A game to teach emotion skills to children with ASD through technology and narrative

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Abstract

The ability to recognise and understand emotions is a key skill used in everyday social interaction. However, some children with Autism Spectrum Disorder have significant difficulties in recognising, understanding, and responding to the emotions of others. There are several existing tools that make use of technology to address these difficulties. In this dissertation some of these tools are investigated to reveal an apparent area for improvement within them. They lack an effective method to motivate and engage their users into completing the desired tasks. This research explores the use of narrative in a game designed to develop emotion skills as a possible solution. Furthermore, this research is a contribution to the range of tools available that tackle emotion skills in children with Autism Spectrum Disorder by designing a new one with this alternative approach.
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1. Introduction

1.1 Emotion skills in children with Autism

The ability to recognise other peoples emotions is an important skill that is used constantly in how we, as social beings, interact with each other (Ekman et al., 1992). Individuals with Autism Spectrum Disorder (ASD) can struggle with recognising and understanding emotions (Pioggia et al., 2005). Typically-developing (TD) people use a mixture of facial, gesture, situational, and aural cues to infer the emotional state of the people around them. From five months TD children begin to recognise the differences between emotions (Walker-Andrews, 1998). Skills such as this lay the foundations for developing emotion understanding which is a fundamental part of everyday social interaction. A deficit in such an important part of social ability inhibits an individual in forming and maintaining relationships. To those with ASD, another person’s face alone can hold an overwhelming amount of information, which they struggle to break down (Celani et al., 1999). Facial expressions, in combination with the other cues mentioned prior, further increase the difficulty that those with ASD have in recognising how others feel. The amount of information these cues provide can be overwhelming and negatively effect day-to-day conversations.

There are several tools that exist that attempt to address emotion difficulties in children with ASD. Some examples include Emotion Trainer, Bubble Dialogue, HyperStudio, Junior Detective Training Program, and Mind Reading. In the following chapter some of these tools are investigated in detail. The research of this dissertation explores how these tools may be lacking in the way they engage and motivate their users to execute desired tasks. Furthermore, the use of narrative as a method for providing engagement and motivation for the users while attempting to teach emotion skills is considered as the basis for the design of a new game.

A game was developed as part of this research to make progress towards an addition to the range of existing tools by exploring an alternative approach. This approach being the use of narrative to provide context to, and to link tasks intended to develop emotion skills. The skills the game targets for development are recognition of emotions, understanding why someone might be experiencing that emotion, and what is an appropriate response given knowledge of a persons emotional state.
This dissertation explores how such a game can be created and what considerations should be made. Following this, the design of a game to improve emotion skills in children with ASD is outlined and then finally evaluated through observations with TD children interacting with the game, as well as interviews with relevant experts for their opinions on the design. Implications for future research is also presented.

1.2 Research Goals

The research presented in this dissertation is an investigation into the technology used to teach emotion skills in children with ASD. The goals of this research were as follows:

1. Is there scope for improvement in the engagement of existing tools designed to teach emotion skills?

2. Can a game designed to teach emotion skills be more effective through the use of a narrative over existing tools?
   (a) Are the activities presented in the game appropriate for the target user group?
   (b) Does the game support the development of emotion recognition and understanding skills in the target user group?

1.3 Paper Structure

The rest of the dissertation that follows is split up into five separate chapters.

Chapter 2 presents an investigation into the literature to provide background information on autism, deficits in emotion, and existing technologies used in interventions. This chapter also serves the justification for this research.

Chapter 3 follows with a detailed explanation on the activities that were conducted to inform the design stage of the research.

Chapter 4 is the chapter on the design of the game developed for this research. It explores various aspects of the the requirements, story creation, user interaction, design justifications, and the implementation itself.

Chapter 5 details the activities that were carried out to evaluate the game described in the design chapter. These activities were observations with TD children interacting with the prototype and interviews with experts from relevant fields that gave their feedback on the design.
Chapter 6 is the concluding chapter for this dissertation and addresses the research questions posed in section prior to this one. Moreover, the implications for future work that could continue this research are discussed.
2. Literature Review

2.1 Autism Spectrum

2.1.1 General Impairments

Autism Spectrum Disorder is a condition classified by the Diagnostic and statistical manual-text revision, known as the DSM-IV, as a pervasive developmental disorder (American Psychiatric Association, 2000). It is a spectrum condition in which amongst diagnosed individuals there are variable levels of symptoms and abilities. ASD affects the development of social skills where symptoms are often identifiable within the first few years of a child’s life (as per DSM-IV). The difficulties people with ASD face are often described by a ‘triad of impairments’ in accordance to the research carried out by (Wing and Gould, 1979). These three classifications of impairments consist of social interaction, social communication, and social imagination. It is widely acknowledged that ASD often appears in conjunction with other developmental deficits and psychiatric conditions (Ming et al., 2008).

Deficits in social interaction are observed in individuals with ASD by a number of indicators. Among these indicators is difficulties in making or maintaining eye-contact, which would normally a sign of engagement in a conversation to TD individuals. Understanding gestures and facial expressions is also often challenging. Struggling to keep up with these social cues makes it harder for those with ASD to identify the emotional states of those around them. The ability to form and maintain relationships is then hindered as a result since how TD individuals interact with others depends greatly on the ability to recognise and understand people’s emotions. Furthermore, it is also suggested that some children with ASD do not respond to actions of affection towards them. For example, not showing any kind of response to their mother’s smile (Charman and Stone, 2008). Deficits in joint attention is another aspect of social interaction that is a strong indicator of ASD. Joint attention references the ability to mutually observe a thing. An example of successful joint attention would be a person pointing to an object for their friend to look at, followed by their friend looking at the object concurrently with the pointer.

The extent in which social communication is impaired varies dramatically in indi-
iduals with ASD (Mandell, 2009). There are those with ASD that may have no speech, and others that are able to speak fluently. Frequently in society people use words or expressions that are not intended to be taken literally. Individuals with ASD have a tendency to only take the literal meaning of a word or phrase, this makes the meaning behind idioms, jokes, and sarcasm difficult to grasp (Gold and Faust, 2012). Additionally, it is sometimes the case that individuals with ASD are delayed in their responses to questions, which may be due to taking longer to process and analyse what has been asked (Calhoun and Mayes, 2005). Another defining characteristic of impaired communication in ASD is a lack of spontaneity (Charman and Stone, 2008). For example not sharing new discoveries, successes, or interest.

The rigidity of thought and repetitive behaviour that is apparent in lower functioning individuals with ASD is regarded as an impairment in social imagination. Imagination is used in the sense that with individuals with ASD it may be the case that they find it difficult to picture alternative potential eventualities to situations. As a result there may be unexpected surprises that they could not prepare for because they could not predict them, potentially leading to distress for the individual that has ASD. An unexpected situation or over-stimulation from a new environment may lead to physical or emotional outbursts (Szatmari et al., 2006). In physical outbursts another action typical to ASD may be seen in repetitive movements such as arm flapping or rocking back and forth.

Individuals diagnosed with ASD are typically given one of several possible diagnoses. Those diagnosed with ASD that demonstrate an IQ in the normal range (above 70) are said to have high-functioning autism (HFA). A diagnoses of aspergers syndrome (AS) is usually given when an individual has cognitive and language ability in the normal range but demonstrates difficulties in the aforementioned triad of impairments (Paul et al., 2009).

2.1.2 Prevalence

The heterogeneous nature of the symptoms presented in ASD generates several challenges in determining the quantity of people with the condition. (Fommbonne, 2012) on the epidemiology of autism mentions that there are no clear biological markers to identify ASD, which further heightens difficulty in diagnosing ASD. Global estimates are especially troublesome, the quality of training given to practitioners varies from country to country as does the quantity of practitioners there are to diagnose ASD. Access to medical services and the ability to track data on prevalence is also of course not globally standard.

Over the past four decades there has been a significant increase in the number of individuals diagnosed with ASD. In 1978 the general estimate was placed at around 4 in 10,000 (Rutter, 1978). Present day approximations stand at 1% of the population (Baird et al., 2006). The precise causes underlying this perceived
increase has been debated by researchers and practitioners for several reasons. Many suggest that the growing number of individuals diagnosed is not down to more people displaying symptom. Over this period the classification of autism has broadened, a study by (King and Bearman, 2009) concluded that roughly 26.4% of the increase in prevalence can be attributed to changes in the diagnosis of ASD. There is further evidence to suggest that an increase in public awareness and improved resources has also had an impact on diagnosis levels (Fombonne, 2009). Moreover, it is likely that increased agreement, in that ASD can often affect an individual concurrently with separate conditions, has also played a part in the trend observed (Baron-Cohen et al., 2009).

The way ASD is diagnosed is of significant importance as it has implications into how early ASD can be identified. As we explore further on in the current chapter, the success of intervention closely relates to how early a diagnosis is given.

2.2 Empathy

Empathy is a key skill as well as a major aspect of typical social behaviour. There are several different definitions of the word empathy. Titchener created the word as an English translation of a German word meaning 'feeling into' (Tichener, 1909). Thus for our purposes we take the term to roughly refer to the ability to feel and experience another’s emotions. A study carried out by (Baron-Cohen and Wheelwright, 2004) suggests that adults with high-functioning autism or aspergers syndrome have a deficit in empathetic ability. They did not have conclusive evidence as the empathy quotient (their measure of empathy) that was used only considered the participant’s judgement on their own empathy. It is not to say that people with ASD do not care about the feelings of others. In fact in their study the authors note, once informed that their actions had caused hurt or offence the participants typically then felt bad, even though they could not understand why their actions caused issue.

Difficulties in empathy skills due to ASD in school-aged children has been linked with social communication issues in adulthood (Charman et al., 1997). Studies that have made these links also assert that empathy is an integral part of a typical person’s development of social skills. (Charman et al., 1997, as previously cited) wrote a publication that speculated whether impairments in empathy, observed in school-aged and above individuals with ASD, is a result of a separate deficit in recognising the emotional states displayed by others. In this study they had an experimenter jointly play with each child, then used feigned distress actioned by the experimenter and observed the participant’s response. Their results showed that fewer of the children with ASD looked at the face of the experimenter in comparison to the developmentally delayed and normal control groups. Additionally, they observed that zero of the children with ASD showed any facial response to the experimenters supposed distress. In contrast, 44% of the developmentally
delayed group, and 68.4% of the normal control group displayed facial concern. However, as the researchers mention, although the lack of a response may imply that the infants with ASD were unable to recognise distress in the experimenter, it is not certain that is the case, i.e. they may recognise the distress and simply not react.

2.3 Emotion recognition

Displays of emotion provides a plethora of information to be used in driving social behaviour. Emotions described in facial expressions for example, inform on how the individual displaying the expression is feeling (Ekman et al., 1992). Additionally, they also tell on an individuals behavioural intention. Although there are few examples of empirical evidence to corroborate this commonly presumed idea, there is research to back up this claim (Adams Jr et al., 2006). That is to say there’s little empirical research in this area, not that there is evidence in opposition. Furthermore, emotions observed in others can provide information on an environment (Olsson et al., 2007) and also on people or physical objects (Moses et al., 2001).

It is widely assumed that individuals with ASD have an impairment in emotion recognition skills. The DSM-IV lists deficits in emotional reciprocity and in the use of facial expression in social behaviour in their diagnostic criteria for ASD. (Walker-Andrews, 1998) found that TD infants as young as five months old could recognise the difference between expressions for certain basic emotions. This has strong implications and further reiterates the importance of the ability to discern emotions as a foundation for the development of social behaviour. An impairment in recognising emotions would then likely significant, negative results, and potentially lead to an inability to operate socially at the same level as TD individuals.

While it is commonly thought that an impairment in emotion recognition is intrinsic to individuals with ASD there is currently not a clear consensus amongst researchers. A meta-analysis of the research, up to 2011, on emotion recognition in individuals with ASD was conducted by (Uljarevic and Hamilton, 2013). In their study they noted that before publication bias was accounted for the mean effect was 0.80, which would have been strong indication of a link between ASD and an impairment in emotion recognition. After publication bias was accounted for they concluded that there was an emotion recognition impairment in ASD with a mean effect size of 0.41. A mean effect of this size gives a medium suggestion that there is a relationship between ASD and emotion recognition deficits.

2.3.1 Alexithymia

Alexithymia is the term used to describe difficulty an individual has in the identification and understanding of their own emotions. Studies have estimated that
between 40 and 65% of adults with ASD may have alexithymia (Griffin et al., 2015). It has also been suggested that the deficits in emotion understanding and empathy that is observed in ASD may be due to alexithymia (Bird and Cook, 2013). A study by (Griffin et al., 2015, as previously cited) argues that a deepened understanding of alexithymia in children may be of importance in therapy. It could enable better identification of alexithymic traits and expose a subgroup within those diagnosed with ASD, allowing treatment to be adapted appropriately.

2.4 Early interventions

There are many highly advocated strategies and approaches in therapies for ASD. Although often passionately supported, there is not extensive, empirical research on how successful treatments that are executed during childhood, are in producing improvements in later life (Howlin et al., 2009). However, research on early intervention programs is growing, as is the evidence in favour of the use of such programs (Green, 2012). There are certain important points that do appear in a large portion of intervention strategies and have empirical evidence to support them. First of which is the age that intervention begins. A study conducted by (Harris and Handleman, 2000) provides evidence that the younger the interventions take place in ASD the greater the improvement. Furthermore, the authors claim that there is a need for intervention in children with ASD at a very young age for the most success. The researchers do also mention that older children, above 4 years of age, in their study did achieve marked gains in IQ as well.

2.4.1 Social Stories

Social Stories are a tool used by support workers and psychologists to help develop social skills in children with ASD, created by Carol Gray (Gray, 1998). The support worker assesses what particular skills or problem situations need addressing and produce a story with that in mind. Stories that are produced are intended to be short and focused on a very specific situation. It is the job of the support worker to then guide the target individual with ASD through the story so that they have a better understanding on what to expect in a particular situation. An example could be that a child has their first ever doctor’s appointment. Through the use of a social story it would be hoped that a child would find the new unknown environment of the actual doctor’s appointment less overwhelmingly stimulating, reducing the likely-hood of physical outbursts or distress. Studies on the efficacy of social stories have demonstrated promising results (Sansosti and Powell-Smith, 2006). In a study conducted by (Sansosti and Powell-Smith, 2006, as previously cited) the authors discuss that there is difficulty comparing the desired outcomes of using social stories to behaviour demonstrated by their TD peers. At the time of the study this was down to a lack of information on how often TD children engage in the types of behaviours that are often under study. They then speculate on a concern that if social stories are overly effective there could be the
negative consequence of a child with ASD overusing a specific social behaviour. Resulting in the child still not fitting into social norms even though the social stories developed the intended skills. A more recent study reviewing the literature surrounding the effectiveness of Social Stories found evidence promoting their use in improving social interaction skills in ASD (Karkhaneh et al., 2010).

2.4.2 Comic-strip conversations

Comic strip conversations is a method also created by Carol Gray, the same that developed Social Stories, that is used to help people understand the subtleties that can occur in conversation (Gray, 1998). The intervention technique makes use of colours and symbols to represent the variable aspects of social communication. Simple figures are also used to illustrate individuals in the comic strips and like Social Stories, they are intended to be used by someone with ASD in conjunction with a support worker. There appears to be less literature focused on comic strip conversations in comparison to social stories. This could be due to the method being published several years later than social stories or because social stories may be used more by practitioners. Studies conducted on comic strip conversations have supported their use (Rogers and Myles, 2001; Hutchins and Prelock, 2006; Pierson and Glaeser, 2007). However there is a clear need for robust research into the effectiveness of comic strip conversations. The studies mentioned prior are not recent and in each case only observe a very low number of participants (n=1, n=2, and n=3 respectively). Hence, beyond anecdotal, evidence on the performance of comic strip conversations is not entirely conclusive.

2.5 Technology in early interventions

Non-technological means of interventions taken towards individuals with ASD are typically very time-intensive and require significant efforts from some form of support staff and/or from family members. To clarify, for the purposes of this report, we use the term technology in reference to electronic devices such as mobile phones, tablets, laptops, and desktop personal computers. For those executing supporting roles in intervention methodologies, it can be stressful not only because of time and effort constraints but also because of behavioural traits that can often come with ASD. As mentioned in previous sections aggressive, shaking, or flapping behaviours can occur in over stimulating environments. Exposure to new situations and social concepts is a necessary part of developing the target skills. Observing and mitigating such behaviours would naturally be mentally and potentially also physically taxing. An intervention that may be used on an individual basis, without these kinds of consequences, is inherently useful.

Evidence of technology-based programs reducing behaviour problems and proving a source of increased motivation when considered in comparison to non-technological means can be found in a study by (Chen and Bernard-Opitz, 1993).
The authors of this study concluded no meaningful difference in learning benefits between the two methods. However, there are other studies that found similar motivation and behavioural benefits, and additional success in educational effectiveness (Moore and Calvert, 2000; Williams et al., 2002).

Computer-based intervention (CBI) systems provide another advantage in that they enable greater control over stimulus. Alternative support worker oriented methods need a relationship with a base of trust and comfort between them and the individual with ASD. The apparent raised interest that can be found in ASD towards electronic devices lessens the necessity of developing such a relationship before the interventions can begin. Audio stimulus can be controlled or removed entirely in order to reflect the needs and learning rates of each child. Visual stimulus can also be controlled to alter brightness or animation levels to suit. The range of customisability that a single computer program can offer, when designed correctly, without having to recreate the intervention method around each child’s coping levels to stimulus, is another reason in support of the use of technology.

2.5.1 Emotion Trainer

Emotion Trainer is a CBI program developed by Dr Miriam Silver (Silver and Oakes, 2001). The program is interactive and uses multimedia elements to describe various concepts in each of its five sections. These sections are split up and each focuses on one of facial expressions, scenarios, desires, thoughts and beliefs, and personal preferences (Silver, 2001). Each section is composed of individual frames that typically present an image or two with some text just below posing a question. Below the text is options for what the answer to the question may be. There is only one answer to each question. If the player chooses an incorrect answer a hint is given.

Presently there appears to be only one research paper looking at the effectiveness of this CBI (Silver and Oakes, 2001). This study’s first author was Dr Miriam Silver, the developer of the software. The results were suggestive of an improvement in two of the three measures. These two measures were in recognising facial expression and understanding of mental states. The measure without improvement was emotion recognition in cartoons.

2.5.2 HyperStudio

HyperStudio is a program promoting creativity by enabling users to make interactive digital presentations, show ideas, and make their own entertainment. The program was designed to be used both inside and outside of an educational setting and without ASD in mind. Support workers or family members can work together with individuals to create 'stacks' (a series of screens that can contain a multitude
of interactive multimedia elements). Alternatively a support worker can make up their own stacks and then allow a individual to experiment and interact with them. One study used the latter method where experimenters created stacks that each focused on particular skills. The participants could select icons depicting various skills and then watch or listen to instructional content (Simpson et al., 2004). The study controlled for possible influence from interventions running in conjunction with their own. They found evidence of significant improvements as a result of their CBI on target behaviours. Their target behaviours were sharing, following teacher directions, and social greeting. Another study looking at the effectiveness of various CBIs referenced the (Simpson et al., 2004) study and after reviewing their procedures, concurred that their results did appear conclusive (Ramdoss et al., 2012).

2.5.3 Bubble Dialogue

The Bubble Dialogue program scenarios were created in order to let users closely explore dialogue between the characters involved. The software itself controls the regulation of turn taking between two users as they assume roles as each character. The scenarios created provide an initial basis for the dialogue, while the users develop a script to progress the story, without any guidance on how it should progress from the program. The scripts that are produced can then be studied to assess ability levels of the participants. A study conducted by (Rajendran and Mitchell, 2000) looked at the programs ability to facilitate interpersonal understanding, executive abilities, and verbal abilities in aspergers syndrome. They found no improvements of significance but do go on to discuss that the use of programs that mediate communication in ways like Bubble Dialogue does, open up an alternative to typical face to face social engagement. This is hugely beneficial because communication in this alternative way exposes individuals to far less multi-sensory information that those with ASD are known to struggle with (O’Neill and Jones, 1997).

2.5.4 The Transporters DVD

Created by the Autism Research Centre at the University of Cambridge, The Transporters is a dvd that consists of episodes that are based on certain emotions. The episodes are about a number of characters that are trains with the faces of real humans superimposed onto the front of each train. Accompanying the dvd is a quiz with short questions on the emotional states of some of the characters. Answers to these questions are given through the remote control for the dvd player containing the dvd. One paper investigating the effectiveness of the tool in improving emotion skills is Golan et al. (2010). The researchers found a significant improvement in emotion recognition, so much so that most of the participants with ASD ended up performing as well as their TD peers on all tasks. This is promising evidence in support of technology as a tool to improve emotion skills.
2.6 Motivation

Currently existing CBIs, focused on developing emotion recognition or emotion understanding skills, appear to be fragmented in their nature. In the case of the Emotion Trainer program investigated above, tasks are presented to the user with little to no context. Each task that is presented is independent of other tasks which could lead to the user losing interest rapidly due to the repetitiveness of completing task after task. The creators of the program appear to have made an attempt at mitigating this issue by providing a reward animation after successfully choosing the correct solution to a task. From descriptions of the program and use of the demo version it appears the range of answers that the user can select from for each task are the same (happy, sad, angry, afraid). This could further hinder the program in maintaining engagement and interest from the user, likely resulting in a loss in the program’s effectiveness.

The Transporters DVD is essentially a tool that lets users watch episodes on certain emotions. Its creators use stories built around emotions. This is a start towards engaging the user while teaching emotion skills. In this case though there is no interaction with the user during these episodes to explore the intricate details of each situation in regards to character emotions. This tool does offer a quiz feature separate to the episodes. These quiz questions fall into the same style mentioned prior. Questions in the quiz are short with little to no context on the emotion state of characters, as they are not linked into situations that appear in the episodes. Moreover, as the characters in the story are all trains, the user will find difficulty in relating events in the episodes to their own experiences. If a game focused on emotions and set them into contexts that the user has experiences with (or is likely to at some point), perhaps they can use the context of situations to infer the emotion state of others in real life.

In both the HyperStudio and Bubble Dialogue programs content is created or driven by the support worker and/or the individual receiving intervention. A well thought through underlying narrative could improve the effectiveness of either of these tools, by engaging the individual more and motivating them to work on the tasks involved. The Junior Detective Training Program is an example where the creators minimally frame tasks similar to Emotion Trainer, that primarily focus on facial expressions, around solving a mystery. There is not an overarching narrative, a fully developed setting, or in-depth characters. Currently, there does not appear to be a fully interactive, narrative-centered tool that exists for teaching social skills to children with ASD. As a result this exploratory research investigates how effective a tool designed to teach emotion skills through a narrative might be.
2.7 Methodology

The methodology followed in this research was an adaptation from the five stage design outlined by Scaife and Rogers (2001).

The first stage was the specification of research questions. During this stage the primary objectives for the design were defined. The purpose of this was to determine what was being built and for what purpose. By the end of this stage the scope of the design was also known.

The second stage was activities used to inform the design. This stage allows potential design ideas to be explored. Participants involved in this stage were used to aid the generation of constraints and requirements for what features should be present in the design.

The third stage was the implementation of a prototype for the design. This can was achieved by adhering to the initial requirements produced during the previous stage and the full set of requirements formed at the start of this stage. At the end of this stage a prototype ready for evaluation activities was produced.

The fourth and final stage was the evaluation of the design. This stage involved activities to evaluate the design. The evaluation activities included a study with TD children, followed by feedback on the design from relevant experts.
3. Pre-design

In this chapter the process used to develop an initial concept for a game, that reflects the research questions posed at the beginning of this report, is discussed. Justifications are given for decisions made in the early stages of the design process in order to develop a concept that can be developed and later physically produced. This section acts as an investigation into what direction the design of a game, that uses narrative to increase the effectiveness of existing emotion understanding techniques, should take.

The methods that were used to inform the design of the program considered in the ‘Design’ chapter of this report are also described in detail. There were two key actions that were undertaken to inform the design. First, was a workshop that was carried out to aid the production of a story that could appear in the program. Second, was a series of interviews conducted with experts in varying fields to gain an insight into the strengths and weaknesses of the proposed concept detailed below. The outcomes of these interviews are also discussed in how they gave direction to the design and what the key goals and features of the game to be developed should be.

3.1 Observations of TD children

3.1.1 Aims

The main aim of this study was to gain an insight into what kind of stories, that involve certain emotions, children can relate to. Following this study, the outcomes would be used to inform the design of a game to help children with ASD better understand the relationship between situations and emotions.

3.1.2 Method

Participants

The participants of this study were eight typically developing children, five females, and three males. Participants were between the ages of seven and ten years old. To find these participants an email was sent around the informatics department that specified details of the study, when it would be running, and
Table 3.1: Participant mappings.

<table>
<thead>
<tr>
<th>ID</th>
<th>Age</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>7</td>
<td>Female</td>
</tr>
<tr>
<td>P2</td>
<td>7</td>
<td>Male</td>
</tr>
<tr>
<td>P3</td>
<td>10</td>
<td>Female</td>
</tr>
<tr>
<td>P4</td>
<td>10</td>
<td>Female</td>
</tr>
<tr>
<td>P5</td>
<td>8</td>
<td>Male</td>
</tr>
<tr>
<td>P6</td>
<td>8</td>
<td>Female</td>
</tr>
<tr>
<td>P7</td>
<td>10</td>
<td>Female</td>
</tr>
<tr>
<td>P8</td>
<td>8</td>
<td>Male</td>
</tr>
</tbody>
</table>

if any of their children would be interested in participating. Attached were the relevant information sheets and consent forms (see appendix for forms). Ethics approval was sought and granted for this study in accordance with the relevant ethics procedures (School of Informatics, 2016). A table mapping participant ids with ages and genders can be found in table 3.1

Setting
The study was carried out at the University of Edinburgh, Informatics Forum.

Materials
The materials used were as follows:

- Pen and paper by the researcher
- The exercise sheet shown in figure 3.1
- A variety of coloured pencils for the participants to use together with a blank sheet of A2 sized white paper.

The list of emotions selected for the exercise sheet are not Paul Ekman’s 6; joy, sadness, fear, anger, disgust, and surprise (Ekman and Friesen, 1971). These were not chosen to simplify the task in this study. It was felt that to make the most effective use of the time participants were available, only five emotions on emotion states should be included. In place of fear we chose worried as it does not sound as negative as fear does. We also used excited, happy, sad, and angry as these terms are most commonly used and after discussion it was felt that this wording would make it easier for participants to think up of times to write about.

Procedure
Upon arrival each parent or guardian was again given the information sheet and consent form shown in the appendix. Participants were walked through a separate information sheet and consent form. Participants were reminded that they can
leave the study whenever they like without giving a reason and were free to ask questions whenever any came up.

To start with the children were asked to complete the exercise sheet shown in figure 3.1 individually. The first exercise sheet laid out five emotions on the left side of a table. Participants were asked to think up of a time when they, or someone they know felt each of the emotions. The term ‘emotion’ was replaced with ‘feeling’ or ‘feelings’ to keep the workshop as understandable as possible, as the participants were so young. The researcher was there at all times to support the participants and to aid anyone that was struggling to think of things to write down. Once they children completed the first exercise sheet they were then presented with a blank A1 sheet of paper and asked to draw the stories they wrote about in the first sheet however they liked. They were also informed that they may make up new stories to draw as long as it still involved a certain feeling. To draw their story the children were provided with a variety of coloured pens. This second task was included as a fun task for the children to carry out after completion of the first exercise sheet. It also provides insight into the kinds of things children would like to see in a story, in terms of visual content and storyline. The whole activity including both tasks should be completed in 20 to 30 minutes. Once the participant completed the tasks they were awarded with a certificate (see appendix).

The procedure was executed on three separate occasions to accommodate both the availability of the participants, and the number of participants that the researcher could manage at one time.

All of the consent forms and information sheets given to the child participants and their parents/guardians can be found in the appendix of this report.

3.1.3 Results

All eight participants made attempts at both of the two tasks. Of the eight participants two (P5, Male and P6, Female) could not think of a response for ‘Worried’, and one (P5, Male) could not think of a response for ‘Angry Or Cross’. The responses that the participants gave were mostly varied with the obvious exception of the ‘excited’ responses in which half of the participants wrote they were exited about Christmas. Interestingly, three out of the eight participants also wrote that a time when they were sad was when they or a friend left school. Nearly all of them could be considered usable by the researcher in the creation of a story for a game to improve emotion understanding skills. However, as explored further in the ‘design’ section, consideration must be made to distinguish scenarios that are age appropriate for the target user group of the game, and that are suitably relate-able to by children that have ASD. A table of the results from the first
Part 1 – Exercise sheet

Thank you for taking time to complete this exercise sheet.

For each feeling listed below try and think of a time when you, or someone you know felt that feeling and then write it down in the space provided. If you can’t think of a time you, or someone you know felt that feeling that is okay, try the next one instead.

<table>
<thead>
<tr>
<th>Feeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy</td>
</tr>
<tr>
<td>Sad</td>
</tr>
<tr>
<td>Excited</td>
</tr>
<tr>
<td>Worried</td>
</tr>
<tr>
<td>Angry</td>
</tr>
</tbody>
</table>
exercise is shown in table 3.2\textsuperscript{1}. In the table names are substituted to preserve anonymity.

\textsuperscript{1}Unanswered sections are left blank in the table.
3.2 Interviews with Experts

Interviews with experts were conducted as part of the concept development process. Carrying out these interviews was necessary to ensure that the initial stages of the design process were well informed and effective in addressing the research goals of this project. Without this stage any misinformation or gaps in knowledge necessary for the design of such a game would likely result in the game produced being entirely ineffective. Through interviews with experts, flaws and strengths of any proposed concept can be scrutinised at least to some degree allowing for mistakes to be corrected early on. These interviews therefore act as further justification for investigating the research questions of this project and for the direction of the design.

The order in which the following experts were interviewed is of note due to discussion on the previous interviews being a part of each consecutive interview.

3.2.1 Aims

Interviews with experts were carried out to answer the following questions:

1. Are there any gaps in the researchers understanding of the issues faced by children with ASD?

2. Is the justification for creating an interactive story-based game to develop emotion understanding in individuals with ASD valid?

3. What are the strengths and weaknesses of the initial concept?

3.2.2 Method

Criteria for Inclusion

Experts were selected based on the relevance of their field of study to the project and/or based on experience from any relevant works the expert was previously involved in.

Materials

To illustrate the initial concept idea there were a number of images describing an example scenario printed onto paper and presented to the experts. This was done primarily to aid description of the format and style of the initial concept idea. The images that were used can be found in figures 3.1 to 3.5.
Table 3.2: Participant responses.

<table>
<thead>
<tr>
<th>Happy</th>
<th>Sad</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 I was happy when I went to the soft play with my best friend</td>
<td>I was sad when my best friend and my other friend went to a really fun park and I didn’t get to go</td>
</tr>
<tr>
<td>P2 Playing with lego and new toys</td>
<td>When I feel left out sometimes</td>
</tr>
<tr>
<td>P3 When I got my first cat</td>
<td>When three gerbils died</td>
</tr>
<tr>
<td>P4 I was happy when I found out about this trip to Edinburgh Castle in p3</td>
<td>Today I was sad because my friend Rebecca left school</td>
</tr>
<tr>
<td>P5 When I joined the football team</td>
<td>I’m sad because my dad does not live with me</td>
</tr>
<tr>
<td>P6 When my mum agreed that when I speak fluent French, I can go to Paris</td>
<td>When a girl said a really horrible thing</td>
</tr>
<tr>
<td>P7 Getting cake in maths</td>
<td>When I moved school</td>
</tr>
<tr>
<td>P8 When I play with my brother</td>
<td>I am sad that my friend moved house</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Excited</th>
<th>Worried</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 Me and my family went to Dunkeld with a friend called Caitlin and another friend called Laura because we had a party and playing on bunk beds</td>
<td>I was worried when Nicola and Lucy had chicken pox and we maybe couldn’t go camping (but in the end we could go camping)</td>
</tr>
<tr>
<td>P2 Making cards</td>
<td>If someone in my family would die</td>
</tr>
<tr>
<td>P3 When I got my first ipad</td>
<td>When my friends are sad</td>
</tr>
<tr>
<td>P4 I am so excited for Christmas!</td>
<td>I was worried when my mum and dad split up</td>
</tr>
<tr>
<td>P5 Sam when he went to Hawaii</td>
<td></td>
</tr>
<tr>
<td>P6 That I am decorating my Christmas tree tomorrow</td>
<td>Forgot my P.E. kit</td>
</tr>
<tr>
<td>P7 For Christmas and holiday in India</td>
<td>When I was very ill</td>
</tr>
<tr>
<td>P8 At Christmas</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Angry Or Cross</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 Also angry in case we couldn’t go camping</td>
</tr>
<tr>
<td>P2 People annoy me then I shout furiously at them</td>
</tr>
<tr>
<td>P3 When my brother wants to watch youtube with me</td>
</tr>
<tr>
<td>P4 I was cross when my mum would not let me eat bubble gum! Until I was 16</td>
</tr>
<tr>
<td>P5</td>
</tr>
<tr>
<td>P6 When I kept being asked the same question even when I answered it</td>
</tr>
<tr>
<td>P7 Teacher got cross because class wasn’t listening</td>
</tr>
<tr>
<td>P8 Me or my friend going home</td>
</tr>
</tbody>
</table>
Figure 3.2: 1st Frame.

Figure 3.3: 2nd Frame.

Figure 3.4: 3rd Frame.
The first three images demonstrate how the main character in the game would interact with the user. The should be no ambiguity with whom the main character is speaking to. This was identified early on in discussions prior to these expert interviews for a few reasons. Primarily, keeping the player’s interaction solely with the main character preserves separation between the user and the stories in the game. This is important as the emotions addressed in the game should not be limited to positive ones. Distancing the user from the story content helps prevent them from getting upset due to potentially having similar personal experiences. The alternative would be to have the user more directly involved with the story and include interaction with several different characters. This would introduce a further level of complication in creating stories when sometimes the user is involved and at other times is not. If the user only interacts with the main character only when they need help at certain points, the story can still progress normally yet the user hopefully would still feel like they are an active participant in the narrative. This reduces the difficulty faced in building a suitable narrative for the game.

The 4th and 5th frames as shown in figures 3.5 and 3.6 were used to demonstrate how questions might look in the game. They show the multiple-choice format and the style of questions asked in this concept. Additionally, from the frames it is clear how from events in the story the user should have enough information to answer the questions on characters’ emotional states. Without these it would be time consuming and challenging to verbally describe this initial concept for the game.

To record the audio during the interview a recording application was used on the researcher’s personal mobile phone. Recording the audio allows the researcher conducting the interview to focus on the expert being interviewed, without concerning themselves with taking comprehensive notes.

Figure 3.5: 4th Frame.
Procedure

Meetings were arranged through email and experts were informed that interviews should take around 30 minutes of their time. At the beginning of each interview the expert was asked if it would be okay to record audio during the meeting. Provided the expert agreed to this then the interviewer will then describe the initial game concept using the visual aides presented in the materials section (figures 3.2 to 3.6). After the concept has been described the expert is asked if they have any initial thoughts on the game to initiate a discussion.

3.2.3 E1

Area of expertise

E1 has a PhD in Developmental Psychology and was at the time of the interview a ‘Reader in Psychology’ at Heriot-Watt University. The reason E1 was selected as a suitable expert for the purposes of this interview was because the expert’s field is hugely relevant to this project. This expert also previously conducted research into the Bubble Dialogue program (explored in the literature review) and has experience in developing technology for children with autism.

Outcomes

During the interview E1 raised the point that the emotions used in the study with TD children are more emotion states and don’t follow Ekman’s basic emotions. The interviewer then explained the reasoning behind choosing those emotions as described in the method of the observations with TD children section above in this chapter. Next, the expert mentioned they used to work with children with ASD in a clinical environment and they can often have difficulty connecting something in a cognitive state with an affective state internally. Further to this he suggestion
was made to add a step prior to asking why a character feels a certain way so that the player can identify the emotion or emotion state. This would facilitate the connection between cognitive and affective states. They should be asked to identify what the emotion is and what caused the character to experience it. In addition it was suggested that the game should also introduce a third step to link with a behavioural response. The user of the game would then make a decision on what the main character should do as a result of knowing how one of the other characters is feeling.

3.2.4 E2

Area of expertise

E2 is a Doctor of Philosophy and a researcher at The University of Edinburgh with research interests in autism and early child development. Their work includes research into alexithymia which, as detailed in the second chapter, is when one has trouble in identifying and describing their own emotions. The benefit of including E2 in these interviews is they can provide further insight into emotion aspects of the proposed concept.

Outcomes

The first issue E2 raised was that the tasks involved in the initial concept would be fairly verbally demanding. They suggested that the any dialogue in the game should be minimised so that the language used is as simple as possible. The reason being, more fuller dialogue might restrict the ages in which the game would be effective with. This expert then explained how in their work they never give negative feedback to the user when they make an error or answer a question incorrectly. Consideration should be given to what kind of rewards are presented as positive feedback. In the interview E2 also went into detail on the construct of alexithymia and recommended that we investigate how it relates to the project and potentially look at measuring participants on this construct in any further studies. Finally, E2 said that it could also be worthwhile getting parents to fill out questionnaires on alexithymia or other emotion-related measures during any further studies to collect more useful data.

3.2.5 E3

Area of expertise

The third expert that was interviewed is a research psychologist at The University of Edinburgh that specialises in autism research who’s research includes investigations into computer-based interventions for individuals with ASD. This expert was chosen as this project is precisely a computer-based intervention for children with ASD it directly links to E3’s areas of interest. Furthermore this expert has
extensive experience reviewing mobile and tablet applications for individuals with ASD.

**Outcomes**

In this interview the E3 explained that the first step of recognising the emotion that a character is feeling needs to be explicit. Instead of the user observing the emotion being experienced by a character in the game then being asked why they feel that way they should first be asked how the character feels. This ensures the player has correct knowledge of what the emotion is before having to answer why the character feels that way. Introducing this step explicitly better reflects the learning goals of the game of understanding what the emotions are and why they are being experienced. The interviewer also asked whether it would be possible to integrate eye-tracking into the proposed game in an attempt to collect data regarding how the user reaches a particular answer for the questions asked. In response, E3 expressed significant doubt at the feasibility of integrating such a feature both due to the short time-frame of the project and technical limitations of commercial tablets that are currently on the market. Furthermore, E3 thought that eye-tracking would likely be an effective measure of reading ability opposed to skills that relate to understanding emotion and as a result wouldn’t be a useful measure for this project. It was also explained to E3 that the target demographic for the game was children between the ages of 5 and 10. E3 felt that a better target would be children with a developmental age of around 7 to 11 due to the significant reading component. There were strengths that E3 saw in the initial concept over existing emotion recognition programs. Existing programs are often boring with a flash-card style design that while aiming to teach simplistic information appropriate for a four year old, they are mediated with a level of text that is more suitable for children 7 or above. They felt that using a narrative structure, like in the proposed concept, improves upon existing approaches as it provides a richness that is more age appropriate for 7 - 11 year olds.

### 3.2.6 E4

**Area of expertise**

The final interview that was conducted at this stage of the project was with E4, a student completing their PhD in psychology. This expert also has experience working with children and adults with ASD.

**Outcomes**

The initial comments E4 had on the concept were around first order versus second order theory of mind, which the interviewer was unfamiliar with. They explained their differences and why it is important to distinguish between the two as they both effect the cognitive load on the user that is being asked questions. First order would have the user be asked the question ‘Why is Sarah sad?’ whereas
second order would be if, in the example, the user would be asked ‘Why does Tom think Sarah is sad?’. With first order there is less cognitive load than with second order. The difference should be carefully taken into account when designing the questions for game. Further to this, E4 said that if there was a study carried out, once the game was made, with children with ASD and the children had difficulty in understanding the tasks it may be because the questions used are second order and not first order theory of mind. Personalisation was another aspect that E4 felt should be addressed and is especially relevant for tools designed for individuals with autism. For example letting the user personalise the way characters look, allowing for various settings to be tweaked like font size or colour, and letting the user select rewards. Features like these address sensory differences between individuals with ASD where certain colours may be easier to read or they may prefer larger or smaller text. Additionally, they could encourage the user to play the game by giving them more ownership over it and be tailored to things that are important to them as individuals. E4 mentioned that if there was an audio narrator in the game that reads out the dialogue there should be an option to turn it off so that each user can process the text at their own speed.

3.3 Discussion

The study conducted with TD children proved invaluable for producing usable scenarios that could be integrated into a story for the proposed game. This was the case even with there being such a small number of participants. In a larger project with more time and resources available, a study with more participants and with children with ASD in the target age range could have given a wider range of results and a clearer picture of what kind of scenarios children think of that they associate with certain emotions. However, without the information we collected, the story created for the game may have been less interesting and harder to relate to by the target user group. With the data this study provided, along with additional consideration for which ones children with ASD can relate to, an engaging story that interests the user can be more easily created.

Together with the study with TD children, the interviews with experts from relevant fields gave an insight into the challenges faced in creating an interactive story-based game to teach children with ASD emotion understanding skills. The interviews also validated the motivation behind the creation of such a game as it was agreed that current tools involve fragmented tasks with an unappealing experience. Following the pre-design activities detailed in this section the following requirements were outlined:

1. The target user group is children with ASD with a developmental age of 7 to 11 years.

2. The language used in the game should be minimal to maximise the potential audience.
3. The game should be played individually with user-entered input available for review by parents or support workers at a later time.

4. Visual rewards should be given as positive feedback after correct answers are selected.

5. There should be no negative feedback for incorrect answers.

6. Emotion related questions should take one of the following three forms:
   
   • How does a character feel?
   • Why do they feel that way?
   • What action could be taken as a result?
4. Design

This chapter outlines the overall design of the game produced as part of this research. It begins by delineating the requirements and the primary goals of the educational game intended to benefit emotion understanding skills in children with ASD. Included in this chapter are detailed descriptions of both the processes followed in order to produce the game and also the design principles that were followed. Justifications are also given for major decisions made during the production phases of the design. How the story was created following the pre-design activities in relation to the characters, scenarios, and aesthetics is explored. A section is dedicated to the user interaction of the game because it is a critical, key aspect of this user-centred game. Furthermore, the chapter looks the technical aspects of implementing the game through its software and hardware components. Finally, to conclude this chapter a brief overview of the completed prototype is provided.

4.1 Specification

In order to create a comprehensive specification for the game, several components must be clearly defined. The goals set out to be achieved by the game are the result of investigation into the relevant research, based on the research questions as per the literature review of this report. Additionally, all of the pre-design activities act as justification and a basis for the game’s goals and requirements. It is important to cover the design principles used as they are pre-existing standards that can be an effective tool in achieving the goals of a design such as this.

4.1.1 Goals

The goals of the game produced with the research objectives of in mind were as follows:

1. The software’s primary objective is to improve upon existing tools used to develop emotion skills in children with ASD through stories.

2. The software should aid interventions in children with ASD that have difficulties in emotion.
The first goal is in response to the skills that children with ASD have difficulties with and the tools currently available designed to help improve these skills. It is hoped that the methods used are successful in achieving this goal. However, it was known from the initial stages that due to the scope of this research it would not be possible to carry out a study to fully quantify how successful the game might be with this goal. Instead, the game was created as a proof of concept through decisions made with this considered as the main objective. It could then later be built upon into a full version that would be able to be evaluated more conclusively.

By introducing the second goal of the game we maintain the findings of existing research into early interventions in children with ASD in that computer-based interventions should not replace human interventions (Whalen et al., 2009). They should be created to supplement other intervention strategies.

4.1.2 Requirements

In order to accomplish the goals outlined above, a set of requirements were produced. An initial set was developed following the pre-design stage of the research, as mentioned in the previous section. The requirements of the game were also frequently iterated upon throughout the development of the game, following regular meetings with an expert and other researchers working on their own research in a related area, developing games for children with ASD. This is explored further in more detail within the development process section of this chapter. The requirements listed in this section should be considered as the final set as they were by the end of production of the prototype. The produced application should also be considered a prototype, that enables exploration of different paths the design could take and allows the concept to be evaluated.

1. The target user group is children with ASD with a developmental age of 7 to 11 years.

2. The language used in the game should be minimal to maximise the potential audience.

3. Visual rewards should be given as positive feedback after correct answers are selected.

4. There should be no negative feedback for incorrect answers.

5. Emotion related questions should take one of the following three forms:
   - How does a character feel?
   - Why do they feel that way?
   - What action could be taken as a result?

6. Only one character should speak at a time on each frame.
7. The emotions characters display should be clear and give no room for ambiguity.

8. The game should be playable independently or with a support worker present.

9. Saved user input must be available for review at a later time by a parent or support worker.

10. The narrative in the game should be motivating and engaging for the user.

11. The content of the story should contain events which the user is able to closely relate to.

### 4.1.3 Design Principles

A set of design principles were used to guide the design of the user interface of the application. The following three usability principles were used as a basis for the interface design (Dix, 2009):

1. **Learnability**: This refers to how easily new users can interact with the system effectively and maximise performance. To address this principle each possible action the user can take should have a predictable outcome. This will be done through the design of the buttons where it should be obvious what is click-able. Buttons that perform certain actions should be in consistent positions. For example question answer options will always appear on the right of the screen. The possible user actions should set a precedent for any other stories that would be developed for the game.

2. **Flexibility**: This is the variety of ways in which the user and the system they are interacting with exchange information. Animation will be used to convey information to the user when the main character in the story switches interaction with other characters to the user and visa versa. Additionally, animation will be used to give feedback on the user’s chosen answers. The pace of the dialogue progression shall be controlled directly by the user so that they are never overloaded with information that they cannot process. Having this control is vital for individuals with ASD as it will allow them to take the time they need to read the dialogue and to look at the comic frame carefully to observe character emotions.

3. **Robustness**: This is the extent in which the system supports the user in achieving goals and in determining when those goals are achieved. It should be apparent to the user when the game requires their input to answer a question. Allowing backwards navigation through the story satisfies recoverability in case the user went forward too quickly. In order to prevent this user error from happening the next and previous buttons will be time-delayed. By only implementing user actions that are strictly necessary for the game the possible user errors are minimised.
4.1.4 Development Process

The development of the game was created through a highly agile process. Nearly every week there was either a group meeting with an expert and with two other researchers working on related projects or with the expert alone. The expert in these meetings was a professor from The University of Edinburgh. Her research interests are in supporting learning and communication in children that have special needs. As the prototype was developed the researcher presented the state of the game and explained plans for the next steps. These meetings provided informal feedback on design components as they were implemented. From these meetings new requirements were discovered and adapted as seen fit to respond to issues that arose.

4.2 Story Creation

In this section various aspects of the designed game are explored with a focus on the story that was created and implemented into the game. The story itself is the main component of the game and so it is important that it reflects the goals of the design and meets the requirements it set out to achieve.

4.2.1 Characters

The prevalence of ASD is thought to be significantly greater in males than in females as the ratio of diagnosed males to females with ASD ranges from 2:1 and 16:1. With requirement 11 in mind along with there being significantly more male diagnoses of ASD, it was decided that the main character should be male. In the story created it was also decided that the other character in the game should be male. Although, if more than one story was developed there would have been females included as there is no reason to make other characters in the game always male. Even though there are potentially so many more males with ASD than females given the time to develop further stories it would have been wise to include other stories with a female lead to cater to the female ASD demographic.

From figure 4.1 it is possible to see the development of the main character Tom from the initial concept stage to the design used in the prototype game. The design of Tom was done in such a way that he can be identified easily when placed opposite other characters. Additionally, it was important for Tom to appear friendly and like a typical child to further relate to the user. Tom had to also be easily replicated accurately across the frames of the story.

Sam was the second character to be created. As with Tom, the user of the game must be able to clearly identify which character is Sam so there is no confusion between the two. When questions are asked regarding either character’s emotional state there should be no doubt of whom is being referred to. The plan for
the story’s frames was that the whole story should be drawn first, then if time permitted colour could potentially be added. Unfortunately, there were too many other priorities and colour was not added to the game. Since this was a known possible outcome we had to make sure the characters were easily distinguishable regardless of colours for clothings or hair. For this reason Sam has clear curls in his hair, a different shaped face, and wears trousers instead of shorts. An image of the character Sam can be found in figure 4.2.

**Character emotions**

A key part of the design is how each characters emotion state is represented and displayed to the user. Facial expressions are the primary method used to convey emotion in the game. It is important that they are as clear and as obvious as possible so that children with ASD that have difficulties in emotion can still identify them. To do this facial features are kept to a minimum (see figure 4.3 to 4.14 for examples) in accordance with requirement 7.

### 4.2.2 Emotion Scenarios

Two emotions were chosen to be included in the story. The story in the game takes place over the course of a day in the Tom’s life and so including two main scenarios was deemed appropriate. It was beneficial to use this format as if time allowed, more stories could have been produced that covered other days in Tom’s life and other emotions without the need to integrate them directly into a single storyline. To keep the game engaging the first emotion encountered in the story is positive before dealing with a negative emotion later. With this ordering it is hoped that the user will be more motivated to continue when faced with negative emotions compared to if the negative emotion was first.
Figure 4.2: Sam.

Figure 4.3: Facial expression example 1
Figure 4.4: Facial expression example 2

It's hard for me to understand how my friends feel

Figure 4.5: Facial expression example 3

Hi Sam. Ready to go?

Figure 4.6: Facial expression example 4

It's hard for me to understand how my friends feel

35
Figure 4.7: Facial expression example 5

This place is great!

Figure 4.8: Facial expression example 6

Figure 4.9: Facial expression example 7

Oh, that’s good, but why is Sam happy?

SAM IS HAVING FUN PLAYING
SAM DOESN’T LIKE SOFT PLAY
SAM LIKED HIS BREAKFAST
Figure 4.10: Facial expression example 7

I need your help. How does Sam feel?

Figure 4.11: Facial expression example 9

I'm tired, would you like to come back to my house for dinner?

Figure 4.12: Facial expression example 10

PREV NEXT
Figure 4.13: Facial expression example 11

Thanks for trying to make me feel better
Tom

Figure 4.14: Facial expression example 12

Wow, that was a long day. Thank you for all the help and maybe I’ll see you tomorrow!
From the information gathered in the study conducted with TD children (see Pre-design chapter) the story could be constructed. One of the scenarios written by a participant describing a time when someone felt happy was when they and a friend went to soft play. Of the scenarios written for Happy this one seemed particularly appropriate for the target user group to relate to.

The second scenario we selected was when a family member or friend is ill. Two participants in the pre-design study wrote this as a time they were worried. Having a friend or family member fall ill is a fairly common occurrence so also fulfils requirement 11, that the story should be relate-able.

These scenarios were then integrated into a complete story that could be used in the game. The story was developed with requirement 10 in mind, that the narrative should be motivating and engaging for the user. This can only really be determined after the evaluation phase although choosing relatable events was hoped to increase user engagement. The plan that was created for the story can be found in figure 4.15. The finished game that implements this complete story can also be found in the appendix section of this dissertation.

4.2.3 Dialogue

In the game it is important to know who is speaking at which point as the dialogue progresses. Clarity is important so a large font size was used with a regular font, sans-serif emboldened and italicised. A large speech bubble surrounds the text too so that the dialogue can be read without issue of confusing text with background elements. One complication did arise from making the efforts we took in making the text clear as possible. A lot of the background image was covered up, potentially causing difficulties for the user in seeing exactly what is going on in the story outside of dialogue. Furthermore, it was also difficult to position the speech bubbles appropriately to maintain an unambiguous speaking order of the characters.

As you can see from figure 4.16 speech bubbles are positioned so that key information from the image is not covered up. However, their positioning goes against the comic book style convention of having the speech bubble of the person speaking first in the most upper left position compared to the following bubbles. This convention is used so that there is no doubt which character said what first. To regain ordering whilst keeping our large speech bubbles we made it so they appear in the order they are said. Figure 4.17 demonstrates this with the left frame first followed by the frame on the right. This feature was added to adhere to requirement 6, that only one character should speak at a time on each frame. The language used in the dialogue was kept as minimal as possible to satisfy requirement 2.
Tom starts the story by greeting the user.
Tom: Hello, I’m Tom, and I need your help!
Tom: It’s hard for me to understand how my friends feel
Tom: Can you help me?
Tom: Great! I’m about to pick up my friend Sam. Come with me
Tom arrives at Sam’s house.
Tom: Hi Sam. Ready to go?
Sam: Yes, I can’t wait!
The two boys are driven to soft play by Tom’s mother and talk in the car.
Sam: I hope soft play is good. I’ve never been before
Tom: I have, trust me Sam, you will love it
They arrive at soft play and are faced with a mass of tunnels, ball pits, slides, and things to play in.
Sam: Where do we start?
Tom: I have an idea!
Tom and Sam go to the top of a slide.
Tom: You can go first Sam
Sam: Okay
Sam goes down the slide and falls into the ball pit.
After playing for while...
Sam: This place is great! (With a big smile on his face)
Tom switches interaction to the user for the first question sequence and returns back to interacting with Sam.
Tom: I’m tired, would you like to come back to my house for dinner?
Sam: Me too. Sure!
During the car ride back to Tom’s house.
Tom: What’s for dinner mum?
Tom’s mum: Spaghetti
Sam: I love spaghetti!
At dinner Sam doesn’t look like he is enjoying his dinner.
Final question sequence.
Tom: Is everything okay Sam?
Sam: I was thinking about my gran. She is ill.
Tom switches back to the user for the final question sequence.
Sam: Thanks for trying to make me feel better Tom
Tom’s mum: Okay Sam it’s home time
Tom: Wow, that was a long day. Thank you for all the help and maybe I’ll see you tomorrow!
Figure 4.16: Unordered dialogue.

Figure 4.17: Ordered dialogue.
4.2.4 Visual Style

The comic strip appearance of the game was chosen for several reasons. The comic strip style caters well to the linear progression of the story in the game, with each frame acting as a step through it. Question sections can be easily integrated in between such steps. Using this style is also age appropriate with the target user group as they will have likely already come across comic books already and know general information about the format they take. For example with speech in a bubble and thoughts in a thought-cloud. If the user has not read comic books at all it is still likely they have come across the style in games or television shows. Another point in favour of using this style is that due to the time limitations, if any other format was used like 3D renderings or flash animation, it would not be possible to complete a comprehensive prototype that adequately demonstrates the design of the game. The researcher that developed the Android implementation of the game also felt sufficiently experienced in drawing and image manipulation to create drawings of a suitable standard. To meet the requirement regarding engagement, it is necessary for the images to be pleasant to look at and be interesting enough to keep the user’s attention.

4.2.5 Frame production cycle

Once the plan for the story was in place the frames could be created. Due to the nature of the comic book style used, a large number of frames were created to tell the story in detail. In total there are 35 frames in the story. To create so many frames and to maintain on schedule with the deadline of this research, a production process had to be developed.

To visualise the frame production process figure 4.18 has been provided. Each frame was based upon a particular part of the story plan and then sketched out on the computer. Sketching was done using a graphics tablet supplied by the researcher themselves. Figure 4.19 demonstrates how one of the frames appeared.
during its sketching phase. They were used as rough guides to make sure that proportions looked appropriate and to act as a template for the final frame produced. Once all of the sketches were made they were developed to a finished state one at a time. The outlines of the sketches were penned over to provide a sharp, clean finish to the images. A finished version of the frame sketched in figure 4.19 appears in figure 4.20. To pen over the sketches a simple method was used using the GIMP image editor. This software supports working in layers that can be worked on individually and turned on and off. The sketch would be a lower layer while the pen tool would deposit onto a higher layer. When the outline has been fully completed the lower sketch layer can be turned off and the refined image frame saved.

4.3 User Interaction

With a user-centered design such as this the user should interact seamlessly with the game. It should be intuitive for the user to perform any possible desired action.

4.3.1 Graphical User Interface

The design of the interface in the game is based upon a minimalist approach intended to support simplicity and ease of use for the user. Any button in the game
has been designed such that its function should be unambiguous. In figure 4.21 you can see the buttons labelled 'NEXT' and 'PREV'. The actions they perform are progression to the next frame and returning to the previous frame, respectively. They have a black outline with white to light-grey gradient background so they stand out against each of the frames. How the buttons appear in the game is shown in figure 4.22. They are the same on each frame to aid memorability and learn-ability. The 'PREV' button was included for safety, so that the user may be able to move backwards in the story to check on details they may have missed or remind themselves of dialogue or emotion clues.

A time delay of half a second was added to both of the navigational buttons. This was done to minimise user errors such as accidental double tapping causing the user to skip ahead, which they may not necessarily notice.
4.3.2 In-game Questions

Question sequences are presented to the user at several points in the story. All of the questions that appear in the game take one of the forms stated in requirement 5. An animation is used to define the moment when the story pauses and the main character switches between interaction with other characters and the user. Figure 4.23 demonstrates this animation. When the story is returned to after the question set the thumbnail is changed to the next story frame and the reverse animation is played to enlarge it to full screen. The frame shrinks from the whole screen to a small image in the top left. The options the user can select from appear on the right of the screen. Questions can be one of three types as per requirement; how does a character feel?, why do they feel that way?, and what action could be taken as a result?. The response can either be multiple choice or text entered by the on-screen keyboard. With keyboard typed answers whatever the user types in is saved to a file with the format:

```
Question_text: user_input
```

where 'Question_text' is the question the user answered. This allows a parent or support worker to analyse the answers the user gives without having to be present during play so that if there are any issues with their responses, that can be addressed. User input was saved to a file following requirement 9.
The first question sequence focuses on details around Sam feeling happy. First the recognition of the emotion state is addressed (see figure 4.24). The user is kept on each question until the correct option is selected. Next, why Sam is feeling happy is brought to attention (see figure 4.25). The other options that are made available to the user follow convention on multiple choice questions where one option is far from being likely and the other incorrect option is more likely. In this case ‘Sam doesn’t like soft play’ is furthest from the answer as it has already been established that Sam is happy. Then ‘Sam liked his breakfast’, would be closer because it would be a reason to be happy, however is not why Sam is happy at the point in the story. Last, an appropriate response is addressed by asking whether or not it would be a good idea for the characters to go back to soft play in the future (see figure 4.26). Logically given that both characters are happy at soft play, it follows that returning would be a good idea.

In the second question sequence the emotion state of being worried is approached. This state is approached across two question sequences to give the user two separate opportunities to learn appropriate responses. To start this sequence Tom had already identified that something is wrong with Sam and asks how Sam might be feeling (see figure 4.27). Previously Sam mentions he likes spaghetti yet in the frame prior he is shown not enjoying his dinner (see figure 4.28). Once the user selects the correct answer, ‘worried’ in this case as neither of the other two could be the case, the user is asked whether Tom should respond to this knowledge of Sam’s emotion state by asking if he is okay (see figure 4.29).

Sam declares that his gran is ill which is then followed by the last question sequence in the game to establish why Sam is worried and what an appropriate response may be. The frame asking the user why Sam is worried can be found in figure 4.30. All of the correct options move to a different place (top, middle, or bottom)
Figure 4.24: Question 1

I need your help. How does Sam feel?

- SAD
- HAPPY
- ANGRY

Figure 4.25: Question 2

Oh, that's good, but why is Sam happy?

- SAM IS HAVING FUN PLAYING
- SAM DOESN'T LIKE SOFT PLAY
- SAM LIKED HIS BREAKFAST
Figure 4.26: Question 3

Should Sam and I come back to soft play again in the future?

YES
NO

PREV

Figure 4.27: Question 4.

Something is wrong with Sam. How do you think he is feeling?

ANGRY
EXCITED
WORRIED

PREV
Figure 4.28: Sam not enjoying dinner.

Figure 4.29: Question 5

Should I ask if he is okay?
among the other options so that the user cannot simply keep pressing the top button (if that was always correct) and ignore the questions being asked. The final question asks the user what Tom can do to try and make Sam feel better (see figure 4.31). This question demonstrates user generated responses. The input is stored to a log file for later review, as mentioned above. There is no limitation to what the user can enter for this question. To fit this into the story the frame that follows has Sam say ‘Thanks for making me feel better Tom’ (see figure 4.32). Saying this gives little implication to the user on how effective their response was but they can still see that Sam appreciates Tom’s attempt to make him feel better.

4.3.3 Rewards

A geometric reward was chosen to be implemented in the game. Ideally the user would be able to select a reward based upon the personal preferences of the user. Instead this single geometric reward system was implemented to demonstrate animation, sound, and positive feedback for the user. For every question answered such that the user can progress through the story a star is animated into the screen. These rewards were implemented to satisfy requirement 3 which refers to positive feedback. Every question answered correctly earns the player either a silver or gold star, as shown in figure 4.33. The first two stars are silver then the third replaces those two silver stars with one big gold star. This is repeated with stars being added until the end of the story, where the user will have accumulated three gold stars. The animation for silver and gold stars and how they appear on the screen can be found in figures 4.34 and 4.35.

In response to requirement 4, in the event the user selects a wrong answer (that
Figure 4.31: Question 7

What can I do to try make Sam feel better?

Figure 4.32: Sam’s response.

Thanks for trying to make me feel better, Tom.
is an answer that prevents progression in the game) a message is displayed at the bottom of the screen for a few seconds before disappearing. Requirement 4 was that there should be no negative feedback. The message that is displayed cycles between ‘Unlucky, try again!’, ‘Almost, give it another go!’, and ‘Try again, you can do it!’.

Once the game is over a the user is presented with a final reward screen with all of the gold stars (see figure 4.36).

4.4 Implementation

4.4.1 Development Platform

There were several potential development platforms that could have been used to meet the aforementioned requirements.

Android

Android studio is the official integrated development environment (IDE) for Google’s Android platform. Java is the programming language used for developing appli-
Figure 4.35: Gold star animation.

Figure 4.36: End screen.

WELL DONE!
You finished the story!
cations on Android. Developing for Android means the application can be used on a range of Android devices, depending on their version of the Android operating system. There is extensive documentation and guides available on-line on various aspects of developing for the platform and on using the IDE itself. When deciding on which platform to build an application on, the level of quality documentation that is available is important, especially if the developer does not have extensive prior experience with it. The author that developed the game had some past experience with developing applications on Android with Android Studio, in addition, the developer also had several years experience programming in Java. Due to the researcher’s experience with Java, Android, and navigating the relevant documentation, Android was the chosen platform with Android Studio as the IDE.

iOS

Developing the game for devices that run iOS (Apple’s mobile and tablet operating system) was another alternative option. As with Android, there also appeared to be significant documentation on developing for iOS. Applications for iOS are written in a programming language called Swift. The researcher developing the game had no experience with iOS or the Swift language. Developing for iOS offered no real advantage over Android, which the researcher had significant experience in. As such, iOS was not selected for use in this design.

Game Maker: Studio

In the early stages of the design it was suggested in several that Game Maker: Studio may be a good tool to develop the proposed game. This tool can build applications for both Android and iOS which is an advantage in that the game would be accessible by more devices and by extension also more people. The creators of Game Maker: Studio advertise it as an easier way of developing games without the steep learning curve that comes with learning programming. Its main feature is a drag-and-drop method of creation although it contains its own programming language, Game Maker Language. The researcher that developed our prototype felt that they would have to get to grips with a new language and a new tool. The software is not free so it would have been necessary for the researcher to request funding to get access to the tool. To process and receive funding would take up valuable time. Given the time-sensitive nature of this project his may have been a hindrance. Comparatively, the researcher decided that they had more control and flexibility over the design of the game with an Android solution, written in Java.
4.4.2 Resource Requirements

Hardware

To play the game, a tablet that is able to run Android is necessary. Additionally, the tablet should also have 21.00MB of free space available and a processor in the range of a 1.2 GHz Quad-Core. The tablet used for development was a Samsung Galaxy Tab A 8”. Anything around this specification or newer would be sufficient to run the game as intended.

Software

The game was developed and tested on a tablet running Android version 5.0.2. Currently, any version from 5.0.0 and above is supported. It may run on older versions but it has not been tested on them.

4.4.3 Xml

The xml is where the interface is built. It contains all of the buttons and images for the geometric rewards.

4.4.4 Java

There are two Java files for this project. The first is StartActivity.java which is the home screen of the game. In a full non-prototype version the settings for the game would be accessed here as would the parent and support worker section where the user’s answers to the typed response question would be viewable.

The second Java file is Story.java which contains the logic for navigating through the story and for all the questions and animations. A counter keeps track of where in the story the user is. Every time the user presses the next or previous buttons the counter is either incremented or reduced, respectively. The game then reacts based upon where the counter is at by loading backgrounds, starting animations, revealing or hiding buttons, or playing sounds. This approach meant changes can be easily made to different points of the game. However, one downside is that it is particularly troublesome to add frames in anywhere other than at the start or finish of the game since it dependant on the counter.

4.4.5 VCS

A private online git repository was set up to track versions of the project. This system allowed work to be carried out from various physical locations without needing to worry about accidentally working on previous code versions or carrying a physical copy of the project files. As a result progress in development could be made whenever the developer had time and was not constrained by location.
Productivity and the ability to meet self-imposed development milestone deadlines was significantly increased.

4.5 Design Discussion

In this chapter we have covered all aspects of the design of the prototype game. Development of the game was based upon building a prototype to adequately demonstrate the idea such that it can be evaluated. Certain features are not present that would be necessary in a commercially deployed version. Precise control over visual and audio stimulus in the game is an example of such a feature. The ability to control audio levels easily from any point in the game, level of animations, explicit brightness controls, and control over colours would be important to prevent sensory overload in the target user group of children with ASD. The extent of features that were considered for implementation but were unable to be is covered as part of the 'Future Work' section of the final concluding chapter.
5. Evaluation

In this chapter the activities carried out to evaluate the proof of concept prototype are described. The first activity was a study conducted with TD children to observe how they interact with the game and discover what they think of it. In addition to this study various experts with different areas of expertise were interviewed for their opinions on the game.

5.1 Evaluation with TD children

5.1.1 Aims

The primary aim of this study was to observe usability and interaction between child users and the application. This was the goal because a comprehensive study involving children diagnosed with ASD was not be possible for this project. A high level of usability of the game is crucial in achieving the design goals and requirements stated. The user must not experience frustration or difficulty in using the game as that will detract from the user’s engagement and their motivation to continue using it.

5.1.2 Method

The method executed for this study was closely related to the observations completed in the pre-design stage.

Participants

To find participants an email was sent to around the informatics department of The University of Edinburgh. Included in the email was a short description of the game and a request for available children between the ages of 6 and 14 to be game testers. The participants that responded and subsequently partook in the study were ten typically developing children, seven males and three females aged between six and twelve. The participant ids mapped to ages and genders can be found in table 5.1.

\(^1\)Participants in this study that were also participants in the observational study with TD children in the Pre-design chapter have there row emboldened.
Table 5.1: Participant mappings.

<table>
<thead>
<tr>
<th>ID</th>
<th>Age</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>12</td>
<td>Female</td>
</tr>
<tr>
<td>P2</td>
<td>8</td>
<td>Male</td>
</tr>
<tr>
<td>P3</td>
<td>10</td>
<td>Male</td>
</tr>
<tr>
<td>P4</td>
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</tr>
<tr>
<td>P6</td>
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<td>Male</td>
</tr>
<tr>
<td>P10</td>
<td>8</td>
<td>Female</td>
</tr>
</tbody>
</table>

Setting

This evaluation study with TD children was carried out in two separate sessions at The University of Edinburgh, in the Informatics Forum.

Materials

The following materials were used:

- Samsung Galaxy Tab A
- Researcher produced notes
- Two printed frames from the game (see figure 5.1)
- Mobile phone

Participants played the researcher created game on the Samsung Galaxy Tab A. As a guide and a script for the researcher to use during the study a set of researcher notes were produced (see appendix for guide and notes). These notes contained an order of events, a rough script for the researcher to refer to, pre and post playthrough questions, and a page with usability measures for the researcher to fill out during the participant’s play testing session that contained spaces for notes on learnability, flexibility, and robustness. A mobile phone with audio recording capabilities was used to capture participant responses to the set of post playthrough questions, the answers of which are summarised in the results section (see figure 5.2 for list of questions without their answers).

Procedure

Ethics approval was sought and received in accordance to the procedure outlined by the School of Informatics at The University of Edinburgh (School of Informatics, 2016). When each participant arrived at a pre-arranged time with a parent or guardian, they were welcomed in by the researcher. Following their arrival, a
Figure 5.1: Example frames shown to participants.

I need your help. How does Sam feel?

SAD
HAPPY
ANGRY
Post-play-through Questions
Don't worry if you can't think of an answer for any of these questions, if you're not sure just say so and we'll move on.

- What did you like most about the game?
- What did you like least about the game?
- Was the game easy or difficult to play?
- Did you find the questions hard or were they quite easy?
- What did you think of the comic style of the game?
- Do you think if there was a longer story that would be okay or would it be too long?
- What did you think of the story? Did you want to help out Tom?
- Could you understand the story?
- Did you think there was too much to read or maybe there was too little reading?
- If you could change anything about the game what would you change?
- What did you think of the rewards?
- Would you like to have been able to customise Tom?
- Would an audio narrator be a useful feature or not?
- Were the feelings easy or difficult to recognise?
- Do you think it would help children that struggle to understand other people's feelings?
- Could you read the font?
- Could you understand which character was talking?
consent form and information sheet was provided to the parent or guardian while separate consent and information sheets were shown to the participant (see appendix for all forms). Participants were walked through the forms and were told that they may stop participating in the study at any point if they wished, without giving any reason for doing so. Once consent had been given the researcher asked the participant if they had used touch screen devices before and if they had played touch screen games before. Minimal background information was given to the participant, only that the game is a story in which the user must help the main character, that has difficulty with a skill. Then the two example frames were shown to the participant so they understand what to expect and understand how the ‘NEXT’ and ‘PREV’ buttons work. The participant was given up to ten minutes to complete the story from start to finish. Whilst the participant played the game the researcher wrote notes in response to the usability measures of learnability, flexibility, and robustness.

Once the participant completed the story in the game the researcher confirmed that they were still happy to be audio recorded. Following confirmation the recording of audio began. The researcher then asked a set of post play-through questions. To encourage detailed answers a follow up question of ‘Why?’ was occasionally asked when the participant’s initial answer was particularly short. After all questions had been addressed and participants had no more comments to make they were thanked for being a game tester and given a certificate in thanks for their participation (see appendix for certificates).

5.1.3 Results

All 10 participants had previous experience with using tablet devices and with playing games on touch screen devices too. The results for the usability goals from notes taken by the researcher were as follows:

1. Learnability: Every participant in this study appeared to navigate the story easily. Buttons presses were always intentional and since navigation buttons maintain their position on the screen, as you would expect once their function was learned the participants could use them without error.

2. Flexibility: All of the participants knew that when the frame moved into the background they then had to answer a question. However two participants did seek additional information by clicking on the thumbnail which the game did nothing in response to.

3. Robustness: Participants rarely used to ‘PREV’ button to return to past frames and never skipped ahead too many frames by accident. The few buttons that are contained within the game means there is not much opportunity for the user to make unintended actions. The only error observed by the researcher was when P8 accidentally pressed the ‘X’ button which returned the game to the start screen and lost all progress in the story. To
avoid this a confirmation message could be displayed allowing the user to confirm or avoid returning to the starting screen.

Many of the participants gave similar answers to the post play-through questions and so for each of the questions listed below the responses are summarised.

**What did you like most about the game?**

Five of the participants liked the story contained within the game the most. Three of the other participants said that they liked helping Tom with his difficulties. P2 liked that the questions in the game were tricky enough to make him think but were not so hard that he could not answer. Furthermore, P7 liked that the game would be useful for learning how to tell people’s expressions as well as how to respond.

**What did you like least about the game?**

Nine of the participants could not think of a response for this question. However, P4 did not like how the frame moved into the upper-left corner of the screen for question segments in the game. He said the answer to the questions were not as obvious because they assumed the question was asking about the larger face on the screen and not characters from previous frames in the story.

**Was the game easy or difficult to play?**

All of the participants felt that they found the controls of the game easy to use and to interact with.

**Did you find the questions hard or were they quite easy?**

In general the participants either felt that the questions were easy or were a mixture of easy and harder questions. One particular question that was mentioned as being hard was the question ‘What can I do to try make Sam feel better?’, where the player has to think up of their own suitable answer instead of selecting an option from a list.

**What did you think of the comic style of the game?**

Overall the participants liked the appearance of the game, more specifically participants liked the simplicity and how clear the pictures are. However, seven of the participants in the study felt that the game would significantly benefit from the inclusion of colour in the picture frames. Some of those that mentioned colour suggested that if colour was added it would draw the attention of the user more. One of the participants, P7, expanded on the idea of progressively challenging levels (mentioned often in response to one of the latter questions) and said that
the style of the game could become more complex and closer to real life as another layer of difficulty.

**Do you think if the story was longer that would be okay or would it be too long?**

In this study five of the ten participants thought that the length of the story was okay, anything less would be too short, and more would be too long and might get boring. Four participants also said that more stories would be better. In contrast the other five did feel that the story was a bit short and they would have liked to have played more.

**What did you think of the story? Did you want to help out Tom?**

The responses for this question were all positive with eight participants stating that they wanted to help Tom understand the feelings of the other characters.

**Could you understand the story?**

Every participant felt that they could easily understand and follow the story presented within the game. However, one participant, P7, felt that there was a slight mismatch between how old the characters looked and the activities they were involved in. He thought that the graphics of the game made it look like the characters were a little too old to be going to soft play.

**Did you think there was too much to read or maybe there was too little reading?**

Three of the participants said they would have liked there to be more reading in the game. They said that more reading could make it more interesting as well as more challenging. All of the other participants said they thought there was a good amount of reading involved.

**If you could change anything about the game what would you change?**

In regards to the start screen (see figure 5.3), P5 said there should be pictures all around because it looks too plain the way it is now. Some of the participants also wanted there to be more characters in the story and questions to have more complex answers. In total seven out of ten participants said that colour would be a good addition to the game in their answer to this or in other questions. Two of the participants wanted to be able to click on the small image in the upper-left corner during question sections to enlarge it and see it better.

**What did you think of the rewards?**

The participants all liked the star rewards that appear in the game. There was one interesting suggestion from P2 that rewards could interact with the story more.
He suggested that the player could use the rewards to purchase items that can be used in the story.

**Would you like to have been able to customise Tom?**

Of the participants only P1 and P8 thought that it would be a good feature to be able to customize the appearance of the main character. In the opinion of each of the other eight participants it would not make a significant difference to the game.

**Would an audio narrator be a useful feature or not?**

Out of the ten participants, nine of them thought a narrator would help people that struggled to read but there should still be an option to turn it off so if they wish they could read at their own pace. The participant that did not want a narrator said that the game looks like a comic strip and so should be more like a comic strip without a narrator.

**Were the feelings easy or difficult to recognise?**

All of the participants said that the feelings were easy to recognise from the facial expressions the characters made and from the dialogue in the story.

**Do you think the game would help children that struggle to understand people’s feelings?**

The participants all thought that this game would help children with the same difficulties in understanding feelings that Tom in the story has. In response to why they thought it would help, the participants felt it would be a good game to help children learn to connect how people look with how they are feeling. Additionally,
four participants thought that to help children learn better, the game could include levels that get progressively more challenging.

**Could you read the font?**

All of the participants found no difficulties with reading the text on the screen and did not think that changing the font size or typeface would be beneficial to the game.

**Could you understand which character was talking?**

None of the participants had difficulty in being able to tell which of the characters were talking during the game’s dialogue. It is worth noting that P8 did say that although they could tell who was talking at what point, the speech bubbles could be closer to the speaking character.

### 5.2 Expert Feedback

To get feedback on the design relevant experts were sought and then interviewed as part of the evaluation phase of the research.

#### 5.2.1 Aims

Evaluation interviews were carried out to answer the following questions:

1. Is the game appropriate for the target user group of children aged seven to eleven with ASD?

2. Would the game be intuitive to play for the target user group?

3. Is there evidence in support of the design as a tool to help children with ASD that have difficulties in understanding emotion?

4. What changes could be made to improve the design?

#### 5.2.2 Method

**Criteria for Inclusion**

The criteria for inclusion was similar to that of those described in the Interviews with Experts section within the pre-design chapter. Experts were selected based on their field of study being relevant to this research. Additionally, with these interviews we also extended inclusion to practitioners that work with children with ASD.
Materials

The game was presented to the experts on a Samsung Galaxy Tab A that the expert could use to play the game themselves. To record the interviews a mobile phone capable of recording audio was used by the researcher conducting the interview. Finally, paper with the interviewer’s questions on it was used as a reference so that all the desired points were covered and no questions were forgotten (see figure 5.4).

Figure 5.4: Evaluation Questions for experts.

1. Do you have any initial thoughts on the game?
2. Is the game appropriate for children ages 7 - 11 with ASD?
3. Was the game intuitive to play and do you think it would be for the target user group?
4. Is there anything in the game you think the target user group might struggle with?
5. Do you think the game could help children with ASD that have difficulties in emotion understanding?
6. Was the length of the story appropriate?
7. Is there any improvements or changes you think should be made to the game?

Procedure

To arrange meetings emails were sent to several relevant experts across The University of Edinburgh. They were given a rough description of the game in the initial contact email. Following replies to the email and provided a suitable time and place could be arranged meetings were set up. At the start of the interview the expert was thanked for their participation and asked if it was okay to record audio during the interview. Once verbal consent to record was received the interviewer gave some background information on the game. This information included was that the game was targeted towards children with ASD between 7 and 11 years of age that have deficits in emotion skills. The expert was then asked to play through the game and mention any of their thoughts while they do so. Once the expert finished the game to the end of the story, they were asked questions designed to initiate a discussion (see figure 5.4) on various aspects of the design. The order in which experts were interviewed was not of any significance as the information provided to each expert was identical.
5.2.3 E1

Area of expertise

The expert, E1 in this study, was the same expert identified as E1 in the Interviews with Experts described in the Pre-design chapter. He has a PhD in Developmental Psychology and is a ‘Reader in Psychology’ at Heriot-Watt University.

Outcomes

The initial thoughts that E1 had on the game were very positive, commenting that the visuals were very good and very clear. He felt that the construct of empathy is taken into account and acts as a good basis for the format and style of the questions. Additionally, he pointed out the in the first set of questions the emotion of the character in question is very immediate, with the character’s feelings directly based upon current events, opposed to later in the story where Sam in the story is thinking about his grandmother who is ill which is far more hypothetical. It was noted that although this may not be an issue it might be worth making the distinction between the two when developing questions. The expert thought that the game is age appropriate for the target user group but wasn’t certain himself if the level of reading required in the dialogue was perhaps too high. Furthermore, it was felt that the game is intuitive to play and would that would likely be the case for children with ASD. The expert also explained that the game would be a useful tool for children with difficulties with emotion although it is not certain what effect use of the game like this would have when children encounter entirely new scenarios not covered in stories contained within the game. He felt that the understanding of children with ASD that play the game could break at any of the question stages. Either in recognising emotion, understanding why, or in motivation to do something given this knowledge and for that reason it could be effective in developing these skills. This differs with children that have down syndrome that would not necessarily have any difficulty with recognition or with what to do after knowing how someone feels regardless of why the feel that way. The expert then suggested we look at research done on inference as a lot of the choices the user has to make are based on inferences that must be made. In this expert’s opinion the length of the story was good and importantly not too long. If the story was too long understanding might be lost due to too great of a requirement on cognitive load. E1 also brought up Mind Reading: The interactive guide to emotions (Baron-Cohen, 2003) as another example of a game that further validates the motivation behind this design, it too presents individual unlinked tasks to the user. Finally, in conclusion, E1 felt there is significant scope for the direction that future development of this game could take.
5.2.4 E2

Area of expertise

The expert E2 was the same as the expert referred to as E2 in the Interviews with Experts section of the Pre-design chapter. She is a Doctor of Philosophy and a researcher at The University of Edinburgh with research interests in autism and early child development.

Outcomes

The first thoughts E2 had on the game were positive and mentioned that the visuals of the game look really good. She felt this was an important quality for the game to have to motivate the target user into playing the game for its visual appeal. This expert strongly agreed that the game is appropriate for the target user group. She was supportive of the presented game as a proof of concept but said there should be a lot of consideration given to how the game could be fully developed. The first task E2 felt should be addressed is the implementation of more stories into the game. Having a diverse range of situations across many stories would give the user more to compare their own experiences to, they can then better develop their understanding of the emotions that may be/have been present in those types of situations. However, E2 also explained that how appropriate the game is would depend on the verbal ability of the individual user as it is a dialogue intensive game.

In terms of how intuitive the game is to play, E2 felt that it was intuitive and the navigation was logical and simple to interact with. One suggestion for improvement was to use arrows instead of ‘NEXT’ and ‘PREV’. With respects to the length of the story, E2 explained that they thought it was certainly suitable and not too short or long. The final point made by this expert was that colour and more animations would be good additions to the game to make it more attractive to children and may prevent users from getting bored of it after a short period of time.

5.2.5 E3

Area of expertise

The third expert interviewed as part of this study was a NHS Lothian practitioner. She works in speech and language therapy, typically with children that have autism within mainstream schools. The expert does a lot of work on developing and understanding emotion as well as the ability to use emotion through stories that she has written. E3’s work involves working both with children in groups and individually.
Outcomes

Her initial reaction was that the layout was good and the format of the game is accessible to lots of children because of the simple language used in the game. In regards to the appropriateness to the target user group, E3 thought that the game was indeed appropriate for children 7 to 11 years old with ASD. She also thought that the game was intuitive to play and that it would be for children with ASD too. When asked whether there is anything that the target user might struggle with, E2 said that it would depend on the child. For example children’s verbal abilities can vary significantly so there might still be too much reading involved for some. After the researcher explained that a feature that read out the dialogue to the user was considered, E3 said that would be valuable in her opinion. She said that a narrator would enable intonation to be used as another dynamic to give information on emotion to the user.

The expert said that she thought it looked like it would be a really nice resource for practitioners. Furthermore she explained, in the game the drawings are nice, simple, easy to understand, and the situations are familiar ones which is crucially important.

E3 also liked the length of the story was suitable although the ability to save a story at the point the player is at so they can return to that same point later would be helpful. It would allow children to work at their own pace and use it for as much time as they’d like.

The expert then asked if the game could become a kind of record for the individual child. In her opinion it would be nice if the user’s feelings could be incorporated into the story. For example the game could ask how the user would feel or has felt in a situation presented in the story. Together the researcher and E3 agreed that such a feature could be placed within the game through framing questions in certain ways. The main character in the story could directly ask the user how they would feel in situations whilst maintaining the objective for the user to help out the main character.

In conclusion the expert said that she really liked the game, especially for its simplicity and its logical approach. She felt that it would be motivating for children to play and that if there was a level progression system that would be even more motivating for the player.

5.2.6  E4

Area of expertise

The final expert in this study is a research postgraduate student at The University of Edinburgh. Her masters research was developing a touch-screen application
designed to teach joint attention skills to children with ASD. With experience and knowledge of the challenges that can arise with designing games for children with ASD, E4 could provide insight for the game designed as part of this research.

Outcomes

The first thing mentioned by E4 while playing the presented game was that visually it looks nice and attractive to users. Next she felt that voice over the text from an audio narration feature would be the most obvious addition. Furthermore, flexibility in the types of audio and visual rewards that appear in the game would be an improvement to tailor the game to the preferences of the individual user. The expert liked that the user can keep track of their progress within the game through the rewards that they see on the screen. E4 explained that the cartoon faces in the game are quite distant to the complexity of a real human face. A way to implement a progression of difficulty in the game would be to make the faces in the game more and more complex and closer to a human face.

E4 particularly liked the way the game allows for user input and that parents or support workers can review the response that the user gave for certain questions. She said the feature was good because it let the user generate their own responses as opposed to the other questions that require the user to essentially choose an answer from a list.

With regards to the rewards in the game E4 explained that they are motivating for the user. To further develop them she said that the game could be more explicit with the user with text for example saying ‘You have 3 stars’ or something along those lines. The result would add to the user’s level of motivation.

In response to whether the expert thought the game was intuitive and appropriate for the target user she felt that it was. Although, to cater to a broader audience by making it easier to use for certain children a voice over narrator should definitely be implemented. An additional benefit from using a narrator would be that information on a character’s emotion state could also be given to the user through tone of voice. As other experts mentioned, E4 thought that arrows would be an improvement over the current navigation buttons as it is a common metaphor that children likely already know by the target age group. Having said that, in her opinion there is not anything in the game that children with ASD would likely struggle with. The structure of the game and the limited options that the user can possibly make result in it being easily played and accessible to users.

The length of the game E4 thought was good as well. When asked whether the game would help improve emotion skills in the target user group, E4 said that her expertise does not cover emotion skills in a great level of detail. Furthermore, she said that in general this is a difficult challenge for any application to achieve and what exactly is meant by help would need to be clearly defined. If the hope
was to improve a child’s ability to generalise concepts this is a major challenge faced by researchers and so without a study conducted to evaluate precisely this she could not speculate how effective the game would be.

5.3 Discussion

The activities presented in this chapter were designed to evaluate several components of the produced game application and identify areas that require improvement. First, the usability of the game can be discussed. From the results of both the evaluation study with TD children and the expert feedback we can indeed claim that the game is intuitive to use as no significant difficulty in navigating or answering questions in the game was found. Observed measures of learnability, flexibility, and robustness support this claim and only lead to the discovery of two minor alterations that should be made to the design. These were that the image in the top-left of the screen during question segments should be made click-able so it may be enlarged, and that the users intention of exiting the story should be confirmed in response to clicking the ‘X’ on the screen. Following the expert feedback, usability may be further improved by replacing the navigational buttons ‘NEXT’ and ‘PREV’ with directional arrows pointing right and left.

Another strength of the designed game appears to be its visual appearance, which all of the experts and children commented positively on. Producing a game that is engaging for the user is one of the primary goals of this research and the visuals is of course a major step in achieving this. If the game is visually unappealing the user is going to be less inclined to continually play it. Although the visuals were deemed to be at a satisfactory level, adding colour is the obvious next step in further maintaining the user’s attention.

All of the experts were asked if the activities in the game were appropriate for the target user group and they all concurred that they were. Whether or not the game would be intuitive for the target user group to play was also discussed and although all of the experts agreed that it would be, an voice over narrator would improve the current design to make it more accessible for children with lower verbal abilities.

Of the experts E3, as a current practitioner in the field, is possibly the best placed to answer whether the game could be an effective tool to help children with ASD that struggle to understand emotions. Her response was that it could be a useful resource for practitioners which supports the design that was produced. The other expert that commented on the potential effectiveness of the game was E1, who speculated that the teaching approach taken by the game could be successful in aiding the development of emotion skills.

Clearly there are also many routes of development that the game could take.
if worked on further. The interviews were conducted at a stage of the research where it was not feasible to alter the implementation and so the changes that could and/or should be made to the design are considered potential future work. There were a mixture of minor alterations and more significant changes to the design that were revealed from the activities described in this section. These changes are discussed further in the future work section of the concluding chapter of this dissertation.
6. Conclusion

The research presented in this dissertation is an investigation into the current state of emotion related tools for children with ASD and into the production of a game intended to improve upon existing tools. To begin a review of the literature was conducted which founded the motivation behind the creation of the proposed design. It was apparent that current tools for recognising and understanding emotions were not optimally interesting to motivate and engage the target users. This resulted in the design of a game intended to provide insight into the research questions laid out. Following the implementation of the proof of concept design, activities were executed to evaluate the design and to aid in answering the research questions.

This chapter is the concluding chapter of this dissertation. It provides answers to each of the research questions described in the first chapter. Following this the success of the research carried out is discussed as is how the design fits in amongst the range of tools that are currently commercially available. The final section of this chapter provides an insight into what additions could be made to the game and what direction the design could be taken in through future research.

6.1 Research Questions

In this section each research question that was laid out in the Introduction chapter will be addressed. The questions that this research set out to answer were as follows:

1. Is there scope for improvement in the effectiveness of existing tools designed to teach emotion skills?

2. Can a game designed to teach emotion skills be more effective through the use of a narrative over existing tools?

   (a) Are the activities presented in the game appropriate for the target user group?

   (b) Does the game support the development of emotion recognition and understanding skills in the target user group?
The investigation completed into the tools that exist currently suggested that there is clear scope for improvement. Tasks presented to the user are frequently independent of each other with little to no linkage between them. On top of this, minimal attention seems to be paid to fully engaging the user so they are motivated to complete the tasks. Experts E1 and E3 in the interviews described in the Pre-design stage shared this sentiment and supported this as justification for producing the design that followed.

The design of the game presented as part of this research was based upon the second research question. A proof-of-concept was created to demonstrate the proposed design. To answer this second research question conclusively a comprehensive study measuring the learning gains from use of the game would be necessary. This was outside the scope of this research however decisions were made based upon the idea of using narrative to support engagement and by extension effectiveness of the game. However, it is still possible to suggest an answer with information gathered from the evaluation activities. All of the experts favoured the visual appearance of the game as a motivator for the target user group. Furthermore, two experts, E1 and E3, both thought that the game could be a useful tool for teaching emotion skills to children with ASD. Together with the children and experts approving of the story and visuals as motivators, the suggestion can be made that the design has the potential be more effective over existing tools.

The experts were unanimous in their opinion that the activities presented to the user in the game (the questions and the story content) were appropriate for the target user group. Only one potential issue was raised by several experts regarding the reading level required of the user to play the game. Although the text was kept simple, two of the experts explained that the range of reading ability varies greatly across children hence why it could be an issue.

The sub-question, shown as 2(b) above, has already been partially answered in the response to the broader question 2 discussed prior. To determine whether the game is more effective over existing tools, first it should be known that the game supports the development of emotion recognition and understanding skills in children with ASD. As previously mentioned it is possible to speculate whether or not the game would support the development of emotion skills. A practitioner interviewed could see its use as a resource for developing emotion understanding skills in children with ASD. Additionally another expert noted that the skills of children with ASD that have difficulties in this area could break down in any of the three skill areas in the game; recognition, understanding why, and what would a suitable response be. The game walks the user through each stage, progressing one after the other to guide the user on details of the situation. Decisions were justified to support the development of these skills, which would suggest that if the justifications were valid the game may be successful in this endeavour.
6.1.1 Discussion

The research discussed in this dissertation intended to constructively make a step towards a contribution to increasing the range of tools available for children with ASD designed for improving emotion skills. Even though the produced game is a proof-of-concept for the design that could be taken in a number of different directions, precise boundaries separating existing tools and this design can still be made. The key point of the design was to incorporate a learning strategy into the game via a narrative with the aim of motivating and engaging the target user group, which may then increase the skills learned. This inclusion of a narrative to link user tasks is what separates the game in this research, from existing tools that are currently available.

6.2 Future work

There are several immediate alterations that should be made to the developed game. First and foremost, a voice over narrator should be an available option for users. All of the experts agreed that this would be a good addition as did the majority of TD children that played the game. This feature would make the game more accessible to children that had issues with reading text. Another alteration should be the changing of the navigational ‘NEXT’ and ‘PREV’ buttons so that they are instead directional arrows right and left respectively. It is also apparent that colour could be a useful addition to the visuals of the game, with the intention to make it more attractive and promote the longevity in which the user is motivated to keep playing.

Another next step would be to implement a parent or ‘Adult Zone’ into the starting screen. In the present game to access the user in-putted answers to questions, they must navigate the file system on the device. This is grossly inconvenient so instead these questions and their answers should be presented in an easily accessible section within the game.

The audio narrator could enable intonation to show how it plays a part in describing a person’s emotion. To further the game’s accessibility the narrator could be extended to describe the scenes within the story and to read out possible answers. This would be a reasonably simple addition that would enable visually impaired children to play the game too.

The evaluation activities made it clear that a level progression system could be put in the game to increase the difficulty to ensure the game remains challenging as the user’s skills develop.

There are two directions that development could take. First, the focus could be on creating a large database of stories to cover an extensive range of situations
linked to certain emotions. An alternative direction could be the development of an authoring tool to let parents and/or support workers create their own stories and put them into the game. However, this would be a major challenge to implement a system that made it significantly easier to design and create stories. A drag-and-drop system may be most appropriate although then repeated use of visual assets may make the game less interesting for the user. The biggest challenge in moving the design forward is in the creation of stories. Research should be conducted to provide a basis for story content which is a resource and time intensive. Drawing the images for each frame also takes a significant amount of time to maintain a high standard of aesthetic quality. Reducing the time required to produce many stories to a satisfactory level is the largest challenge that future researchers continuing this design would face.
A. Child information sheet and consent form for Pre-design study

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 recognise 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 is making a game and would like to know if you enjoy playing it.

Patrick - Patrick is trying to see if games such as Minecraft that allow children to be creative and to collaborate can be used to teach other children skills that they 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 - The exercise will have two parts. The first part is a sheet that will list several feelings and ask you to write down a time when you, or someone you know, felt those feelings. Once the first part is completed the second part can start. In this part you will be put into a pair and asked to make up a story, or several stories, with your partner that includes some of those feelings you wrote about in the previous part. There will be paper provided so you and your partner can write or draw your story. This exercise is just for fun and no one wins or loses. Some children may think it is easy. Other children may think it is hard. That is OK. All children can help. Michael and Helen will learn from what children write.

Fraser - Fraser will first ask you about what you like playing with and what you find fun. This will help Fraser understand what makes a game fun, so he can make his own game as much fun as possible. After this you will then play a game that Fraser has made. Fraser would like to see if you enjoy playing the game or if you don’t like the game. This will help him make changes to his game and make it better when he creates it for a computer. The game will take you through a story and you and some friends can act out parts of the story by moving your body. The aim of the game is to do some actions and movements that your friends can guess. If your friends guess correctly then the story will keep going. Don’t worry if you think the game will be too hard or too easy to play. You will be playing with a group of friends and Fraser will be there all the time to help.

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 on a laptop. 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 is the computer game?**
The researchers are all making different games.

**Michael** - Michael is making a game that will walk the player through a story. The player will work together with the main character to understand why other characters feel certain feeling, because of events that happen in the story.

**Fraser** - Fraser’s game will be similar to the game you play today, except you would play it on a computer. Whoever is playing will be taken through a story and they have to act out different things that the character does. This will help some children to express themselves with their bodies.

**Patrick** - Patrick is interested in making a modification in Minecraft that can be used to teach other children how to play together with other children and give them practice at talking to other children.

**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 help? 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. |
Child Consent Form

To be used as a guide for securing consent or refusal, after the child has had a chance to get information about the study. The child may mark (or be helped to mark) this form, or the child’s consent/refusal may be video-recorded.

I can choose to complete the exercise.
I do not have to help if I don’t want to.
I can decide to stop playing or take a break.
I do not have to say why.
It is OK if I change my mind later, and say I do not want to be involved any more.
It is OK if some parts of the exercise is hard for me!
Anything I can do is helpful.

Do you want to be a complete this exercise?  YES □ NO □

Write your name: ____________________________________________

THANK YOU!
B. Parent information sheet and consent form for Pre-design study

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 (m1223393@sms.ed.ac.uk; 07450219004)
Mr. Fraser Lennon, lead researcher (a1123035@sms.ed.ac.uk; 077398754396)
Mr. Patrick Cartridge, lead researcher (s1230556@sms.ed.ac.uk; 07445025069)
Prof. Helen Pain, Project Supervisor (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 exist 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-use) 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 play as a ‘Game Tester/Designer’. This will greatly inform us on what aspects of our designs children like or dislike, but also provide 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 know, felt each emotion. After the children involved have completed the exercise sheet they will then be split 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 Charades 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 warm down activity we will ask your child to draw some gestures that s/he may like to see in the game.
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.

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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 packet. 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. If you say “no”, we will not contact you again about this study and will not speak to your child about these exercises.

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 a 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: 07450219904
E-mail address: s1223335@sms.ed.ac.uk

Fraser
Mobile phone number: 07786754308
E-mail address: s1126353@sms.ed.ac.uk

Patrick
Mobile phone number: 07445925089
E-mail address: s1229055@sms.ed.ac.uk
Research permission form (for parents)

Have you read the information sheets?  
Please circle YES / NO

Have you received enough information about the study?  
Please circle YES / NO

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

Please sign this page to indicate that you understand and accept the conditions of this study, including video recording. By signing, you agree that the researchers may explain the study to your child and invite him or her to take part as a games tester.

**If you give permission for this study, please return this form to your child’s teacher.**

**If you DO NOT wish to give permission, you do not need to return this page. We will not ask your child to participate.**

Full name of participating child:

Child's date of birth (DD/MM/YYYY): _______/_______/_______

Your relationship to the child:

Your name (please print clearly):

Contact telephone number: ______________________________________

E-mail address: ______________________________________________

Best time and method to reach you?

Signature:

Date: _______/_______/_______
C. Child certificate for Pre-design study
D. Child information sheet and consent form for Evaluation study

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.

Why are Michael, Fraser, Patrick and Helen asking for help?
Some children find it hard to recognise 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 to collaborate can be used to teach other children skills that they 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 help? 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: 07450219904  
E-mail address: s1223335@sms.ed.ac.uk

**Fraser**
Mobile phone number: 07768754398  
E-mail address: s1126353@sms.ed.ac.uk

**Patrick**
Mobile phone number: 07449925069  
E-mail address: s12288955@sms.ed.ac.uk
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 for Michael’s story game? YES / NO

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

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

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!
E. Parent information sheet and consent form for Evaluation study

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 Wilson, lead researcher (m1223233@ams.ed.ac.uk; 07450219921)
Mr. Fraser Lannon, lead researcher (m1175655@ams.ed.ac.uk; 07789754366)
Mr. Patrick Carlin, lead researcher (c1223233@ams.ed.ac.uk; 07444535068)
Prof. Helen Pain, Project Supervisor (helen@inf.ed.ac.uk)

An overview of this project, and how you can help

What areAutistic 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 exist 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-use) and we are investigating how games might help children learn to express themselves by
nonverbal means. The game has been developed for a touchscreen tablet interface. This research workshop aims to evaluate the effectiveness of my game and how well I have achieved my project goals.

**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?**

By this stage we have developed our games for our chosen computer/technology platform and we would like your child to play them as a ‘Games Tester’. Your child’s interaction with the game will provide valuable evaluation material that can be used to answer our research questions, and determine how successful the game is (e.g. How well does my game hold the interest of a child?). Most of what we want to find out will come by observing them play and what they produce during the activities, however there will be chances for your child to give some direct feedback into how they enjoyed playing the games.

**What will your child be asked to do?**

**Michael** - To start, Michael will talk to your child about the game and explain what kind of things you can expect to see in the game. Then they will be given roughly 10 minutes to play through Michael’s game by themselves. In the story the player has to help the main character of the story, Tom, identify and understand the feelings of another character in the game. After they have finished, or once the 10 minutes has passed Michael will ask your child some questions about their experience of playing his game. With your child’s help, Michael will find out how he can improve his game and what its strengths and weaknesses are.

**Fraser** - My game has been developed for an Android tablet interface. The game can, in some sense, be compared to Charades with a story, in that your child will be asked to perform some action without talking in order to provide some meaning in the story. Your child can create their own profile or avatar and will be placed into the story as themselves, where they play alongside another child to progress through the game. There is a level of role-playing to the game however there is no pressure for your child to perform well, the workshop’s purpose is to see how well the implementation goes down with the audience. Your child will be given a run-through on the game and help and hints are available throughout. Afterwards we will ask your child some questions about how they enjoyed (or didn’t enjoy) the game. The whole process should take about 35 minutes.

**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 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 space.

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

Additional study information

What happens when the project is over?
After the workshop has finished and we have analysed the information we collected, it will be used as summative feedback on the effectiveness of our games 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 Cartidge and their research advisor Helen Pain. 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.

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 packet. 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. If you say “no”, we will not contact you again about this study and will not speak to your child about these exercises.

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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: 07450219904
E-mail address: s1223335@sms.ed.ac.uk

Fraser
Mobile phone number: 07768754396
E-mail address: s1123353@sms.ed.ac.uk

Patrick
Mobile phone number: 07445925069
E-mail address: s1223855@sms.ed.ac.uk
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 Cartledge
- Nonverbal Communication with role playing game - Fraser Lennon

Print Name: ____________________________
Signature: ____________________________
Date: ______/____/______
F. Child certificate for Evaluation study
G. Researcher guide and notes for Evaluation study

Evaluation Workshop

Order of events
- Introduce self and thank participants
- Check permission to record
- Introduce the game

Pre-play through questions
- Have you used touch-screen devices before?
- Have you played games on a tablet before?

Explain
- Story to help main character, Tom
- Tom has trouble
- Short version of what a full game might be like
- Help me find out what works and perhaps what doesn’t work
- The game is designed for children with some difficulties

- Looks like a comic strip except with questions
- Move forward with NEXT, back with PREV
- I’ll give you some time. Might be easy or hard
- If you need help or have any questions, I’ll be here
- Once you’re through the whole story I’ll ask a few questions
- Can stop or take a break whenever you like

The game I’d like to you to play today is an story where you have to try and help out the main character, Tom. As you’ll see in the game Tom has some trouble with a skill that most people are pretty good at. The game is meant to be a short taster of what a full game might look like and I would like your help finding out what works and perhaps what doesn’t work.

The game looks a lot like a comic strip except at some points Tom asks you some questions so that you can help him. You can move forward to the next part of the story by pushing the NEXT button, and go back in the story with the PREV button in case you need to take a look back.

What I’ll do now is give you 10 minutes to play the game, you might find it really easy and fly through the story, or you might find it a bit tricky and need the whole 10 minutes. If you have any questions or need help at all I’ll be right here. Once you’ve got through the whole story I’ll ask a few questions and see what you made of the game. Ready?
Learnability:

Flexibility:

Robustness:
H. Complete game screen-shots

Hello, I'm Tom, and I need your help!

It's hard for me to understand how my friends feel
Can you help me?

Great! I'm about to pick up my friend Sam. Come with me.

Hi Sam. Ready to go?
Yes, I can't wait!

I hope soft play is good. I've never been before.

I have, trust me Sam, you will love it.
Where do we start?
I have an idea!

You can go first Sam

Okay
This place is great!
I need your help. How does Sam feel?

Sad
Happy
Angry

Oh, that's good, but why is Sam happy?

Sam is having fun playing
Sam doesn't like soft play
Sam liked his breakfast

Should Sam and I come back to soft play again in the future?

Yes
No
I'm tired, would you like to come back to my house for dinner?

Me too. Sure!

What's for dinner, mum?
Something is wrong with Sam. How do you think he is feeling?

Options: ANGRY, EXCITED, WORRIED

Should I ask if he is okay?

Options: NO, YES

Is everything okay Sam?
I was thinking about my gran. She is ill.

Why is Sam worried?

- Sam didn't like dinner
- Sam wants to go to bed
- Sam wants his gran to get better

What can I do to try make Sam feel better?

NEXT
Thanks for trying to make me feel better, Tom.

Okay Sam it's home time.

Wow, that was a long day. Thank you for all the help and maybe I'll see you tomorrow!
WELL DONE!
You finished the story!
Bibliography

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Baron-Cohen, S.

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Baron-Cohen, S. and S. Wheelwright

Bird, G. and R. Cook

Calhoun, S. L. and S. D. Mayes

Celani, G., M. W. Battacchi, and L. Arcidiacono
Charman, T. and W. Stone

Charman, T., J. Swettenham, S. Baron-Cohen, A. Cox, G. Baird, and A. Drew

Chen, S. H. A. and V. Bernard-Opitz

Dix, A.

Ekman, P. and W. V. Friesen

Ekman, P., E. Rolls, D. Perrett, and H. Ellis

Fombonne, E.

Fommbonne, E.


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Rutter, M.

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Scaife, M. and Y. Rogers

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