among 3 different projects and so the material seen here has combined the information and consent from all three projects into single documents.
Research Consent Form - Child
To be used as a guide for securing consent or refusal, after the child has had a chance to get information about the research session. The child may mark (or be helped to mark) this form, to assess if they want to take part and be video recorded.

- I can choose to be a games tester.
- I do not have to help if I don’t want to.
- I can stop playing or take a break and I do not have to say why.
- It is OK if I change my mind later, and say I do not want to be a games tester any more.

Do you want to be a games tester  YES / NO
for Michael’s story game ?

Do you want to be a games tester  YES / NO
for Patrick’s Minecraft game ?

Do you want to be a games tester  YES / NO
for Fraser’s gesture game ?

We will have a video camera to record what happens when I play the game.
We will look at this video later.
We may show it to other people who make games for children.

Is it OK to take a video?  YES / NO

Patrick also has a microphone to record what I talk about when I play the game.
We will listen to the audio later.
We may play the audio to other people who make games for children.

Is it OK to take a voice recording?  YES / NO

Write your name: ____________________________

THANK YOU!
Appendix A

APPENDIX A2 - Parent/Guardian Consent Form

Research Consent Form – Parents/Guardians

CHILD’S NAME: ______________________________

CHILD’S AGE: ______

YOUR RELATIONSHIP TO CHILD: _______________________

YOUR CONTACT TELEPHONE NUMBER: _______________________

Please circle appropriate YES or NO answers

Have you read the attached information sheet? YES / NO

Do you feel you have received enough information about the research projects? YES / NO

Do you give permission for your child to be audio recorded? YES / NO

Do you give permission for your child to be video recorded? YES / NO

Do you give permission for short videos of your child to be used in public documents or presentations relating to the research? YES / NO

Do you understand that participation is completely voluntary and your child can leave the sessions at any time, without having to give a reason? YES / NO

Please indicate with a tick which workshop sessions you permit your child to participate in:

- Emotion Recognition game with stories - Michael Nelson
- Collaboration through Minecraft - Patrick Cartlidge
- Nonverbal Communication with role playing game - Fraser Lennon

Print Name: ______________________________

Signature: ______________________________

Date: ___/___/______
New computer games to help children

This page is for children. It is about some people who are looking for some help. It says who they are, and what they will do if you agree to help them.

The researchers will ask for your help. You can help by carrying out an exercise. You can decide if you want to say “yes” or “no” to helping.

Who are the researchers? This is Michael, Patrick, Fraser and Helen. Their job is to learn about how children use computers, and how to make computer games that can help children. They will ask you to help them by completing some exercises.

Michael

Patrick

Fraser

Helen

Why are Michael, Fraser, Patrick and Helen asking for help?

Some children find it hard to recognize how others are feeling and struggle to understand why they are feeling a particular way. They may also find it hard to interact, talk and work together with other people around them, especially when they are in new situations.

Michael - Michael and Helen have a question: “Can we make it easier for children to understand people’s feelings?” Michael and Helen will ask children like you to help them find the answer. You can help by completing an exercise for them.

Fraser - Fraser will ask “Can children communicate with their bodies instead of talking with the help of computer games”. Fraser has made a tablet game and would like you to play it.

Patrick - Patrick is trying to see if games such as Minecraft that allow children to be creative and collaborate can be used to teach other children skills that might have trouble learning.

What will they ask you to do?

Fraser, Michael and Patrick will have different activities for you to do, and they will learn about how helping children by watching you do the activities.

Michael - To start, Michael will talk to you about the game and explain what kind of things you will see in the game. Then you will get roughly 10 minutes to play through Michael’s game on your own. In the game you will help the main character of a story, “Tom”, identify and understand the feelings of another character in the game. After you’ve finished, or once the 10 minutes has passed Michael will ask you some questions about your experience of playing his game. With your help, Michael will find out how he might be able to improve the game for other kids that want to play his game. You might find the game easy or maybe you will find it hard. Michael will be there if you have any questions and will help you if you get stuck.

Fraser - Fraser has made a game to play on a touchscreen tablet (like an iPad). The game involves a player doing actions with their body while another player has to guess what the action is. You will get a chance to make yourself in the game (an avatar) and then you will be placed into a story. At times during the story you will get the chance to do an action or you will have to guess somebody else’s action. Don’t worry if you get stuck. Fraser will show you how to play beforehand and the game can give hints to help you. Afterwards, Fraser will ask you what you thought of the game. It will take about 35 minutes to finish.

Patrick - In this workshop you will be playing a game with another game tester using Minecraft. You’ll work with a partner in turns to create a building in Minecraft. To start off you will be given time to plan and prepare what you are going to make and you’ll be able to get used to the controls of Minecraft if you’ve never played it before. After this you will have a time to build and it will be equally divided between you in turns. This will help Patrick understand what happens when children play together and will allow him to develop a new game to help children play together better.
You can tell the researchers if you want to stop doing the exercise at any time. You do not have to tell them why. Please tell them if you need the toilet, or if you want to take a break. You can also say you do not want to be involved any more, and that is OK. They will always listen to you.

What will happen after I am finished helping? Fraser, Patrick, Michael and Helen will learn a lot about how children play and learn. After all the children have finished the exercise, we will take all our information away with us and write about what they have learned and use it to develop their ideas.

Your mum or dad said it is OK for you to help us.

Do you want to be helped? You can say “yes” or “no”. It is OK to say “no”. It will not hurt anyone’s feelings.

Do you want to ask a question? It is OK to have more questions. You can ask the researchers as many questions as you want about being the task. Ask your mum or dad to help you call them on the phone or write an email with your question.

Michael
Mobile phone number: 07456219904
E-mail address: s1223335@sms.ed.ac.uk

Fraser
Mobile phone number: 07766754398
E-mail address: s1126535@sms.ed.ac.uk

Patrick
Mobile phone number: 07444625069
E-mail address: s1228955@sms.ed.ac.uk
Appendix A

Appendix A4 - Parent/Guardian Information Forms

Designing educational games for children with Autism:
A research project
Information sheet for parents and guardians

This information sheet is for parents and guardians and explains a research project in which we would like your child to participate. It gives information about the project in the form of questions you might have, and their answers. If you have further questions, we are happy to discuss them and give you more information.

There are 3 different lead researchers involved in the project. All 3 are undertaking the same underlying project with different methods and outcomes. The researchers on this project and their contact details are as follows:

Mr. Michael Nelson, lead researcher (m1223396@emse.d.ed.ac.uk, 07952019904)
Mr. Fraser Lennon, lead researcher (m1123353@emse.d.ed.ac.uk, 07968743998)
Mr. Patrick Connolly, lead researcher (m1223995@emse.d.ed.ac.uk, 07744195869)

Project Supervisor: Helen Pain (helen@inf.ed.ac.uk)

An overview of this project, and how you can help

What are Autistic Spectrum Disorders (ASD)?
ASD is a lifelong condition that affects how people interact with the world and people around them. They often have difficulties with social interaction and communication and have trouble adjusting to new situations. It is a spectrum condition which means it affects people in many different ways and levels of severity. Roughly 1 in 100 people in the UK are affected and there is no cure. However, the severity of the difficulties can be greatly reduced with targeted education, and it is widely acknowledged that the earlier education begins, the greater the effect.

What is the project goal?
We are investigating how integrating techniques used to help children with ASD, presented through a computer game, might be more effective than current methods. Each researcher will produce a different game, focusing on a different difficulty affecting children with ASD.

Michael - Children with ASD often have trouble identifying both emotions and the underlying reasons behind why people experience those emotions. There are various tools to help identify emotions, but few focus on how situations that people are involved in influence the emotions they feel. The tools that exist currently also tend to present their tasks for the user to carry out in a bland and unengaging way. It's because of this that we are interested in discovering whether children will learn more effectively if they have an active interest in the tasks they are presented with.

Fraser - My project will focus on the development of nonverbal communication (gesture-based) and we are investigating how games might help children learn to express themselves by nonverbal means. The game is to be developed for a touchscreen tablet interface. This research workshop aims to evaluate my game prototype and find out how the design can be improved.

Patrick - I am investigating Virtual Learning Environments and their benefit for developing social skills for children with ASD, in particular using the game Minecraft in which players can create their own "worlds" as a basis for building new educational activities. The game has a capacity for creative collaborative play which could be expanded upon to help develop social skills in autistic children.

How can my child help?
We are currently in the early design phase of our games and we are trying out ideas to get a feeling for how the games may be received by children. We have developed a number of activities and we would like your child to play as a ‘Game Tester/Designer’. This will greatly inform us on what aspects of our designs children like or dislike, but also provides us with ideas that can be incorporated into the final game. Most of what we want to find out will come from observing them play and what they produce during the activities, however there will be chances for your child to give some insight into how they would like the game to be designed.

What will your child be asked to do?
Michael - At this stage of the project we are investigating what kind of scenarios should be included in the story we hope to create. We are looking to find out what emotions and situations children aged 7 – 14 will be able to relate to. In order to do this we’ve created an exercise sheet for your child to complete which will then be followed by an activity. The exercise sheet presents a few emotions and asks your child to write down a time when they, or someone they knew, felt each emotion. After the children have completed the exercise sheet they will then be split up into pairs and asked to come up with a story that involves one or more of the emotions they wrote about. They can then draw or write down the story that they come up with.

Fraser - Since the focus of the project is developing nonverbal communication, the game proposed will be somewhat similar to Chocodile with a story or narrative. Beforehand they will be split into 2 groups and collectively assume one of the characters in the story. At certain points during the story an action will then have to be performed by 1 group while the other group tries to guess what they mean. There is an element of role-playing with the game, however your child will be part of group acting out an action together and there is no pressure for your child to perform well in the game; they will be given hints and help all along the way. We are interested in whether your child had fun during the game, and if their playing of the game helps us improve the format.

As a warm up, I’d also like to have a little group chat about what the children are interested in at the moment – be it films, toys, TV characters. After we have played the game, as a
Appendix A

Who paid for this research?
This study is part of the undergraduate work of the lead researchers. It is indirectly paid for by the University of Edinburgh and the funding is not attached to a specific project or to any outcomes of that project. Conducting this research brings no financial benefit to the researchers or to the university.

Would you like to participate?
We ask parents to read this information sheet so you can decide whether you think it is a good idea for your child to participate in either of these exercises. If you say “yes” when returning the permission form, we will then explain what’s involved in the exercise to your child, and ask him/her if s/he wants to help. We will remind your child that they can stop participating in either of the exercises at any time, without having to give any reason, and that we will always listen to them. This explanation will be based on the child information sheet included in this pack. We feel strongly that children should be given a real choice about whether to participate. Even if you say “yes” on the permission form, your child may still say “no” if s/he does not want to be involved. We will respect your child’s decision.

Once again, this study is completely voluntary and you and your child are under no obligation to take part. Even if you say yes now, you may withdraw your child from the study at any time and for any reason by contacting us. Your child may also withdraw at any time by saying that s/he does not want to be involved any more.

Thank you for taking the time to read this.

If you would like to know more about this research and/or if you have questions, please feel free to contact any of us using the following details:

Michael
Mobile phone number: 07456021904
E-mail address: s1223336@sms.ed.ac.uk

Fraser
Mobile phone number: 07768754398
E-mail address: s1128353@sms.ed.ac.uk

Patrick
Mobile phone number: 07445692903
E-mail address: s1122866@sms.ed.ac.uk

Additional study information

What happens when the project is over?
After the study has finished and we have analysed the information we collected, it will be used to develop the design of the game and will likely be presented in a final report. This report along with the data and videos may be shared or presented in scientific journals or conferences. We never share children’s names, schools or other personal information.

How will personal information be protected?
Confidentiality is extremely important to us. Information (such as forms with children’s names) will be stored safely on password-protected computers or in locked cabinets. Access will be limited to the people involved in the research: Michael Nelson, Fraser Lennon, Patrick Cartridge and their research advisor Helen Pahl. Information will be identified only by participant codes or pseudonyms, and will be separated from identifying information (such as name or birth date). Likewise we do not include school names in publications and presentations as this could also be used to identify children.

Patrick - As my project will be created in Minecraft, I would like your child to engage in an activity with the game. Your child will be tasked with working together with another child attending the workshop to create a new building in Minecraft. The pair will be given a specific structure to build. They will then be given a time to practice the mechanics of Minecraft and plan and sketch their design. After this they will take turns to create the building, one child taking control of the laptop with the game on it at a time. I am interested in the interactions that occur when carrying out a collaborative task with another child and whether or not I could improve on the mechanics of Minecraft to facilitate better collaboration and socializing.

Video and Audio Recording
As part of Fraser’s workshop he would like to video record the session, to provide a record for later analysis and allow us to freely interact with your child during the session without worrying about taking notes. If you prefer that we do not use videos or pictures of your child for publications, presentations or teaching purposes, you can indicate this on the relevant consent form. In that case, the video would be seen only by us during the analysis. If you’re not comfortable with your child being videoed at all, then you may also indicate this on Fraser’s consent form.

Patrick would like to be able to audio record the interactions between the players when they are working together. This would allow Patrick to analyse the arising social situations that can result when two children are paired together to collaboratively complete a task. These interactions will help the design of the final game. If you are not comfortable with your child being audio recorded then you may indicate this on Patrick’s consent form.

warm down activity we will ask your child to draw some gestures that she may like to see in the game.
Workshop Questions

1. What did you think of the game?
   a. Did you enjoy playing the game?
   b. Why did you enjoy playing the game?
2. Was the game easy to play?
3. Did you understand the game and how to play?
4. What did you think about how the game looked?
   a. Did you like the colours?
   b. Was it easy to navigate through the game?
5. If you pick 1 thing, what was your favourite thing about the game?
6. If you could change 1 thing about the game what would it be?
7. If the game could be played on multiple devices would you prefer that?
8. If you had the chance to create your own stories and put them in the game, would you like that idea?
APPENDIX B

Expert Interview Resources
Expert Interview 1

Begin with introduction from myself
- Currently doing a research project as part of my final degree. Essentially my dissertation
- The project brief is Designing Educational Games for Children with ASC
- Currently looking at the area of non-verbal communication
- In the process of designing a prototype – DOGE WORKSHOP
- Given your experience with children with Autism and computer assisted learning
  I am seeking your input on the progress I have made

Question 1
Can you briefly describe your profession and experience relating to Autism?

Question 2 (if not answered above)
How many years have you been involved with this work?

Question 3
Is there a general age group you are used to working with and is there a general level of functioning you are interested in?

Introduce game
- The idea of my game is like charades with a narrative
- To be played on a tablet, each player gets a different view of the game
- Etc.
- For relatively high functioning children, with help from parents

Question 5
I’d simply like to invite you give any feedback on the framework so far:
- Do you have any questions?
- Anything that you think may cause problems
- Anything that you see is positive and would work well
- Any additional ideas you would like to contribute

Question 6 (if not answered above)
- Do you think it may be too difficult or too easy
- To what extent do you see the children participating

Question 7
Alongside this, I also developed a variation on the game (EXPLAIN) – how do you think this will be received by children with ASC. What scope is there to include it in the final design?

Explain Avatar issue
- The thing I am trying to pin down is the balance between customisation and attractive graphics
- I would like to allow profiles for the child to be created with avatars
- And I would like those avatars to be in the stories
- I’d also like to create some form of animations for the stories
- If I am to include custom avatars in stories I don’t think I will be able to work in a system of custom animations for each avatar.

Question 8
Do you have any advice on what balance I want to be striving for?
APPENDIX B

APPENDIX B2 - Example of Evaluation Expert Interview Structure

**Evaluation Questions**

- Explain what the project is about and the area I am focusing on.
- Charades with a Narrative
- Idea is that explicit gestures and actions will improve individuals ability to recognise and produce non-verbal communication
- DEMONSTRATION (feel free to ask questions throughout)

**Questions**

1. What are your initial reactions of the game? Any Questions?
2. Is the game easy to follow and navigate through in general?
3. Is it suitable for a child with autism?
   a. How easy do you think the game is to pick up?
   b. Is the language suitable?
   c. Do you feel the reward system is adequate?
4. Can you suggest any improvements?
5. If you could summarise, what are the main positive points and what are the main negative points. (Only if not clear enough)
6. A couple of ideas for future directions:
   a. Multiple Device Support
   b. Authoring Tool
7. For write-up purposes can I ask about your experience?
Evaluation Questionnaire

From your experience using the game, do you have any initial reactions or thoughts you would like to express?

Could you please briefly write about how suitable you think the game is for the audience – children with autism. Focus on things such as ease of use, level of language, is the reward system adequate or anything else you think is relevant?

It is important when designing games for people with autism that the game can be customized and personalized to the individual. In this game, customization and personalization is made apparent in a couple of ways – changing elements of the interface (background color, text size) and allowing children create their own character profile? Is this level of customization suitable for this game? Can you think of any ways this aspect could be taken further?

The game is designed to encourage nonverbal communication. Do you think it would succeed in this sense? And any additional comments about this aspect.

Do you think the game has potential to promote any additional skills beyond just nonverbal communication (e.g. collaboration)?

2 ideas I had for extending the game are as follows:

1. Adding an authoring tool – A part of the game where a teacher, parent or even a child can create their own stories for the game.
2. Adding functionality for multiple devices – Instead of the children having to share a tablet device, the app can be placed on 2 devices (separate tablets, smartphones) that are linked wirelessly so that each child has their own separate view of the game.

Can you give any input to how these ideas would be received by the audience?

If you have any questions about this evaluation task or the project in general please feel free to contact me by email (dr.123@uni.ed.ac.uk) or telephone (07787504380).
APPENDIX C

In-Game Walkthrough

A walkthrough of the system from Home Screen to Story. The following sequential screenshots are actually delivered from the in-game tutorial system on how to play the game, so instructions are already included in the screenshots.
To begin a Story press the PLAY button from the Home screen

The next screen allows you to choose a story to play. The stories that have options in the game are "Going to the Park" and "The Sleepover"
Once you have selected your story you have the chance to choose your characters. The first screen you will see allows to choose the FIRST player.

On the next screen you can choose the SECOND player.
Once you have chosen the story you want to play and both the playing characters you will see this screen. If you are happy with everything, press BEGIN STORY. If not, press BACK and change the story or characters.

When you begin the story you will see this screen. This is the middle screen. At the bottom there are 2 character buttons. Only press the button of your character. The player with the green outline is acting and goes first.

It's a Friday after school and Mike is going over to his friend's house for a sleepover. Mike is waiting for his friend, Connor, so that they can walk to his house together. Mike is waiting for Connor at the school gate and he thinks it would be fun to do something before Connor arrives.
This is the screen of the acting player, it tells them what action to do. Only the acting player should see this screen. If you get stuck or don't know what to do you can press the HELP button and a help video will pop up.

You think it would be fun to hide from Connor. Do an action that shows you are hiding.

This is the screen that the guessing player sees. It asks you a question and you have to guess which option is correct from the options below. Simply tap the option the other player is acting out.

What has Mike done while waiting for you?

- Mike is trying to get your attention
- Mike is hiding from you
- Mike is playing in the trees
This tutorial taught players how to play a Framework 1 story. By pressing the ‘Try it Yourself’ button this last scene of the tutorial allows the users to play the first few gestures of a story with dummy characters to understand the layout of the screen in story mode.