

Developing and Evaluating An Educational Game for Teaching Children with Autism about Comprehending Sarcasm in Natural Language

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Master of Science
Artificial Intelligence
School of Informatics
University of Edinburgh
2017

Abstract

Autistic children often interpret the surface form of language literally, which can produce issues with their understanding in cases where non-literal language such as sarcasm is used, as may be common in many conversations such children are likely to have with others on a regular basis. To assist autistic children in better understanding sarcasm specifically, an educational game was produced using knowledge gained from researching relevant literature, interviewing experts in relevant fields, and involving proxies for the target population in a design workshop and participatory design session. The game was subsequently evaluated by typically developing children and experts in relevant fields. The game acts as a proof-of-concept, showing that it is possible and rational to develop such a technological intervention for this population, and for the task at hand. The results of the evaluations indicate that the proof-of-concept is effective and usable, and would be worth developing further.

Acknowledgements

I would like to thank my supervisor, Dr. Helen Pain, for being supportive and helpful throughout the course of this research, and for arranging evaluation sessions with children. I would also like to thank all the children and experts who gave me feedback and helped inform my design decisions.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(David Halperin)

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1. Introduction and Motivation

1.1 Figurative language comprehension difficulties of individuals with Autism Spectrum Conditions

The autistic spectrum comprises a broad range of cognitive and affective impairments and their associated difficulties for individuals on the spectrum. Generally speaking, individuals with autism spectrum conditions (ASC) often exhibit difficulties communicating and interacting with others [Levy et al. 2009; American Psychiatric Association, 2013]. These communication difficulties can lead to impaired social ability; for example an ASC child may misinterpret others' figurative (non-literal) language [Happé, 1993; Rundblad & Annaz, 2010]. Broadly, figurative language consists of utterances in which the surface form differs from the intent, for example in sarcasm, the intent is actually the opposite of what the surface form alone entails. Often, ASC children interpret syntax literally when another meaning is present [Stuart-Hamilton, 2013], e.g. failing to detect sarcasm. These misunderstandings by an ASC child can cause problems such as alienation from other children if, during a dialogue, the ASC child responds incorrectly, or does not respond at all, perhaps leading to that child becoming ostracized by other children, suffering from lower confidence or even developing anxiety, and making them more prone to bullying [Cappadocia, 2012]. This can start a vicious cycle: an ostracized child will likely spend most of their time alone, further inhibiting the development of the language and social skills that more social children will develop. The effects of this can reach far into an affected individual's adulthood, causing further anxiety, depression and other mental issues [Ozsivadjian & Knott, 2011]. A study of children with complex communication needs by Waller et al. in 2009 highlights the issue of poor communication ability in children leading to social difficulties, and resultantly educational, workplace and other life difficulties, and it can be said that ASC children who have similar issues with communication can

potentially suffer the same effects [Swineford et al. 2014]. Currently, roughly one in every hundred people in the UK has been diagnosed as being somewhere on the autism spectrum [The National Autistic Society]. Thus it can be said that autism is a fairly prevalent issue, and one with potentially harmful consequences if ASC individuals do not receive appropriate support.

1.2 Interventional Treatments

It may not always be apparent when an individual has autism - in fact, the affected individual themselves may not know they have it, and may not seek a diagnosis and further help which could benefit them. Thus, there is a large focus on identifying signs of autism early in developing children [Lord & McGee, 2001], such that the issues can be addressed at that stage e.g. through interventions of special education or therapy [Howlin et al. 2009], hopefully leading to that child having a higher quality of life. Currently there are interventional treatments for autism; these interventions must continually strive to be effective and beneficial in enabling ASC individuals to lead lives relatively similar to those of their neurotypical peers.

The focus on interventions for improving social and communication skills has been argued to have the greatest positive impact on ASC children's social development [Howlin et al. 2009]. The research in this dissertation focuses specifically on developing an intervention to combat the difficulties ASC children have in understanding sarcasm; it can be said that this is one aspect of the broader category of improving figurative language comprehension, and also social and communication skills.

1.3 Research Goals and Hypotheses

This research had the overall goals of facilitating children with autism being able to detect sarcasm, infer the correct semantics from sarcastic statements and thus reason about why a statement was sarcastic (or not), and respond appropriately in cases where sarcasm is present. Directly involving ASC children in this research was not done due to the ethical considerations of doing so, e.g. disruptions to the children's routines, and other potentials for them to become upset during the course of evaluations. The young age of the required participants could especially aggravate these factors.

This research hypothesises that an educational game can assist ASC children in detecting, understanding and responding to sarcasm in a virtual environment. To this end, the game was formatively evaluated by typically developing (TD) children, and adult experts in relevant fields such as autism, speech and language therapy, education, and human-computer interaction. Due to ASC children not being directly involved in the design or evaluation process; it can only be said that, based on the feedback from the design and evaluation, as well as by adhering to relevant guidelines for developing technology for ASC individuals, the game should theoretically succeed in the assistance of teaching ASC children an understanding of sarcasm. In this regard, it could be said that the game is more of a proof of concept than a complete, fully evaluated product. However, this gave rise to a sub-goal of the project, that of making the game easily modifiable and extensible by other programmers, such that after this project's conclusion, work on the game could potentially continue, perhaps eventually becoming a fully completed and evaluated product that can be used with ASC children in practice. To this end, the code was released with comments, and simple documentation was produced, although this sub-goal was not formally evaluated due to being out of the scope of this research.

Sarcasm cannot be easily detected from isolated phrases, e.g. one cannot simply tell if the phrase "I'm looking forward to it" is sarcastic when no other information is given, therefore the game made use of a contextual narrative to provide players with simulated situations in which sarcasm may occur, meaning the player must infer from a situation's context whether a statement is sarcastic or not, and how best to respond. This produced a more realistic experience, and one that should foster the development of sarcasm comprehension skills that transfer outside of the game to real situations (although this transfer was not measured in this research, as it is out of scope).

1.4 Chapter-by-chapter summary of this Dissertation

There are 11 chapters in total, including the introduction (chapter 1).

Chapter 2 is a literature review in which various aspects of the problem domain are researched and discussed, looking at figurative language, autism (e.g. Theory of Mind), interventional treatments, the use of technology in such interventions, social stories and comic strip conversations, game design and usability, and adaptive learning

environments.

Chapter 3 is an overview of the methodology used in this research, based loosely on that suggested by Scaife and Rogers [Scaife & Rogers, 2001].

Chapter 4 presents a first look at approaching the design space based on reviewed literature and usability principles.

Chapter 5 details a design workshop conducted with typically developing children in order to gain a further understanding of the design space.

Chapter 6 details the first prototype version of the game that was produced.

Chapter 7 discusses expert interviews, the resulting design changes, and a participatory design session conducted with a typically developing child.

Chapter 8 talks about evaluations done with typically developing child participants, producing qualitative and quantitative data pertaining to the system's effectiveness and usability.

Chapter 9 gives an overall discussion about the research findings, and suggests future improvements.

Chapter 10 provides an overall summary and conclusion of the research, discussing whether the initial hypothesis was met.

Chapter 11 is the appendix, and holds various figures and images which were not entirely necessary to include in the main body of text, e.g. images of participation certificates for children.

2. Literature Review

The following is a discussion of relevant literature, covering fields such as linguistics and information about figurative language such as sarcasm, as well as autism itself and the difficulties it presents for affected individuals, an overview of past and present interventional treatments for autism, potential approaches to conducting this research, e.g. through researching what techniques have been beneficial so far, and which of those, if any, may be appropriate for this research.

2.1 Figurative Language and its Importance in Every-day Dialogue

As discussed in Austin's Speech Act Theory [Austin, 1962], any linguistic statement consists of three things: its locution, or its "surface" syntax and apparent meaning, its illocution, or its actual intended meaning, and its perlocution, or the resulting act that follows from the statement, i.e. the statement's effect, e.g. to make a hearer aware of something, or to make them feel a certain way. In essence, Speech Act Theory discusses how utterances are used to achieve one's intentions. In order to go beyond mere locution, people utilise more complex linguistic structures such as figurative language, which can be thought of as a tool enabling them to convey deeper, embedded (even nested) meanings into their dialogue, and pick up on the same when uttered by others. The National Behaviour Support Service discusses the importance of figurative language in areas such as understanding others' dialogue, being able to express oneself emotionally, conveying thoughts and ideas, and knowing how to adapt communication style to the current situation [NBSS, 2011].

Those with an impaired understanding of figurative language can be said to experience difficulty with social interactions and self-expression, potentially leading to

poor social emotional wellbeing [NBSS, 2011], reduced confidence and higher anxiety [Cappadocia, 2012], and less social and linguistic development throughout their childhood [Brinton et al. 1996; Brinton et al. 2004]. These issues can lead to poor pragmatic skills [Bishop et al. 2000], e.g. not knowing when it is appropriate to speak in a conversation, a problem which only exacerbates their existing social and language issues.

Lazar et al. conducted a study on figurative language use by teachers in primary education, finding that teachers used multiple forms of figurative language often whilst teaching, and warned that this may be harder to comprehend for students with less understanding of figurative language [Lazar et al. 1989]. Children have been shown to use and comprehend figurative language at as early as seven years old [Pollio & Pollio, 1974; Naylor & Van Herwegen, 2012], so it can be said that the detrimental effects of not understanding it can be present from a young age; a child may get "left behind" by others who have access to more linguistic skills and understanding. Overall, it can be said that those with an impaired understanding of figurative language may be at a significant social and academic disadvantage [Yeh, 2012].

2.1.1 Sarcasm

Gibbs investigated the frequency and usage of irony in everyday language, finding that 8% of all conversational turns (in the study) were ironic, and 28% of those were specifically sarcastic [Gibbs, 2000]. Thus it can be said that while sarcasm may not be excessively prevalent in everyday language, it is used fairly regularly, and may be used more often in certain circumstances e.g. with friends or family, and so being able to understand it can be said to be a necessary part of holding effective dialogues in many cases. Sarcasm is a relatively straightforward case of figurative language, as its meaning is basically an inversion of what the speaker actually says (i.e. the illocution is the opposite of the locution) [Camp, 2011], e.g. "I like your hat", as said by someone who does not actually like the hat, but who does not want to say so outright, instead choosing to let the hearer decode the actual intended meaning, allowing the speaker to remain somewhat innocuous. Even this simple example demonstrates the potential complexity of figurative language such as sarcasm, and its wide range of applications for various social situations, such as to convey emotions, or in humorous statements [Pexman et al. 2011]. If one cannot effectively understand and utilize such linguistic

techniques as sarcasm, one's ability to partake in a social dialogue will be very limited.

Ruiz writes that there are three "elements" of sarcasm: facial expressions, context, and vocal cues [Ruiz, 2012]. That is, one cannot usually determine whether a statement is sarcastic when none of those elements are present, and it gets easier to do so when more of them are present; however it is not always necessary for all of them to be present, e.g. one might be able to detect sarcasm over the phone from context and vocal cues.

2.2 The Social and Communicative Difficulties of Autism Spectrum Conditions

Broadly, ASC are classified as neurodevelopmental disorders, with particularly large impact on the areas of social and communicative ability [American Psychiatric Association, 2013]. The American Psychiatric Association's DSM-5 distinguishes between ASC and more "severe" cognitive disabilities such as intellectual disability, involving significant cognitive developmental delays in many areas. Comparatively, individuals with ASC can (but do not necessarily) have normal cognitive function in most areas.

Autism consists of a range of different impairments, hence affected individuals are classified as being somewhere on the autism spectrum, as there is no one set of symptoms that can be applied to all individuals [Robinson, 2012]. However, many affected individuals do share characteristics including impaired social and communicative ability, lack of imaginative ability, which is sometimes subclassed into a lack of "Theory of Mind" [Baron-Cohen et al. 1985], and repetitive, often rigid behaviour, along with an aversion to changing their routines [The National Autistic Society].

2.2.1 Theory of Mind

Theory of Mind [Baron-Cohen et al. 1985; Leslie, 1987] is the cognitive ability to reason about the mental states of others, e.g. their beliefs, emotional states, and so on. Studies have shown that ASC individuals, particularly children, often have deficits in this area [Baron-Cohen et al. 1985; Leslie & Thaiss, 1992; Tager-Flusberg, 1999; Klin, 2000], which implies they have a tendency to only see things from their own

perspective. For example, autistic children commonly fail false belief tests, such as the one presented in figure 1.



Figure 2.1: (A common false belief task presented to children. Image source: <https://spectrumnews.org/opinion/viewpoint/1985-paper-on-the-theory-of-mind/>)

In the false belief task, autistic children are likely to answer "the box" because they have not taken into account that Sally does not know that the ball was moved, i.e. they are not seeing things from her perspective, or it might be the case that they see her perspective as being the same as their own. Baron-Cohen's study used 20 ASC children with a mean age of 11, and showed that 80% of ASC children failed the false belief test, compared to 15% of non-ASC children, including those of a similar age with Down's Syndrome [Baron-Cohen, 1985]. As of yet, while deficits in autistic individuals' Theory of Mind may be a likely reason for them failing the false belief test, currently there is no indisputable proof that this is the case; the test could be failed for many other

reasons, such as cognitive deficits in other areas such as attention. An additional study was proposed by Zaitchik in 1990 - the "false photograph" test, which is in essence a false belief test but with the added factor of the subject being told that Sally takes a photograph of the ball in the basket before leaving. This test was intended to discover deficits in other areas of cognitive reasoning, since the test now makes it logically obvious that Sally expects to find the ball in the basket (since she has a photograph of it), with the hypothesis that if children fail both the false belief and false photograph test, the reason for their failure may be due to something other than a deficit in their Theory of Mind [Zaitchik, 1990]. However, Zaitchik's study was carried out by others [Charman & Baron-Cohen, 1992; Leslie & Thaiss, 1992], who found that ASC children tended to fail the false belief test, but pass the false photograph test. Therefore, an impairment of Theory of Mind is a sound argument as to why ASC individuals perform poorly on tests that require reasoning about others' mental states. It also shows that ASC children typically have adequate cognitive resources in other areas, e.g. the logical reasoning required to pass the false photograph test. Baron-Cohen reported that autistic children can have average or above IQ [Baron-Cohen, 1985], and there are also the rare autistic "savants", those who, despite having ASC, exhibit mental capabilities far beyond that of the average neurotypical person [Treffert, 2009].

This deficit in Theory of Mind is relevant to why ASC children have difficulty comprehending figurative language such as sarcasm. By not being able to effectively see things from another's perspective, when confronted with a sarcastic statement, even when context is present, an ASC child is likely to interpret it literally [Stuart-Hamilton, 2013], i.e. think that the sarcastic statement is actually the case when in fact another meaning was intended. However, the presence of context combined with the adequate cognitive resources of ASC children in other areas [Zaitchik, 1990] may lead to them being able to derive the correct semantics from figurative language by using other, more "logical" reasoning approaches.

2.2.2 Autism and Anxiety

On average, around 40% of children and adolescents diagnosed with ASC are also diagnosed with anxiety [White et al. 2009; Kerns et al. 2014; CSESA, 2015]. Since many ASC individuals can have trouble expressing their emotions, it can be difficult to produce such diagnoses. However, some individuals (especially young children) can

exhibit “telltale” behaviours of anxiety, such as rocking back and forth, curling up into a ball, repeatedly asking questions which have already been answered, withdrawal and reluctance to participate in group activities [CSESA, 2015; Spain et al. 2017]. These social deficits can worsen over time as a “vicious cycle” of impaired social ability and heightened anxiety unfolds, each indirectly worsening the other [Factor et al. 2017]. In extreme cases, ASC children can experience "meltdowns" [Ryan, 2010], when the child becomes so distressed that they essentially have a nervous breakdown, with effects varying from wild, erratic, perhaps aggressive behaviour, to becoming completely unresponsive to most stimuli. Ryan finds that meltdowns can arise out of seemingly trivial circumstances or simple misunderstandings that an ASC child cannot correctly decode, e.g. misunderstanding a sarcastic statement.

Adverse effects of autism can also be present in those around an affected individual, for example parents of ASC children are more likely to suffer from anxiety and depression [Herring et al. 2006] as a result of the extra difficulties present not only in caring for their child, but also in socially interacting with them.

2.2.3 Social Relationships and Communication

The difficulties ASC individuals have in understanding and interacting with others can negatively impact their social lives. The impairment of a Theory of Mind implies problems with understanding the dialogue and actions of others; this along with anxiety and other language understanding issues [Tager-Flusberg, 1999] can make social interactions daunting and confusing for ASC individuals, especially children.

ASC children often struggle to make friends in school [The National Autistic Society; Jordan, 2003], and the resulting alienation only serves to worsen their issues, as they will miss out on opportunities to partake in regular dialogues, leading to poorly developed social skills, e.g. in pragmatics.

Studies have shown that even though ASC children are usually bad at forming and maintaining social relationships, this does not necessarily mean that they are not interested in such relationships, or that they have little or no emotional depth - a common misconception held e.g. by other children, sometimes even teachers or parents [The National Autistic Society; McGeer, 2009; Schriber et al. 2014]; rather, they often

find themselves unable to effectively understand and engage socially with others, e.g. through dialogue [Wetherby & Prutting, 1984; Attwood et al. 1988, Lee et al. 1994]. Another factor that contributes to ASC individuals having poor semantic understanding is that of impaired self-insight [Schriber et al. 2014], that is, the impairment of the ability to self-reflect and form internal representations of complex semantic concepts, leading to less interconnected semantic and contextual associations; put simply, an impaired ability to derive meaning from context, also referred to as weak central coherence [Jolliffe & Baron-Cohen, 1999].

ASC children usually do not initiate conversations [Hauck et al. 1995], and when initiated, conversations typically do not last very long [Tager-Flusberg & Anderson, 1991]. This can be for a number of reasons, but looking at the linguistic aspects, ASC individuals have been reported as prone to making irrelevant statements during a dialogue, repeating the same statements, talking extensively about their own perspective or about one narrow subject area, and being unable to effectively assign meaning to the dialogue spoken by others, e.g. failing to detect sarcasm [ASHA; National Autistic Society]. The weak central coherence [Jolliffe & Baron-Cohen, 1999] can lead to problems such as not knowing when it is appropriate to initiate dialogue with someone, and not knowing what is appropriate to say during that dialogue (this can also be due to executive function issues, and problems with pragmatics e.g. lack of inhibition).

These problems can lead others to perceive ASC children as being rude, insensitive or stand-offish [Ryan, 2010], decreasing the likelihood of further social interaction with them, and often excluding them from friendships and other social groups [CSESA, 2015; Sasson et al. 2017], leading to isolation and resultant impediments to social and linguistic development, and also potentially leading to loneliness and other negative emotions [Bauminger et al. 2003]; the associated problems can and often do persist into adulthood [Turner-Brown et al. 2008]. Therefore, interventional treatments can help to ensure better development of social skills, and attempt to provide a means for ASC children to get into (or back into) social groups and develop normally alongside other children.

2.3 Interventional Treatments

2.3.1 Applied Behavioural Analysis

Perhaps one of the oldest interventional treatments for autism is Applied Behavioural Analysis (ABA), in which common "socially significant" [Baer; Wolf; Risley, 1968] behaviour patterns for various social situations are instilled into subjects via a three-step process of teaching "appropriate" actions in various "antecedent-behaviour-consequence" scenarios, e.g. that if someone says hello to you, you look at them and say hello back, meaning you are letting them know you have acknowledged them and are ready to start a conversation. Subjects are encouraged to seek out good consequences through techniques such as reinforcement learning and pivotal response treatment [Tweed et al. 2009]. However, this approach can be said to be somewhat rigid in that it is restricted to handling specific situations, and therefore may not generalise well. ABA therapies can also potentially last years, as learned behaviours must become routine; this form of learned behaviour is also relatively arbitrary, and as such, it is debatable as to whether the individual has truly learned anything, or is simply re-enacting a taught habit, and if that which is learned will be successful in all variants of situations, since many such situations encountered in life are likely to vary considerably, e.g. in terms of context and complexity. Some have also argued that it is ethically questionable to "drill" behaviour patterns this way and to seek to eliminate "unacceptable" behaviours (which may actually be forms of emotional regulation for an individual, the removal of which can lead to meltdowns as a result of the individual being unable to regulate their emotions), as opposed to adopting a more socio-constructivist approach, providing contexts for those behaviours to develop naturally [Baron-Cohen, 2009]. Despite this, the ABA approach can still be useful to serve as groundwork upon which further skills may be built, at least giving ASC individuals the ability to handle those common situations, and perhaps work from there. ABA is also advantageous in that, since it is human-led, it can be more easily specialized and adapted to suit the needs of a specific child, however one could also argue that with recent advances in AI and Adaptive Learning Environments, e.g. in systems like Affective AutoTutor [D'Mello & Graesser, 2012], technology-based interventions could also be just as adaptive.

2.3.2 Technology-based Interventional Treatments

In many cases, technology-based treatments have been empirically shown to lead to improved social and communication skills for many ASC individuals [Hoque et al. 2009; Bte et al. 2010; Fletcher-Watson 2013; Grynszpan et al. 2014; Aresti- Bartolome & Garcia-Zapirain, 2014]. One example of such a technology is *Grace* [Troughton-Smith, 2010], an app to allow non-verbal people to communicate via manipulating pictures and storyboards on a smart device instead of writing things, which they may struggle with. *Grace* is an example of PECS (Picture Exchange Communication System) [speechandlanguagekids.com, 2014], a common method of teaching language skills to non-verbal children, and one which lends itself well to automation through interactable apps. The downside to such technology-led approaches is that they are usually less flexible and robust than human-led therapy, but are more controllable and predictable, and can provide a comfortable environment for ASC children to interact with, which has potential benefits for mitigating anxiety and meltdowns. However, if implemented in such a way that does not facilitate improved social and communication skills, technology-based approaches can potentially worsen an ASC individual's condition [Powell & Jordan, 1997], for example encouraging them to spend more time using the technology than interacting with other people, or perhaps providing them with incorrect or unhelpful information. Great care must be taken to ensure this does not happen, fortunately there exist well-researched guidelines on developing technologies for ASC individuals [Powell & Jordan, 1997; Howlin et al. 2009; Fletcher-Watson 2013].

Studies have shown that ASC children spend more time interacting with technology than the average typically developing child [Fletcher-Watson, 2013; Mazurek & Wenstrup, 2013; Kuo et al. 2014], and also report that many ASC children have reported finding computer games and other interactable applications intuitive and enjoyable, making it an attractive avenue to pursue when designing educational interventions. Games also provide benefits in their suitability for simulation, i.e. simulating social situations and contexts, and letting children practice skills in a more forgiving, and perhaps more comfortable environment than reality, while receiving detailed and appropriate feedback, tailored to their mistakes and level of learning, as commonly shown in adaptive learning environments such as Betty's Brain [Biswas et al. 2005]. However, the aforementioned studies also give caution that ASC children can spend

too much time using technology (in isolation), which can be detrimental to their social development - although there seems to be more rhetoric than evidence supporting this, it is still something to consider.

Rahman et al. discuss the importance of play in technological interventions for ASC children [Rahman et al. 2011], as ASC children exhibit a desire to willingly play games, as opposed to being practically forced to undergo ABA style therapies. The play aspect of games leaves control of the interaction primarily with the child, as opposed to with others. This means the child can progress through the game at their own pace, and practice skills repeatedly. It could be argued that this willingness to partake in such game-based learning is not only more ethically preferred over ABA, but could also lead to improved learning gains and social development - although currently, there is not an overall consensus that this is the case, as ABA and its variants have been around for much longer than technology-based interventions, and are generally accepted as the "go to" for interventional therapy, as opposed to more educational perspectives. However, alternatives do exist, such as SCERTS [Prizant et al. 2006], which emphasizes a more child-supportive approach and aims for "authentic progress" rather than the "forced progress" ABA emphasizes - although SCERTS does take some pointers from ABA.

It could be said that the limited evidence of benefits from technological interventions compared to ABA style approaches is one reason why such interventions are currently not used as extensively as ABA [Gillespie-Lynch et al. 2015]. It can be said that technology-based interventions have the potential to be highly effective for teaching language and social communication skills, although given the heterogeneity of results from relevant studies, it is difficult to go beyond a general notion of effectiveness, although several systematic reviews and meta-analyses have been conducted which argue for the effectiveness of such interventions [Fletcher-Watson, 2013; Grysman et al. 2014].

2.3.3 Interventions for Teaching Language and Sarcasm Comprehension

Zervogianni investigated the potential of using an educational game to help children with Asperger Syndrome to understand idioms, and showed promising results for game

technology as a means of assisting idiom comprehension [Zervogianni, 2015]. There have been ABA-style approaches to teaching sarcasm to ASC children; one study carried out by Persickle et al. involved training three ASC children to detect sarcasm through typical explicit ABA means, which were then faded over time until the children could successfully detect sarcasm alone [Persickle et al. 2012]. The study utilized multimodal approaches such as video clips and training dialogues with therapists to provide a wide range of contexts and training examples for the children to learn to detect sarcasm, showing promising results as children were able to demonstrate improved understanding of sarcasm, and an ability to respond appropriately to certain sarcastic statements. This implies that teaching these concepts can be effective, and that they may be able to be implemented technologically, e.g. in a game.

Other examples of social and language-related technology-based interventions include a study by Vellonen et al., who reported that four children with ASC who exhibited difficulties in vocal communication demonstrated improved vocal communication skills through use of a technology-enhanced learning environment, where they were able to play educational computer games and engage in PECS-type activities [Vellonen et al. 2012]. Further examples include Nikopoulos & Keenan, who reported that ASC children demonstrated enhanced ability to socially initiate with others after undergoing a video-based treatment involving role-play [Nikopoulos & Keenan, 2003]. Massaro & Alexis. reported that ASC children were quickly able to learn new vocabulary skills through use of a computer-animated tutor, and that the skills gained did not degrade over time, and the children were able to generalize what they had learned [Massaro & Alexis 2003]. Heimann et al. developed an interactive multimedia computer program, and reported that ASC children were able to increase their word reading and phonological awareness by using the program [Heimann et al. 1995]. De Leo et al. developed a smartphone app using the PECS approach to enable less verbal ASC children to communicate, and also enabled them to customize their pictures and words through a companion website [De Leo et al. 2011].

Currently, there appears to be relatively few existing interventions for teaching sarcasm to ASC children. Since other technology-based interventions for language have been quite successful, and since ABA interventions specifically for teaching sarcasm have also reported success (i.e. it can be done), it is therefore both possible and rational to design a technology-based intervention for this case, ideally in the form of a game,

due to ASC children generally responding positively to games.

2.3.4 Social Stories and Comic Strip Conversations

Social stories, developed by Carol Gray in 1991 [Gray, 1991; The National Autistic Society], are concise narrative-based descriptions of situations that one may encounter in everyday life. These situation descriptions come with information about e.g. the mental states of others involved, what behaviour would be acceptable and why, and what events or actions can possibly occur. Although the name contains the word "social", social stories can be used in a variety of ways, such as teaching life skills like cleaning one's teeth. This review focuses on the more social (linguistic) applications, such as school activities or public manners.

Social stories have been used for many years across a variety of applications, with empirically positive results for teaching ASC individuals of various ages [Gray & Garand 1993; Spencer et al. 2008; Ozdemir, 2010], although, like technology-based interventions, such results are less extensive than those for ABA, as social stories are a comparatively new approach. As a result, there have been calls for more research to determine whether and why social stories are effective or not, e.g. whether the positive results come from the stories themselves, or from some other factor [Reynhout & Carter, 2009]. These calls have been addressed through meta-analyses such as one by Foster in 2015, who noted that although there is currently limited evidence as to the effectiveness of social stories (mainly due to small n studies), they are still a noteworthy form of intervention, and one which has many applications and potentials [Foster, 2015].

Creators of social stories must all follow the same design guidelines, summarily involving gathering information about the situation to be covered, and tailoring the story's content and format to the intended audience, e.g. utilising personalized text and illustrations [Gray, 2014]. Social stories emphasize that mistakes (e.g. misunderstandings) can take place from two different, but equally valid perspectives: That of the person with autism, and that of the person or people without autism [Gray, 2015]. This is intended to encourage authors of social stories to see the situation from the autistic person's perspective, hopefully avoiding the tendency to take for granted things that an autistic person may not know or understand. Social stories are also intended to be safe

for their intended audience, i.e. eliminating or minimizing any triggers or upsetting information [Kuttler et al. 1998], while staying true to the content and purpose of the story, even if it is about a difficult situation, and making it meaningful for its audience. Gray states that social stories should aim to boost self-confidence of the audience, with at least 50% of social stories being designed to applaud personal achievements in some way, e.g. with story characters being rewarded for sharing or demonstrating resilience or compassion [Gray, 2014].

Social stories present many benefits for ASC children, such as mitigating anxiety while teaching meaningful information about social situations and interactions. A similar approach developed by Gray is that of comic strip conversations [Gray, 1994; The National Autistic Society], which are a more visually oriented form of social storytelling, commonly depicting two or more characters engaging in a conversation. Comic strip conversations can be highly intuitive to and understandable by ASC children, as such children typically exhibit a preference towards visual rather than purely linguistic stimuli, and often perform better in tasks where visual aids and stimuli are available, compared to when these are not available [Kuttler et al 1998; Bryan & Gast, 2000; Dettmer et al. 2000; Thiemann & Goldstein, 2001], and children of all ages commonly enjoy storybooks containing pictures, as well as cartoons and drawing activities. Comic strip conversations make use of thought bubbles to provide insight into what characters are thinking, which may be beneficial in getting ASC children to see an event from another's perspective. Visual representations allow for more detail and content to be placed into a situation's description, allowing ASC children to "see" situations unfold, including the characters' facial expressions and actions, which provides more context and arguably a more realistic experience for the child, compared to purely textual information.

A downside to social stories and comic strip conversations is that they can be time-consuming to create, and are usually tailored specifically to a certain child, meaning they are not quick or easy to create, and are not very "portable" or customizable once created. However, the ISISS project [Constantin, 2015] created a technology-based platform for practitioners to easily create, customize and assess social stories, and reported that practitioners commented that the system was an improvement over their current, non-technological approaches of doing so. This implies that social stories, and by extension, comic strip conversations, lend themselves well to use with technology.

2.4 Game Design and Usability for ASC Children

Previously in this review, it was stated that ASC individuals spend more time than the average person interacting with technology, and that ASC individuals particularly enjoy games. A relatively famous example of a game which is popular in the ASC community is *Minecraft*, a sandbox construction-type game in which the player is free to navigate and build in a randomly generated world. While there are no official studies as of yet discussing why this game is so popular with ASC individuals, many people have put forward their own theories, including autism experts and parents of children with autism. These theories include that there are practically no rules other than the basic rules of the game; players are free to go where they want and do what they want at their own pace, providing a sense of ease and freedom. The game is also easy to learn and get into, is quite forgiving, safe, and allows the player a great deal of control over their environment [Kulman, 2015]. This safety and the forgiving gameplay could be said to provide benefits for reducing anxiety. The game world is relatively “real” in that it is a fantasy-based explorable simulation of our world, having grass, trees, mountains, deserts, etc., as well as animals and other creatures, so players are not completely isolated, and the world feels alive. There is also the option to play online with others should one wish; there are specific communities dedicated to the purpose of providing a safe and fun atmosphere for ASC children (and adults) to play *Minecraft* together, an example being the "Autcraft" server (see <http://www.autcraft.com/>).

A 2014 review by Zakari et al. discusses the effectiveness of “serious games” for teaching ASC children various skills, finding that such games are highly effective in some areas, mainly social and communication skills, whereas there has been less reported success in areas such as improving imaginative play [Zakari et al. 2014]. This gives reinforcement to the idea of creating a game for teaching linguistic social skills (sarcasm), as it can be expected to have a positive effect if designed well. Zakari et al.’s review states that while games can be highly effective, one must also be wary of certain unintended “pitfalls”, such as an example of ASC children deliberately selecting wrong answers because they liked the error sound produced upon doing so. Zakari et al. suggest including a customization mechanism for parents and teachers, e.g. the ability to turn off certain sounds, to mitigate any such unintentional pitfalls which may be hard to predict at design time. The review also states that ASC children tend to exhibit a preference for playing in the “first person”, that is, not controlling an arbitrary

character, rather playing “as themselves”, or selecting a character whose traits align closely with their real selves.

Varnagy-Toth highlights the importance of stability and predictability for ASC children playing games [Varnagy-Toth, 2015]. This implies that the software absolutely should not crash or react in unexpected ways, although one might say that this should be a given for any released product. However, even in cases where the software is working as intended, Varnagy-Toth states: “If [ASC children] try to do something and fail, they just try the same thing again – and again and again.” This implies that it must be clear at all times what is happening on the interface, and why, although this must be presented in a way that does not lead to information overload, and in a way that does not lead to infinite loops, i.e. problems must be resolved eventually.

2.5 Adaptive Learning Environments

Since this review has been focusing on educational and technological interventions, it is sensible to review examples from the field of Intelligent Tutoring Systems (ITSs), also known as Adaptive Learning Environments (ALEs). While these are not all games, they can still provide useful insights into how software is used to teach and adapt to a learner’s behaviour. For example, Biswas et al. conducted a study using their ITS, “Betty’s Brain”, uncovering problems such as the tendency for some students to “game the system” [Biswas et al. 2005]. Gaming the system basically involves using some exploit to progress through a task in a way that was not intended by the developers. For example, in the first version of Betty’s Brain, it was possible for students to spam-click the help function, causing the system to reveal the answer; the system was working as intended, but students found a way to exploit it to avoid doing real work. To remedy this, Biswas et al updated Betty’s Brain to no longer explicitly reveal the answer, as well as adding system feedback such as recommending resources to look at, or actions to try [Kinnebrew et al. 2013].

An example of an ALE that is a game is Crystal Island [Rowe et al. 2009, 2011], in which players take control of a character and explore a virtual world, carrying out an investigation in a narrative-based environment, and learning along the way. Rowe et al.’s study focused on learner engagement, that is, the degree to which players are “engaged” with learning in the game, and not exhibiting disengaged behaviour such as

off-task actions. Rowe et al. state that games are inherently advantageous for engagement, as they can provide a sense of presence and immersion which may be lacking in other forms of media. However, they also give warning against taking the “game” aspect too far and introducing seductive details [Harp & Mayer, 1998]: things that, while perhaps being interesting or otherwise pleasing, do not contribute anything to a learning experience, and may lead to disengagement from learning. For example, Rowe et al. discovered that students would frequently become distracted by moveable physics items, choosing to play around with them instead of progressing the game’s story [Rowe et al. 2011].

With regard to feedback, some ALEs give immediate feedback upon detecting errors in students’ reasoning, such as Andes [Gertner & Van Lehn, 2000], whereas others guide students towards correct reasoning by assisting them in detecting and fixing their own errors, such as AutoTutor [D’Mello & Graesser, 2012]. Tan & Biswas investigated the role of feedback in ALEs, specifically in learning-by-teaching environments, finding that both immediate and guided feedback have their uses, and can be used together in a system, although which one has more focus is dependent on the system’s content and its learners [Tan & Biswas, 2006]. Roll et al. conducted a study on help in ITSs [Roll et al. 2011], stating that students typically do not make satisfactory use of any on-demand help resources most ITSs come with, tending to either over or under-use them [Roll et al. 2011]. With regard to ASC children, since there is currently no literature discussing their use of help-seeking features in ITSs specifically, one could speculate that they might fall into either the over or under-use categories, perhaps forming routines of doing so, e.g. by asking for help once, they may think that that is the “correct” thing to do in every case. One study by Bergstrom et al. states that ASC children may not develop help-seeking behaviour at all unless given explicit instruction [Bergstrom et al. 2012]. However, since ASC children react positively to games and technological interventions, it could be theorized that they may actually be more willing to seek help in such an environment, since it may be more comfortable for them to do so there than in real life.

2.6 Summary

ASC children can be said to be possess a variety of social communication and linguistic understanding issues, which can potentially have negative effects such as social

isolation and increased anxiety. The most widely accepted reasoning as to why such difficulties are present is that ASC individuals suffer from an impairment of Theory of Mind, that is, the inability to understand other people's perspectives, beliefs, desires, and intentions.

Interventions for such deficits have existed for many years, perhaps one of the oldest and still widely used being ABA therapy. This research moves away from traditional approaches such as this and aims to follow a more child-supportive approach, scaffolding their journey through a game world and their resultant understanding of sarcasm, and including context for situations such that they can be effectively generalized.

In any case, the literature shows clear benefits to individualized treatments, something ABA does well; while this will be more difficult in a software-based approach, there do exist techniques from the field of adaptive learning environments which can potentially be applied to such software to produce a more tailored and adaptive treatment.

Social stories and comic strip conversations are tested methods of teaching social and pragmatic skills, and seem to lend themselves well to "gamification", and in fact this has already been done [Touch Autism, 2012], being reported effective due to combining the ASC-related benefits of games and the highly visual aspects of social stories and comic strip conversations. Therefore, it seemed wise to adopt a similar approach when developing such games.

A strong focus on visual aspects was of importance, in order to provide an effective means of learning for ASC children. This includes things like animated characters, backgrounds, and generally an interesting and intuitive visual interface.

From reviewing game design and usability with respect to ASC children, it can be said that ideally, any game produced for them should aim to be safe, forgiving, flexible, personalized, intuitive, accessible, learnable, predictable and controllable. While it may not be practically possible to completely include all of these factors in the game (due to the teaching-based proof-of-concept nature of the game), the game will draw upon them where it is feasible to do so. It is also sensible to allow customization of

features for parents and teachers, perhaps also to an extent allowing the ASC child themselves to alter certain aspects of the game if it is discovered at “play time” that certain things are a hindrance to game progression and learning. Games are inherently advantageous because they allow players to progress at their own pace, on their terms, which ASC children will likely find beneficial for their learning.

Adaptive Learning Environments (ALEs) give some useful insights into various issues and mitigations present when designing educational software, for example gaming the system, learner engagement, feedback, and help-seeking behaviour.

Overall, based on reviewing the literature, a game was chosen as the most appropriate means of intervention in this case.

3. Methodology

Here, it was decided to follow an iterative prototype-based approach, starting from initial requirements gathering and background research; from this constructing a first prototype version of the game which was evaluated in the form of expert interviews and participatory design [Kortbeek, 2014] with typically developing (TD) children, the results of which were fed back and used to develop subsequent versions. The evaluation and feedback process was repeated until a final version was evaluated by TD children.

Scaife and Rogers write that, at the outset, it is important to gain a thorough understanding of what will be constructed and why [Scaife & Rogers, 2001], as making large changes to the overall design after coding has begun can be very time consuming. To this end, a literature review (above) was conducted, in order for the researcher to gain a relatively thorough understanding (at least, in terms of breadth) of the myriad concepts associated with teaching an understanding of sarcasm to ASC children, as well as what existing interventions had been conducted, specifically those related to technology, and what their effects (if any) were, and how all of this could be used to inform the design of the prototype game.

In addition to this, Scaife and Rogers state that one must identify the target user group and involve them in the design [Scaife & Rogers, 2001], and so a design workshop was conducted with TD children, who acted as proxies for the real target user group of ASC children. This enabled an understanding to be derived (by the researcher) of how TD children comprehend sarcasm, as well as what sort of game they would find effective in teaching it. It was necessary to use proxies here, as ASC children could not participate in the workshop in this case due to the medical and ethical considerations of doing so, and due to the fact that this project serves as a proof of concept rather than a “true” psychological study. Knowledge gained from reviewing the literature, as well as the results from the workshop, was used to inform the design

of the first version of the game.

During the design workshop (see chapter 5), it was noted that one participant seemed to have many ideas for the game, and was quite interested in talking about them. Due to this, a further participatory design session was conducted with that participant, this time as an equal co-designer rather than a design informant (as was the case in the design workshop). Participatory design was deemed appropriate in this case as it would be with one participant only, which naturally lends itself well to one-on-one co-design sessions where the researcher and participant create and refine ideas and designs together. The co-design approach was also beneficial in terms of enabling the researcher to go beyond vague, high-level concepts (such as those obtained in the design workshop) towards lower-level, more concrete designs that were fully grounded in the participant's mindset. Participatory design also allows designers to gain a deeper understanding of users' tacit knowledge [Björgvinsson et al. 2012], by getting them to think about how to actually "solidify" vague concepts into something more tangible, e.g. by mocking up a user interface.

Once the initial prototype of the game had been created, experts in the fields of autism, speech and language therapy, game design, and usability played the prototype and were then semi-structured interviewed [Martin & Hanington 2012, chapter 48] about the experience, as well as contributing general ideas and feedback. The results from these interviews were fed into the first official version of the game. Some experts were interviewed again with subsequent versions of the game.

The game was evaluated by TD children (as proxies for ASC children), who participated in a "pseudo" think-aloud protocol (see chapter 8.3.1) [Nielsen, 2012], semi-structured interview, and answered a SUS questionnaire [Brooke, 1996], modified to suit the younger participants. The evaluations mainly focused on assessing usability, engagement and effectiveness in teaching an understanding of sarcasm, bearing in mind the intended users.

Summarily, the overall structure of the methodology was as follows:

- 1. Generate high-level requirements**

- (a) Theoretical background
- (b) Existing interventions
- (c) Guidelines for developing technological interventions for ASC children

2. Design workshop to generate more specific requirements and ideas

3. Design and develop first version of the game

- (a) Review and consolidate results from previous steps
- (b) Generate concrete high-level requirements
- (c) Design and build initial prototype of the game

4. Expert interviews and participatory design sessions

- (a) Conduct participatory design session with individual participant
- (b) Interview experts and get their feedback on the current version of the game
- (c) Feed results from previous two steps back into next version of the game, repeat as many times as is feasible in the project's duration

5. Final Evaluation

- (a) Conduct think-aloud protocol and semi-structured interview with TD children, and get them to complete modified SUS questionnaire

4. High Level Requirements

Scaife and Rogers write that several factors need to be taken into account before development of an educational virtual environment can begin. These include “*the activity being supported, the experience and characteristics of the user group, the appropriateness of the interaction styles*” [Scaife & Rogers, 2001]. Therefore, prior to obtaining specific requirements from design workshops and interviews (e.g. specific functional and non-functional requirements), it was deemed sensible to generate high level requirements in order to get an accurate understanding of what would be developed, and why. The following high level requirements were created as a result of reviewing relevant literature.

4.1 Context of Use

Following Scaife and Rogers’ criteria, and going by usability.gov’s user centered design basics [usability.gov], the first stage in generating high level requirements is to specify the context in which the system will be used. That is: who will be using it, what will they be doing, and under what conditions will this take place?

4.2 User Group Specification

The intended users of the system were high-functioning ASC children of reading age, that is, approximately ages 7 and up. It was necessary to assume reading ability since pre-reading age children are unlikely to be able to understand most figurative language [Naylor & Van Herwegen, 2012], and would probably need constant adult assistance and supervision to operate and progress through the game, and would also be unlikely to understand all of its content. This age range was selected as it is during this time that childrens’ understanding of figurative language begins to properly develop [Demorest et al. 1983], and so it was sensible to target this age range to assist in this development.

Technically there was no upper limit on the age range of users, although older users, say teenagers, may find a game targeted at children to be somewhat immature for them. Summarily, it can be said that the target users were roughly middle to late primary school age high-functioning ASC children (around 7 to 11 years old). It was also assumed that the target users would not have significant intellectual disability in language production and understanding, i.e. significantly below that of the average high-functioning ASC child of the target age range. For the purposes of this study, it was assumed that "low-functioning" ASC means that the child has a mental age of several years below their actual age, or has an IQ of less than 70, and requires substantial adult support to carry out day-to-day activities [American Psychiatric Association, 2013].

While this description specifies the intended audience for the game, it should be noted that the game was designed to be extensible and customizable by other developers, and so it is reasonable to say that other versions could be created and customized to better suit other target populations, such as low-functioning ASC children, or older individuals with ASC (e.g. adolescents).

4.2.1 Task Specification

Players would use the mouse and keyboard (or an on-screen equivalent e.g. touch interface or virtual keyboard) to interact with the game. Tasks would include clicking different kinds of buttons, reading on-screen text, and looking at on-screen visuals such as characters and backgrounds. The child would need to select the appropriate option when they believe they have detected sarcasm, as well as selecting the option corresponding to the correct reasoning as to why it is sarcasm, as well as one corresponding to the correct response to that sarcastic statement.

4.2.2 Environmental Specification

The program would most likely be used either at school, e.g. in a computer lab or library, or at home on a personal computer or other personal device such as a tablet. The school environment is potentially loud and distracting, e.g. if there are other classroom activities going on at the same time at which the game is being used, however it was assumed that there would likely be teachers and assistants available to help the child

operate the game and progress through it should they become stuck. The home environment would likely have less distractions, although there may be less human help available, e.g. if a child's parents are occupied with household tasks.

4.3 Initial Design Decisions

It was necessary to bear in mind that this game was intended to be a proof-of-concept, that is, not a completely finished, polished and ASC-evaluated product. Therefore, while it may have been preferable to include certain features, ultimately it was necessary to prioritise some features at the expense of others, and focus on implementing the core aspects of the game. For example, while it may be useful to enable players to speak to characters in-game, e.g. through text or voice, this would require complex natural language understanding approaches which are beyond the scope of this research; therefore it was decided to restrict players' interactions with characters to pre-defined choices. Adding multiple language support was also considered, since the linguistic structure and semantics of sarcasm are likely to be similar between languages, however this would require professional translation, which again, was beyond the scope of this research, and will therefore be considered as future work.

4.3.1 Graphics

Going by Ruiz's three elements of detecting sarcasm [Ruiz, 2012]: context, facial expressions, and voice tone, it was decided that whilst the game should ideally have means for presenting all three when appropriate, the third element would necessitate voice actors, which could be overly costly and time-consuming for this proof-of-concept game. Social stories and comic strip conversations lend themselves well to this form of "textual" presentation, with graphically presented contextual information and characters speaking in a dialogue, so it was sensible to follow a similar visual approach when designing the game. Since ASC children are highly visual learners, the game needed to present this visual information clearly, without crowding the screen with information and overwhelming players. To accommodate this, 2D cartoon-style graphics were selected as most appropriate in this case, fitting with the comic book aesthetic, and enabling simple information to be presented in an interesting manner.

4.3.2 Dialogue

There are many possible ways of expressing sarcasm, some more obvious than others. While definitions exist - google defines it as "the use of irony to mock or convey contempt" - that still does not give a full picture of the myriad possibilities sarcasm offers in terms of conveying emotions, thoughts, opinions, and so on. Little information was found detailing possible classifications of sarcasm (the only example found being a somewhat arbitrary classification found on a writer's blog [Lamb, 2010]), and as such, a somewhat ad hoc classification was created for the purposes of this research, as follows: it was decided that the dialogues and sarcastic statements themselves should ideally range in difficulty from being obvious, e.g. a character saying "phew, it's hot today!" while it is snowing outside, to less obvious, e.g. "Bill's going to love this cup", which may require knowing that, since the cup is blue, and Bill's least favourite colour is blue, he will not actually love the cup. This gave rise to two main categories of sarcastic statements for inclusion: those that can be detected from the immediate context (e.g. the first example), and those that require further knowledge and reasoning outside of the immediate context (e.g. the second example). It was decided not to include examples that require long and complex chains of reasoning, as this was not the point of the game, as it relies more on other cognitive resources (e.g. memory) which are not fully relevant in this case. The sarcastic statements were selected to not make use of complex wordplay, or require overly subtle inferences, since these may be hard to detect even for an adult. In short, the dialogues and contexts were intended to be simple and relevant to a child's everyday life, while still providing somewhat of a challenge; not all sarcastic statements that children encounter in their real lives will be obvious, and so these slightly more complex examples must also be learned.

The frequency of sarcastic statements occurring was also taken into account; sarcasm occurs relatively infrequently in everyday language [Gibbs, 2000], but the point of the game is to teach an understanding of sarcasm, which requires setting up contexts and dialogues in which sarcasm takes place. It was thus necessary to strike a balance between "realism" and learning in this regard; in a realistic dialogue, people usually do not constantly use well-telegraphed sarcasm (unless perhaps one regularly engages in informal dialogues with friends or family who are all highly sarcastic, but this can not be assumed for everyone), but in the game, there needed to be sufficient occurrences such that learning and practice could take place, without making too many statements

sarcastic, as players could potentially get used to unrealistically high occurrences of sarcasm.

The inclusion of thought bubbles (as in comic strip conversations) was considered, as one could argue that on one hand, they may help to give more insight on others' perspectives, and assist in the users' deficits in Theory of Mind, but on the other hand, they are not entirely realistic and may detract from the actual dialogue. Therefore, this factor was left to be elicited from design workshops and interviews.

4.3.3 General Appropriateness for Target Users

The game needed to be age appropriate. That is, not contain any advanced or archaic language or concepts beyond what a typical primary school child would understand, nor any vulgar or offensive language. The controls and game mechanics needed to be simple and intuitive enough for a child to use effectively on their own. The game needed to communicate its current status, as well as relevant information such as dialogue in a clear, easy-to-understand manner.

In addition to this, it was necessary for the game to be ASC appropriate. That is, it needed to promote a feeling of safety and control, and reduce unexpected events, but not to the point of players being omniscient or omnipotent - the game would simulate reality and respond to players appropriately, so there would inevitably be things in-game that are beyond the player's control, such as what other characters say, although these "external" things were aimed to not be distressing or otherwise unpleasant for the player. A game setting naturally allows players to progress at their own pace, as they are in control of the interaction. This seemed beneficial as it may be less anxiety-inducing than a real conversation, and also allows more time for reasoning, since players do not have to respond straight away, and can be scaffolded in choosing their responses.

Since ASC children are likely to make mistakes, the game needed to be forgiving enough to accommodate this, while still not letting them game the system, i.e. there needed to be some form of mild penalty for getting things wrong, so that players cannot e.g. randomly select answers until they happen to get the right one. Any mistakes made should be clearly identified as mistakes, with appropriate reasoning and feedback

given.

Allowing users to edit the game's settings, e.g. sound levels and font size, would enable at least superficial customization for individual players, and would enable the switching on or off (by adults) of certain features that may end up serving as distractions, and which cannot be predicted at design time. In a similar regard, it was deemed desirable to achieve superficial learner personalization through simple tricks such as getting players to enter their name, and then having the system refer to players by name, which can persist between sessions through saving and loading data.

4.3.4 Gameplay

The gameplay aspect was mainly left to be elicited from the design workshop, although with regard to the research goals of teaching ASC children to detect, reason about, and respond to sarcasm, it seemed appropriate to envision a dialogue-based game enabling simulated social interactions with various characters, where those three aforementioned skills (detect, reason, respond) can be practiced. In this regard, there would need to be room for players to explore consequences of and alternatives to certain choices in-game, e.g. seeing the effect, good or bad, of their response to a sarcastic statement, along with reasoning as to why that effect occurred.

There needed to be adequate incentive for ASC children to play the game to begin with, and to maintain their interest and engagement throughout. Since social stories and comic strip conversations make use of narratives, the presence of an interesting, but not overly complex narrative seemed beneficial for promoting learner engagement [Rowe et al. 2011]. It seemed appropriate to follow an "episodical" format for dialogue interactions, i.e. instead of arbitrary and disjointed examples of sarcasm, it made sense to form a coherent narrative, while still breaking interactions down into episodes or chunks that could be reviewed.

4.3.5 Deployment Platforms

As there exist numerous different digital platforms which children commonly interact with, it was decided to develop the game in such a way that it is not restricted to one platform only, and could be ported to others with relative ease by other developers.

4.4 Summary

A 2D comic book style narrative game was chosen as the best initial design. It is important to note that the design was not simply a digital social story or comic book conversation, rather it took inspiration from them, as well as from ASC, game design and other relevant researched literature. Social stories and comic book conversations are relatively static, whereas the game was intended to be dynamic and responsive to users, e.g. through their dialogue choices.

Several questions remained, such as whether it was appropriate to include thought bubbles in dialogues, and how the game's difficulty could adapt (or be manually changed) appropriately to the player. Another question was how to make the game effective in teaching, while also being engaging for players (in fact, these goals were complementary). These questions were left to be elicited from the design workshop, interviews, and further evaluations.

5. Initial User Research

To further inform the initial design of the game, a design workshop with typically developing (TD) children was conducted. This was deemed beneficial as by actively involving users in the design process early on, it becomes possible to "design with" rather than "design for" [Scaife et al. 1997], and to gain a better understanding of users, their characteristics, ideas, and so on [Kortbeek, 2014]. This was especially useful for this project, as the target users (children) were somewhat distant from the researcher in many aspects, and it can be difficult for children to voice their opinions to adults, so gaining this understanding was highly necessary. Put succinctly, a common usability saying is (some form of): "You are not your users" [Norman, 1988].

5.1 Design Workshop

One aim of this workshop was to gain an understanding of how TD children detect, reason about, and respond to sarcasm, and whether they had any particular difficulties in doing so. It was necessary to gain this understanding, as if it were to be discovered that TD children do not have a good grasp of the concept of sarcasm, then the game's teaching strategy would need to be altered to accommodate this, i.e. it could not simply dive into examples of sarcasm without first explaining in detail what sarcasm is, and somehow ensuring that the taught material has been absorbed and understood.

Another aim was to collect ideas and gain an understanding of how children envision a design for a game to teach sarcasm, e.g. what players do in the game, and how this teaches an understanding of sarcasm. To this end, the researcher posed questions to participants, and discussed ideas with them as a group. Scaife and Rogers write that in these early requirements gathering stages, qualitative feedback is preferred, and only a small number of participants are necessary, as the user research sessions are more about generating and refining ideas and conceptualizations, rather than e.g. elic-

iting user characteristics in some form or finding patterns [Scaife & Rogers 2001].

Before the workshop was carried out, an ethics proposal was submitted and accepted as per the University of Edinburgh's regulations. The researcher also underwent a Basic Disclosure Scotland check, meaning that he had no criminal record and was allowed to work with children. Participants and their parents/guardians were given information sheets and gave informed consent for the child to participate in the study and be audio recorded, and have pictures taken. These sheets can be seen in appendix A.1.

5.1.1 Participants

Participants were three school children from the ages of 7 to 9. Two participants were male, one female. The only screening criterion was that participants fall into the age range of 7 to 11, as average and above reading ability must be assumed, i.e. the ability to read reasonably well alone, or at least with only minimal assistance. Participants were also intended to not be "too old" to be considered a child, e.g. a teenager.

1. D1: Age 9, male.
2. D2: Age 7, male.
3. D3: Age 9, female.

5.1.2 Materials

Stationery supplies were available for participants to use; each had access to pencils, pens, paper, highlighters, crayons, sticky notes, glue sticks, safety scissors and sellotape. An audio recorder was used to record the session, and photographs of participants' drawings were taken. Cartoon storyboards were presented on A4 paper, and contained appropriately detailed context and character facial expressions (such that sarcasm could be detected). An example of a game poster was also presented on A4 paper. A large flipchart was used to temporarily hold drawings/sketches and writings.

5.1.3 Design

Since this was an exploratory study, not an experiment, there were no independent or dependent variables; no evaluation was being done, this was simply a workshop to

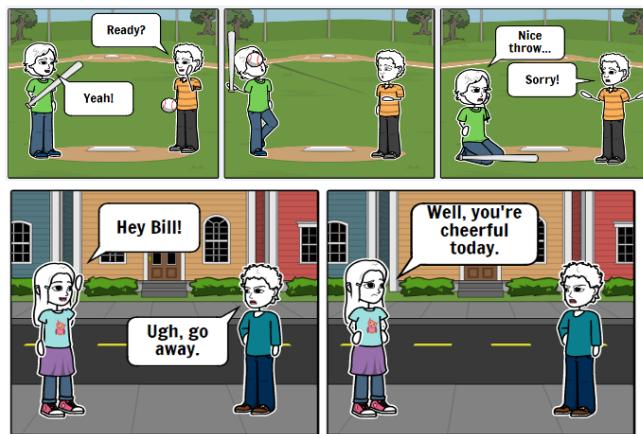


Figure 5.1: Examples of comics presented to participants. The comics were created using the storyboard generator at <https://www.storyboardthat.com/storyboard-creator>

elicit ideas and gain a general understanding of how the participants understand the problem at hand.

5.1.4 Procedure

The session lasted 30 minutes. The researcher and assistant took photos throughout, mainly of the participants' drawings and the group drawings, e.g. the brainstorm, and also a few of the participants themselves working. The activities were intended to be done in pairs, however, since there were only three participants, an adult assistant was enlisted to be the partner of the youngest participant. The assistant was instructed to mainly be a support for the participant and not to "help too much", as they themselves may find the activities quite easy. The assistant did not directly contribute any answers.

5.1.4.1 Phase 1 – Introduction (5-10 mins)

Participants were brought into a meeting-style room and seated around a table. Once they were all seated, the researcher stated that he was switching the audio recorder on, did so, and then directed their attention to the flipchart, with a fresh brainstorm containing the word "sarcasm". He gave participants A4 paper, and asked them, in pairs, to write a list of words, phrases or examples that they felt were associated with sarcasm, initially prompting them to think about examples of sarcasm, or definitions, or reasons for using it. Some initial prompting questions included e.g.:

"What situations might you find sarcasm in?"

"Who would you use sarcasm with?"

After a few minutes of participants working in pairs, the researcher called their attention, and asked them to contribute their ideas by alternating between each pair and asking them "tell us (the group) something about sarcasm", until no pairs had anything left to say. If participants struggled to come up with a response, the researcher might prompt them with e.g. "Would you use sarcasm with a teacher?", and follow up with a resulting discussion.

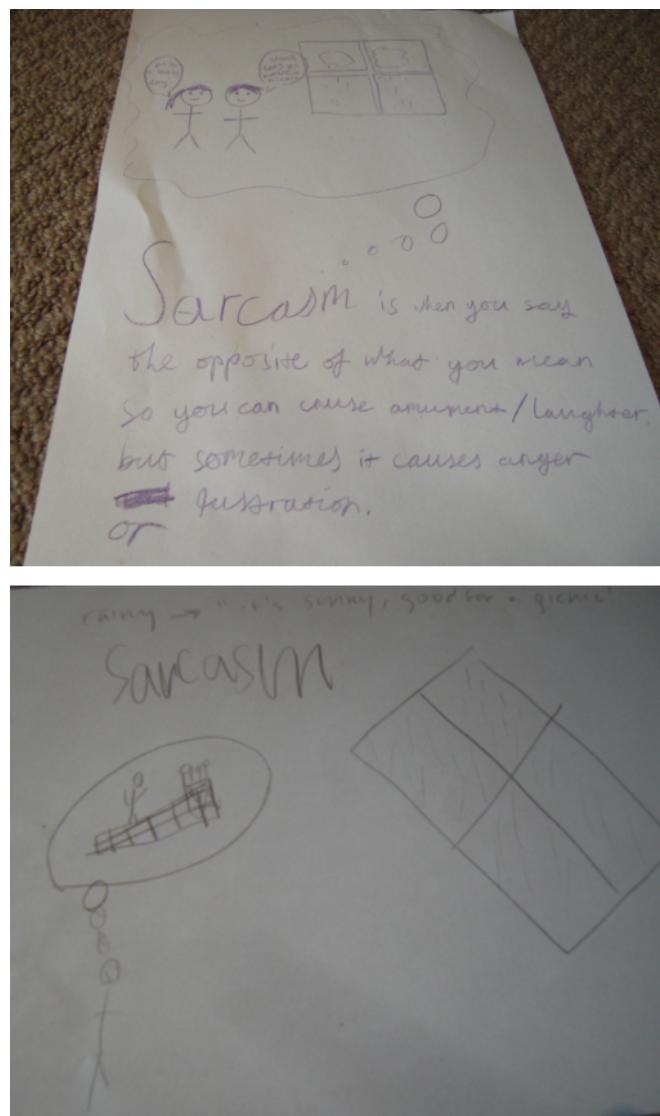


Figure 5.2: The participants' drawings of their definitions of sarcasm.

These answers were written on the brainstorm, so that participants were clear on what sarcasm was, and had such information to refer to throughout the session.

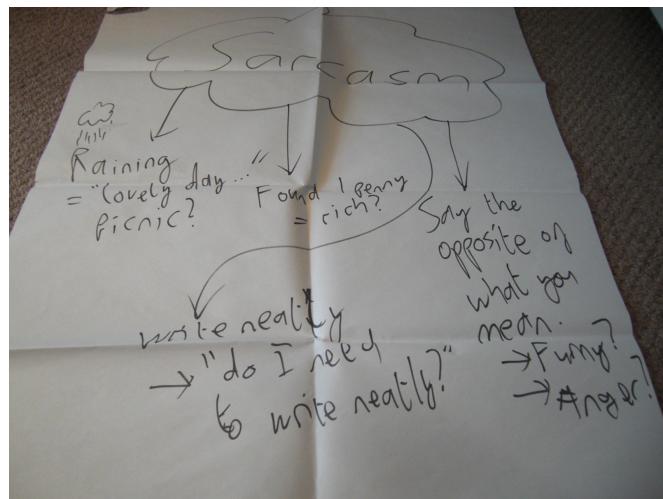


Figure 5.3: The brainstorm that was jointly created by the participants.

5.1.4.2 Phase 2 – More about Sarcasm (10-15 mins)

The researcher then gave each pair of participants some simple cartoon-style storyboards on A4 paper detailing various situations where one or more of the characters possibly used sarcasm, and asked the participants, again in pairs, to see if they could identify any sarcastic statements by circling them. The researcher told participants to look at the context of the storyboard, as well as the facial expressions of the characters, in addition to the dialogue itself. The storyboards were also present on a large flipchart, for group annotation purposes later.

When the participants were all finished, or after a few minutes if participants had not finished, the researcher called their attention to the larger storyboards, and again alternated between pairs, asking them to identify the statement(s) in a storyboard. When participants correctly identified a sarcastic statement, the researcher circled it on the larger storyboard. The researcher then asked that pair why they thought it was sarcastic, and wrote brief notes next to each circled statement. If the pair struggled to come up with reasoning, or if their reasoning was vague, the researcher would prompt them to think about how the characters might be feeling in the current situation. If no participants could correctly identify a sarcastic statement in a storyboard, the researcher would tell them the correct answer, and get them to think about and say why that was

the case. The researcher also explained incorrect answers, i.e. why a statement was not sarcastic when participants thought it was.

5.1.4.3 Phase 3 – Design a Poster (15-20 mins)

Participants were given access to stationary supplies, and told that now, they were going to come up with an idea to turn "teaching sarcasm" into a game, bearing in mind all the discussion and notes on the board so far. They were told that the game is supposed to teach children around their age with special educational needs how to detect, understand (i.e. reason about), and respond to sarcasm in social situations.

Participants were told that the name of the game could be "Sarcasm Stories" or "Sarcasm Quest", although they were free to come up with another name if they wished. They worked in pairs to create a poster design to serve as an advert for this game. They were shown an example of what one such advert could potentially look like. They were told essentially to put the core concepts on the poster, drawing the visual aspects of the game, as well as to think about and briefly write about how it would be played, what features it has and how it would teach an understanding of sarcasm.

During this time, the participants were mainly left to their own devices while the researcher observed and answered any questions. If it was clear that participants were struggling to make progress, or having a time-consuming disagreement in their pair, the researcher would step in and try to resolve the situation.

After around 10 minutes of design time, participants were asked to briefly present their ideas, explaining how their design meets the initial requirements. The researcher actively engaged in discussion with them, asking clarifying questions and making suggestions, receiving participant feedback on them.

5.1.4.4 Wrap-up

Once the session was completed, the researcher signaled the end of the session by thanking the participants and switching the audio recorder off. He then presented participants with participation certificates, which can be seen in appendix A.3.

5.1.5 Results

All participants demonstrated at least a reasonable understanding of what sarcasm is, and were able to come up with various sensible and valid examples. Both pairs of participants actually came up with the same example: a scenario in which it was raining outside, and one character said to another that it was a nice day and that they should go outside for a picnic. Other scenarios included a character finding a penny and stating that they were rich, and an example of a situation where a teacher lectured a student about the student needing to improve their handwriting, which prompts the student to respond "so do I need to improve my handwriting?", i.e. a pointless statement which is intended to aggravate. Participants demonstrated a reasonable breadth of imagination in coming up with examples of sarcastic situations.

D1 and D3 provided a very good definition of sarcasm, stating that it was when someone says something but means the opposite, which can be for humorous or offensive reasons; specifically, D1 and D3 came up with the following definition: "*Sarcasm is when you say the opposite of what you mean so you can cause amusement or laughter but sometimes it causes anger or frustration.*". D2 came up with a similar but less detailed definition.

All participants were able to detect most of the sarcastic statements in the storyboards and reason about why that statement was sarcastic, although sometimes they had difficulty articulating their reasoning and needed to be prompted. Their reasoning included the context of the storyboard, and the facial expressions of the characters, as well as the dialogue itself. Although they were able to correctly identify most of the sarcastic statements, it took them some time to do so, and generated debate and discussion within each pair as to whether a statement was sarcastic or not. The sarcastic statements that were not identified required a higher level of reasoning than the easier ones which were identified. The unidentified sarcastic statements were then revealed by the researcher. D1 and D3 commented that they were not sure whether the statements were sarcastic or not (instead of a definite "no"), but said that it made sense after it was explained by the researcher. It was noted by the researcher that participants responded positively to the comic strips and found them amusing.

D2 and D3 struggled to come up with ideas for the game. D1 came up with the

idea of an "RPG" (role-playing game) style game in which a player can walk around an environment and talk to NPCs (non-player characters), getting "sarcasm points" if they were able to correctly detect sarcasm as spoken by the NPCs, and losing points if they were not able to detect it. D1 also mentioned having a "party" (friendly group) of NPCs with which to practice sarcasm with no penalties or gains before trying it on other NPCs for points. D1 stated that the incentive for getting points was that they can be used by the player to level up their character in terms of other attributes, like attack power, which implied a combat system with the usual RPG staple of "experience points" being replaced with "sarcasm points". D1 mentioned that there could be different interactable NPCs in the world, who have different characteristics, e.g. some may use sarcasm often, while some may use it rarely, and others not at all.

D2 had a similar idea, which basically involved walking around a world and engaging in dialogues with NPCs, detecting their sarcastic statements. D3 was unable to come up with anything substantial, even when prompted.

5.1.6 Discussion

It can be said that TD children have a good grasp on what sarcasm is, i.e. the ability to give definitions and examples. However, the literature showed that ASC children are less likely to have as good a grasp. In any case, it could be said that merely knowing what sarcasm is is not necessarily enough to be able to detect and reason about it; participants were able to successfully detect most of the sarcastic statements in the storyboards, but it took some time, and not all statements were correctly identified. This implies that the detection and reasoning process may be an area of difficulty for TD children, and likely moreso for ASC children, especially in cases where it is not immediately obvious that a statement is sarcastic. However, the participants did agree that the previously unidentified statements were in fact sarcastic after an explanation from the researcher, and so it could be said that, should a similar situation be encountered in-game, as long as an explanation is given, ASC children could potentially learn from their mistakes in this case.

Since participants were able to correctly identify most of the sarcastic statements from context and facial expressions alone, this implied that voice tone is not always necessary to detect sarcasm, although participants did agree that it could help.

The participants' positive response to the comic strips implied that this may be a good format for the game itself to adhere to.

The fact that two participants struggled to come up with ideas for the game was possibly due to the fact that they were quite fatigued by that point, having done two other design workshop sessions immediately prior, and also because they may not have fully understood what was asked of them. It may be beneficial to come up with a simpler exercise for future workshops, such as participants creating their own storyboards, as the brief of coming up with a game poster is quite broad and vague.

The ideas which were presented mainly involved players participating in dialogues and detecting sarcasm, with associated rewards and penalties for doing so (or not). The participant who commented the most detailed idea seemed to be starting from a pre-existing idea of an RPG-based game, and then attaching sarcasm-related mechanics to it. Since the game was intended to primarily focus on teaching sarcasm and not other aspects such as RPG-style gameplay, things such as combat did not seem to be a sensible choice in this case, as arguably they would detract from the "teaching" part. However, two participants came up with a similar reward and penalty system, which lends itself well to mitigating players gaming the system, as they would be penalized for doing so through losing points, perhaps reaching a threshold and losing the game.

5.2 Summary

Based on the results from the design workshop, TD children can be said to have a relatively good grasp on what sarcasm is, and seem to be able to intuitively understand it, being able to detect it in most cases, but occasionally needing help when reasoning about it. When prompted, they were able to exhibit correct understanding and reasoning capabilities, and so if a game also prompted them similarly, the same effects could be produced. If trained through many examples of detection and reasoning, it is likely that children would become better at detecting and reasoning about sarcasm, as they commented that explanations given by the researcher made sense.

At this point, enough information was present to enable development of a first prototype version of the game. The RPG style was clearly preferred by the participants, and it seemed to make sense in the game's context, which was mainly exploration and

conversation-based. Combat mechanics were considered, but ultimately their inclusion was left to be discussed in future expert interviews, as there was not enough evidence that including such mechanics would benefit players' learning in any way.

6. First Game Prototype

6.1 Unity Game Engine

The game engine of choice for development was Unity engine [Unity], as it provides a free means of creating a highly portable (i.e. multiple platform support) game, as well as easily enabling the game's source code to be modified and extended. This was beneficial, as others, e.g. educators, may wish to customize and improve upon the game after it is released, and also enables the game to be accessible to a wide audience, lending itself to touchscreen as well as regular desktop PC deployment.

6.2 RPG Maker

To support the creation of non-rudimentary graphics outside of Microsoft Paint, RPG Maker's sprite and faceset editor [Enterbrain] were used. This was done to enable the researcher to quickly and effectively create good graphics in a certain style and format which lends itself well to the gameplay and desired aesthetics at hand.

RPG Maker was also considered as a possible development environment instead of Unity, but was ultimately not chosen as RPG Maker games can only run on a limited set of platforms, and have comparatively less developer power and available functionality compared to Unity games. RPG Maker games do not lend themselves well to modelling players in the educational manner that was intended, and arguably the games would not easily be modifiable and extensible by others, as a paid license is required to develop with the software - this was owned by the researcher, but it was somewhat unreasonable to assume that others would pay for this license.

6.3 Overview of the First Prototype

Based on participant feedback from the design workshop, an RPG (Role-Playing Game) style game was constructed, in which the player controlled an avatar that moved around the game world talking to NPCs (Non-Player Characters). The game was constructed in a 2D top-down perspective in order to fit with a typical "classic RPG" aesthetic, as well as lending itself to 2D "comic book" stylistic presentation. Refer to figure 6.1 for an annotated screenshot of the game. Players moved their character around and talked to NPCs. The dialogue box showed the currently speaking character's name, their current line of dialogue, and their face portrait. Note that the old health bar in figure 6.1 was simply how the bar looked before it was changed to a series of hearts (see figure 6.4).

The chosen input modality was the keyboard and mouse, as this version would be played on desktop PCs, and many children are already experienced with using these [Fletcher-Watson, 2013]; in addition to this, other input modalities such as gestures would not have made sense in this context, as the game was highly "input-heavy" and exploratory in terms of player movement, and so it was viewed as easier and more intuitive for players to simply use the keyboard and mouse, rather than potentially becoming fatigued at constantly needing to use repetitive gestures to do simple actions like moving a character. Many other similar PC games (for example, *Minecraft*) use the keyboard and mouse, and children may be used to these games. This did assume some dexterity on the users' part, but the game was designed to have large and easily clickable buttons, as well as smooth, direction-based movement mapped to the arrow keys, and so arguably, not much dexterity was required. If the game was on a touch device, even less dexterity would be required, as players could simply tap to interact with the game.

The game's premise was that a robot called "Sarcbot" wanted to learn about how others understand sarcasm - this was where the player came in, as Sarcbot wanted to observe how the player learns about sarcasm, while also serving as a guide for the player. This premise was selected as being fairly easy for children to understand, while still giving the player a sense of purpose and making their presence in the game world seem less arbitrary. The game directly acknowledged itself as a game, e.g. characters directly mentioned concepts like "levels" and UI functionality, because the game was



Figure 6.1: An annotated screenshot of the game.

intended to simulate reality, not be a surrogate for it. To further promote a feeling of situatedness and presence in the game world, players were directly engaged in conversations, and could affect the state of the world. This was selected over simply having players be passive observers of events unfolding, having no real control of or input into the world.

To help Sarcbot, players could play levels, each of which was a stand-alone simulation of some conversations in which the player must engage, detecting, reasoning about, and responding to sarcasm. Players progressed linearly through the levels, and could save their progress, letting them resume where they left off upon starting a new session - this is a common game design convention, as it is unfair to force players to replay all previous levels just to get back to where they were when they last stopped playing. To minimise cognitive load and fatigue, each level was only intended to take around 5-10 minutes, depending on reading speed. Levels were created by the researcher in an editor using sprite resources known as "tilesets", and so many types of level could be created, for example, a level could take place in a sunny park, where children are playing, or inside on a rainy lunchtime at school. These would be designed to provide familiar contexts for children, which they could easily understand and believe (although for the purposes of the prototype, the tutorial level took place in a mock virtual reality-style simulation with "computerized" graphics). In each level, players could walk around and talk to NPCs, as well as explore the environment. What players had to do was complete the level's story by talking to NPCs and making the correct dialogue choices in conversations. When the player got close enough to start a conversation with an NPC (i.e. the player had entered the corresponding trigger area), an on-screen prompt appeared telling players to "press Space to interact", which

would then start that NPC's conversation. During a conversation, the speaker's name was shown in a dialogue box, along with a large picture of their face (called the face portrait), which varied depending on the character's emotion (e.g. if a character was saying something sad, their face portrait would look sad). It should be noted that some of the graphics were obtained from free sprite repositories, and were not created by the researcher (with the exception of Sarcbot's face and the ones created in RPG Maker). Full credit for the graphics not created by the researcher is given in appendix A.2.

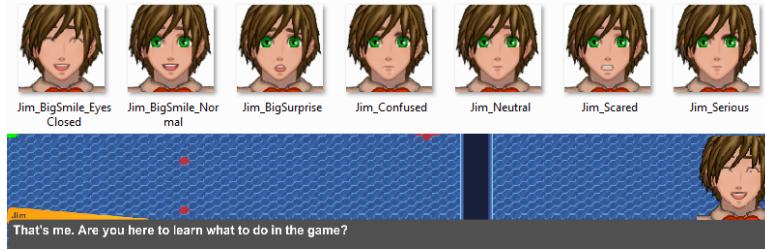


Figure 6.2: An example of facial expressions and dialogue of a character called "Jim". Face image source: <http://commandocherry.deviantart.com/art/Face-Set-Spain-RPG-Maker-VX-Ace-429344128>

**Yeah, what's that about?
Can you please show me again?**

Figure 6.3: An example of dialogue choices the player could make, which were highlighted when the player selected them using the keyboard or mouse.

Players had a health bar, visually presented as a sequence of hearts in typical RPG style and to make it clear through recognition that the hearts corresponded to health (instead of e.g. some arbitrary bar or numbers), which started out at full, decreased if players made a mistake, and increased when players did something correctly, e.g. picking the correct response in a dialogue. This health system was put in place to prevent "gaming the system", because if players were to simply choose random answers in the hope of getting the right one, they were likely to lose more health than they gain, and would eventually reach zero health, having to restart the level; although it was unlikely that players would reach zero health, since in order for that to happen, players would basically need to get everything wrong at every opportunity. This small amount of "pressure" was intended to encourage players to think more deeply

about their responses, and hopefully gain more understanding as a result, discouraging mindless spam-clicking behaviour. There was also an overall score for each level, which increased and decreased the same way as health. This was intended to provide incentive for players to score highly, since further levels were locked unless the player achieved a sufficient score on previous levels, although again, this score threshold was not very high, and players would need to do very badly in order to not get a high enough score to unlock the next level. Put simply, the health and score systems were not there to stop players from progressing, rather they were intended to encourage thoughtful responses, and to provide incentive to do well in-game, ideally leading to increased learning gains. Even if players could not progress to the next level at any point, they were allowed to re-attempt previous levels as many times as they like, theoretically improving through practice, getting better scores, and ultimately progressing.



Figure 6.4: The health bar, which consisted of filled hearts in a typical RPG style. The health decreased upon players choosing incorrect answers.

Since one of the game's learning outcomes was for players to be able to detect sarcasm, they could gain health and score points by correctly identifying sarcastic statements. This was done by choosing the corresponding dialogue option in a conversation.

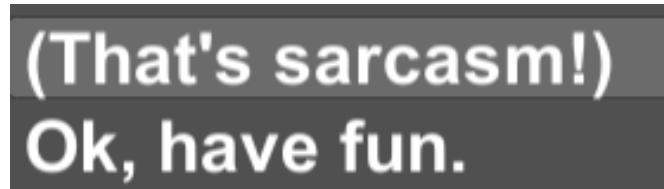


Figure 6.5: Players could choose (That's sarcasm!) if they think an NPC's statement was sarcastic, or simply give a response to continue the conversation, since not all opportunities to say (That's sarcasm!) will be correct to do so.

If players choose (That's sarcasm!) correctly, they gain health and points, and progress to being able to choose their reasoning as to why it was sarcasm, which is the second learning outcome of the game. Again, players could choose various dialogue options, gaining health and points for correct answers, and losing health and points for

incorrect answers. Multiple possible reasons as to why a statement was sarcastic were presented, only one of which was correct. The reasons were somewhat similar, but not overly similar to a point of being almost indistinguishable. After progressing correctly through the reasoning stage, players could practice the final learning outcome: responding appropriately to the sarcastic statement. Again, the same health and points gain and loss through dialogue choices was utilised. These three stages fed consecutively into each other, and provided scaffolding for answering the next question in the sequence. When players made a dialogue choice, their character repeated it to maintain consistency between how NPCs and the player spoke (i.e. the spoken dialogue line always appeared on its own). Players progressed through dialogues one statement at a time, advancing the dialogue by clicking the "»" (i.e. "next") button in the dialogue box.

It was necessary to ensure that dialogues could only be played through once, as otherwise players would be able to exploit the fact that they can do the same dialogues multiple times to get very high scores and lots of health.

The multiple-choice answer format was deemed suitable, as the target users will be fairly young and may not yet have fully developed typing skills, thus it would be easier and quicker for them to simply select options using the keyboard or mouse. While some have argued that multiple-choice questions typically only encourage shallow understanding compared to e.g. essays [Scouller, 1998], a counter-point would be that in this case, it is arguably not necessary and in fact may not be sensible to try and get young players to type their responses, as this would likely take them much longer and require more cognitive processing (and resultant fatigue) than simply selecting a response, and also implies the game having complex natural language processing approaches which are beyond the scope of this research. It also made sense to use the multiple choice format because “real” dialogue typically proceeds in a turn-based manner, and so in the game, at each player turn, it was not sensible for them to write an essay about why something is sarcastic or not, rather it made more sense for the player to select a response, as if they were actively engaged in dialogue with the NPC.

At any point, if players choose incorrectly, then short and friendly feedback was presented (by Sarcbot) explaining why their answer was incorrect, after which they were presented with the same choices, but with the ones they had already chosen

marked as such. This was to help mitigate ASC children repeatedly making the same mistakes [Varnagy-Toth, 2015], i.e. repeatedly choosing incorrect dialogue options, by reminding the player what they had already said, so that they did not mistakenly say the same things again. Feedback consisted of context-relevant information, as well as hints telling the player to think about how the other character is feeling, however, the answer itself was never explicitly revealed in feedback, although it could ultimately be found if all dialogue options were explored, leaving one remaining. However, that "process of elimination" approach was quite costly to the player in terms of their health and score, so it made more sense for them to review the feedback. Feedback was always positive and supportive, ideally promoting a sense of friendliness and easing stress and anxiety. It was necessary to tell players that they had made a mistake, but not in a de-motivating or belittling way, as this would likely make ASC children less willing to play the game.

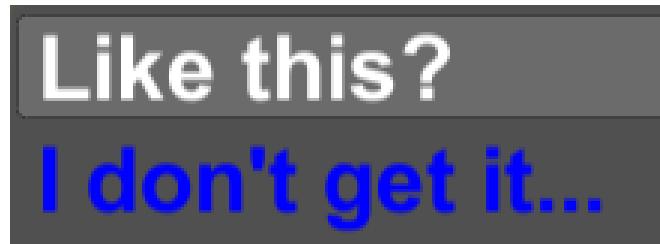


Figure 6.6: Previously selected responses were highlighted to remind players that these answers had already been chosen. Here, the player's previously selected response was "I don't get it..." .

The dialogue choices were intended to give players a degree of freedom and control over how they interact with NPCs, while also providing a scaffold to guide players towards choosing the correct answer, without explicitly revealing it to them. Another benefit of this approach was that it mitigates ASC children playing the game from saying irrelevant or "incorrect" things. The dialogue choices also allowed players to explore consequences of what they say, for example an NPC might get upset if the player said something inappropriate (although NPCs never became more than mildly annoyed at the player, and quickly went back to being friendly), or may become happy if the player says something nice. Explanations for these effects were always given. This was intended to give conversations more depth and realism, while still keeping the overall dialogue relevant, and allowing ASC children to understand and recover from "errors" in a dialogue, which may potentially be costly in a real conversation. The scaffolding was also beneficial as during the design workshop, participants sometimes

struggled to articulate their reasoning as to why a statement was sarcastic, but when the reason was revealed, they all agreed with it, as if it had helped them to verbalize their thoughts. Therefore, a similar approach was adopted here, letting players review potential answers and selecting what they believe is the correct one, rather than coming up with the answer themselves "from scratch".

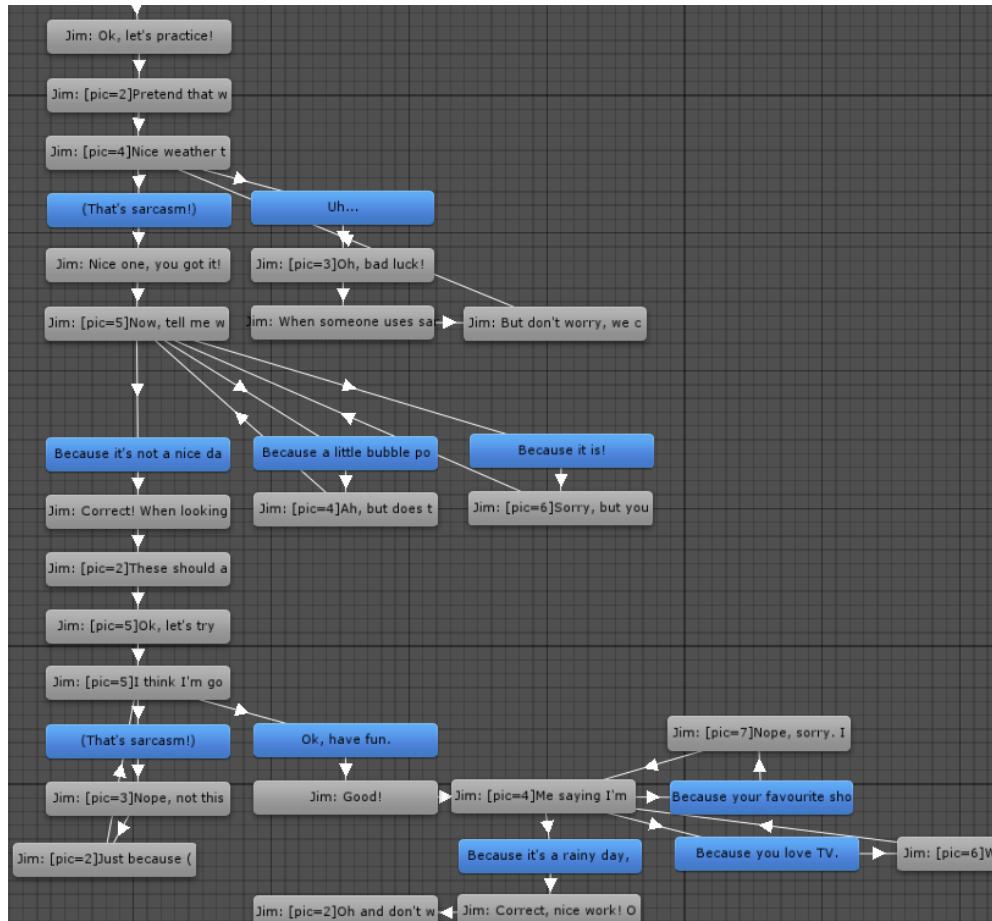


Figure 6.7: An example of a partial dialogue tree from the game's tutorial, with NPC dialogue in gray, and player dialogue in blue. The image shows that, in this case (for the tutorial), the dialogue "loops", so even if players choose an incorrect dialogue option, an explanation is given, and players are allowed to re-select a new response.

At any point, if players chose a correct or incorrect dialogue option, clear visual and auditory feedback was given, through the health bar increasing or decreasing, a sound effect playing, and a floating number and heart icon (green, positive number for health gain, red, negative number for health loss) appearing on the player and floating upwards, in typical RPG style. This visual feedback was deemed preferable as ASC

children are usually quite visual learners.

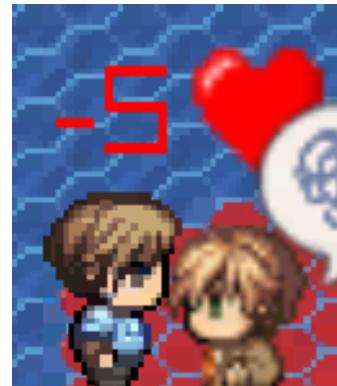


Figure 6.8: Here, the player chose an incorrect dialogue option, and lost 5 health and score. A red "-5" and heart icon appear on the player, slowly floating upwards, and then disappearing.

Players interacted with the world and with NPCs on their own terms; that is, players were always in control of initiating conversations, ideally providing them with a greater sense of control and comfort. NPCs indicated to the player that they could be spoken to by presenting a small icon of a speech bubble with an exclamation point.



Figure 6.9: An example of the player (bottom left) being able to see an NPC (the robot) with an exclamation bubble.

This was intended to let the player know that the NPC has something to say, and should be spoken to. This was deemed beneficial for ASC children, as their weak central coherence means that they may not always know when it is appropriate to approach and speak to someone, so the game made it explicit.

Other bubble icons were used during conversations to show the emotional states of NPCs, thus assisting with ASC children's deficits in Theory Of Mind - the game provided a means for players to "see" the emotional states of characters they talk to. It was deemed necessary to convey these emotional states, as in some cases it may be hard for the target population (or even neurotypical players) to detect sarcasm simply from words and facial expressions alone.



Figure 6.10: Bubble icons were used to convey emotional states of NPCs. From left to right, they represented: Can be spoken to, confused, happy, very happy, angry, sad, grumpy, speaking, has an idea, bored. Graphics source: RPG Maker.

To promote a feeling of personalization, and to enable persistence between game sessions, upon first starting the game (i.e. the first ever time), players were asked to input their name. This name was used by NPCs in dialogue to simulate speaking directly to the player, instead of to an arbitrary character, as ASC children usually respond better when playing as themselves. This personalization is also motivated by Gray's social stories, which make use of personalized text (e.g. of the reader's name) [Gray, 2014]. The game also recorded statistics about the player, such as the state of their progression through the game (i.e. what levels they had unlocked), as well as their scores on each level. Upon quitting and later resuming a game session, players could see their progress and begin playing any level they had previously unlocked.

Players could also access game options and change settings e.g. altering the volume of the background music and sound effects, as well as accessing a "quick help" menu with short explanations of various functionality covered in the tutorial (e.g. what the balloon icons mean). This also means that parents could have access to these customizations, giving them the ability to e.g. turn sounds off to mitigate a child becoming addicted to certain sounds.

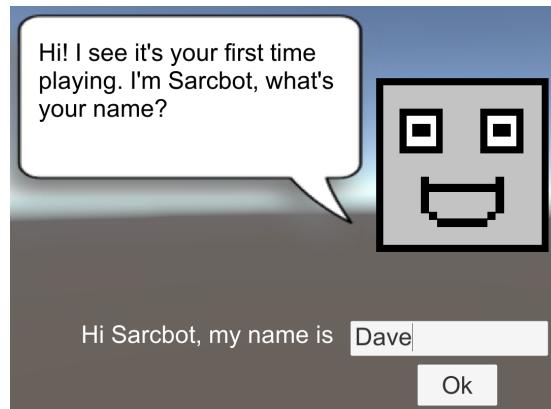


Figure 6.11: Players entered their name, which was then used by NPCs in conversations.

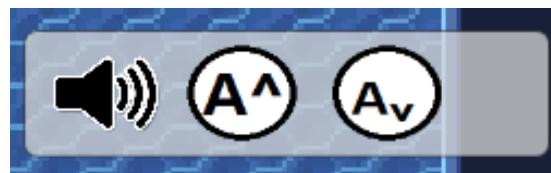


Figure 6.12: Players could use the on-screen "quick options" to mute or unmute the game's sound, and increase or decrease the text size.

6.4 Summary

All together, the context of the situation, along with the spoken dialogue, facial expression of the NPC, and balloon icons conveying an emotion were assumed to be enough for a player to detect the presence of sarcasm. Whether players correctly detected sarcastic statements or not, the system scaffolded players' resultant reasoning and responses to sarcastic statements.

The dialogue choices scaffolding players responses were deemed beneficial for a number of reasons, for example mitigating the tendency of ASC children to say irrelevant or incorrect things during a dialogue, while also letting players explore consequences of their actions (including mistakes) in an informative, safe and friendly way.

With regard to teaching players how to play the game, such explanations were made quite explicit, as studies have shown that ASC children usually need this sort of instruction [Bergstrom et al. 2012]. However, the explanations were still presented in such a way that was intended to be understandable by children, and not too long, as

that may lead to disengagement.

The contexts and stories were intended to be relevant and interesting for children to participate in, to better promote a sense of realism and presence in the game world, as well as engagement, with the intention of leading to increased learning gains for said children.

The gameplay and game mechanics left the player primarily in control of the interactions (e.g. by allowing them to initiate dialogues and choose what they want to say), and let them progress through the levels at their own pace. The settings and characters were all friendly and stress-free, and there were no unpleasant or upsetting dialogues or events.

The exclamation icons were intended to assist with ASC children's weak central coherence, by making it explicit that certain characters could be spoken to, as well as providing navigational hints on which characters to speak to.

The health and points system provided incentive for players to think more deeply about responses instead of trying to game the system. However, the penalties for mistakes were very mild, and were intended to provide incentive to do well.

In addition to referring to the player by name, it was deemed desirable to allow players to customize their avatar (including their face), which would be beneficial for having a more personalized experience, however, this functionality was deemed too costly in terms of time for the prototype version, arguably being a seductive detail [Harp & Mayer 1998], and was left to be discussed in further evaluations.

7. Participatory Design and Expert Interviews

Starting from the prototype version of the game discussed in chapter 6, participatory design and expert interviews were conducted to refine that prototype into a version that would be evaluated by typically developing children. Note that this section is not in chronological order (for example, due to restricted expert and participant availability, the participatory design session was conducted after the first expert interview); it merely shows what was done, what feedback was obtained, and what design changes resulted from this.

7.1 Participatory Design Session

This session involved the same 9 year old TD participant who contributed the most during the design workshop (hence referred to as "D1", as was the case in the design workshop). While it would have been preferable to conduct the session before the prototype of the game was constructed, due to time constraints involving D1's availability, this was not possible.

This session was highly similar to the design workshop in terms of its "specification", i.e. no formal evaluation was being done, nothing was being measured, the session was designed to elicit and refine ideas and designs for the game.

The session essentially involved the researcher and D1 creating and refining ideas and designs for the game, adopting an approach of co-design; that is, both D1 and the researcher had equal say and input into the designs, and worked together to do so. D1 also played a version of the game with the changes from the first expert interview sessions implemented (see chapter 7.3.1), gave feedback, and spoke about how the dis-

cussed designs could influence the game.

To avoid biasing D1, the game was only played in the second half of the session, so that D1's mind was clear to come up with new ideas and designs from scratch, without being influenced by the current game.

7.1.1 Materials

Paper, stationary (pens, pencils, crayons), laptop, audio recorder.

7.1.2 Procedure

The researcher briefly explained the purpose of the session, also reminding D1 of the purpose of the game. The session was relatively unscripted; the researcher essentially prompted D1 with some initial methods of coming up with designs, such as drawing mock screens of the game (an example prompting question was "draw what you might see when you play the game"). D1 and the researcher then jointly did these activities, with the researcher's role being mainly of an assistant, and to keep the session grounded in practicality, while still enabling D1 to put forth designs.

This continued for around 20 minutes, at which point the researcher then got D1 to play the current version of the game, give some feedback on it, and discuss how the current game related to the ideas discussed previously, and whether things in-game could be changed (and how).

The entire session lasted around 45 minutes.

7.1.3 Results

After reminding D1 of the purpose of the game, and explaining the session, some initial design ideas were laid out. The researcher suggested that they start the session by drawing a screen of what players would see if they were playing. D1 drew a forest-type level with a stick figure character to represent the player, as well as some NPCs in different locations around the level. D1 also drew some UI elements including a health bar and information about the player's statistics (stats). These stats were essentially

typical RPG-style attributes of the player, such as "attack" i.e. how strong the player is in combat, "defense" i.e. how much damage the player is able to take in combat, and "speed" i.e. how quickly the player moves and attacks. These stats were based on "sarcasm points", which were obtained by engaging in dialogues with NPCs and detecting sarcasm. Once players had sarcasm points, they could spend them by allocating sarcasm points into their stats, e.g. if players had 10 sarcasm points, they could choose to allocate 6 to attack and 4 to defense, thus improving those stats.

D1 said that the player could walk around and have conversations with people (NPCs), and essentially help NPCs with their problems. This would mainly be done through dialogues involving sarcasm; D1 commented that NPCs could perhaps indirectly state their problems using sarcasm, and the player would then have to decode the true meaning. D1 also suggested combat as a means of helping NPCs, e.g. a shepherd who was having trouble with wolves might ask the player to drive off the wolves. This "helping" was discussed and refined into a quest-like system, in which players perform tasks for NPCs and are rewarded. Item rewards such as potions and other consumables were considered by D1 and the researcher, but were decided against due to being unnecessary and irrelevant to the point of the game, which was to learn about sarcasm. In this regard, the reward for doing quests was sarcasm points, and also the progression of the story. D1 also mentioned differentiating between "main quests", which would be required to progress the story, and "side quests", which would be optional, but would still reward the player for doing them.

D1 also mentioned having a "party", a friendly group of NPCs that follow the player around, and who can be spoken to. D1 commented that party members might personally know other NPCs, or have information about the world, including about enemies which could be fought. For example, a party member might know what sort of attacks are effective against a certain enemy, or an NPC might not talk to the player unless a certain party member was with them. D1 mentioned that party members may also be sarcastic in their dialogues, and could be a source of sarcasm points.

D1 liked having an "outdoor" setting, first drawing a forest, and then a town, but also commented that the player would be able to enter houses and buildings, and said that any setting would be fine, and that it did not have to be realistic.

When asked whether a 2D or 3D setting would be preferable, D1 commented that he felt no strong preference either way, and that it would not make much, if any difference in this case. D1's drawn designs were from a 2D perspective.

For NPC dialogues, D1 noted that not all dialogues should be sarcastic, and that there should be a mix of sarcastic and non-sarcastic statements, leaving it up to the player to determine this and respond appropriately.

In terms of generating scenarios involving sarcasm, D1 struggled with this, but did suggest an example of a rainy day in which NPCs sarcastically commented on the "great" weather. D1 and the researcher also came up with an example of a fisherman who was not catching any fish, and who spoke sarcastically about his "great catch".

D1 agreed with the idea of unlocking things with points, for example unlocking further levels.

D1 then played through the new tutorial of the updated game prototype (see chapter 7.3.1). Overall, D1 commented that he liked the game, and it was noted by the researcher that D1 smiled at the visual rewards and found the sarcastic dialogue humorous. It was also noted that D1 was able to successfully complete the tutorial with minimal help from the researcher - the researcher read some of the dialogue aloud, as it took D1 some time to read it themselves. The researcher also briefly directed D1 at various points, as the game did not yet make it clear in what order players should do tasks in-game (e.g. which NPCs to speak to at which point). D1 also tried to initially move during dialogue, but was unable to. D1 seemed to intuitively know how to operate the game, e.g. interacting with NPCs and selecting dialogue options, and recognized the health bar, as well as the balloon icons signifying that NPCs could be spoken to, and was generally able to play the game as it was intended to be played. Upon engaging in a sarcastic dialogue, D1 was able to successfully progress through it, correctly detecting the sarcasm, picking the best answer for the reasoning, and an "ok" answer for the response. D1 commented that, for the responses, there were a lot to choose from, and so he did not know which one to pick. D1 commented that there was too much text in dialogues, and that it could take a long time to read. D1 also commented that if a player was not a strong reader, they might read the dialogue in a "flat" manner, e.g. not with any emphasis due to punctuation, and so this may make it

harder to detect sarcasm. However, D1 agreed that the face portraits were a good idea in this regard (as they provided another cue with which to detect sarcasm).

In terms of the health and points system, D1 said that it was useful in that it provided motivation to get answers right, but that it should not be overly punishing for mistakes, as this would discourage players from engaging in conversations, i.e. players would be less willing to engage in conversations if they ran the risk of being at a loss afterwards. Rather, D1 agreed with the idea of having "degrees of preferredness" for answers, so no matter what players choose in a dialogue, they would always gain points and never lose any, although it would be possible to gain more points by performing better in dialogues. D1 noted that the current score system was essentially what he had in mind for the sarcasm points system.

Upon discussing the combat system, D1 and the researcher agreed that combat should not be the primary focus of the game as this would distract from the game's true purpose of teaching sarcasm. Rather, it was agreed that combat could simply be an aspect of the game that is fun to play, and which provides motivation for players to get lots of sarcasm points, so that they will be better at combat - it would be impossible or at least difficult to progress through the game via combat if players had not previously engaged in dialogues and gained sarcasm points. This could also tie in to E2's (the expert from the prior interview) notion of a reward, or "*something that is tempting [for the player]*". D1 noted that having this sort of combat system, i.e. one that is not overly challenging or distracting, could cater to players who like combat in their games, as well as those who would rather e.g. explore a world and discover things, as both would be possible in the game. D1 commented that having a fully player-controlled combat system was unnecessary, suggesting that battles would "play" automatically, the outcome being determined by the player's current stats and the enemy they faced, e.g. if the player has high attack and defense, they are more likely to do well in battle. D1 suggested typical RPG fantasy enemies such as wolves in this regard. D1 noted that the combat system was intended to provide incentive to perform well in dialogues, as doing so would enable players to gain a lot of sarcasm points, which they could then allocate into their stats and progress through combat (and thus the story) more easily.

For the feedback given upon players making a mistake, D1 commented that it was good that the system did not explicitly reveal the answer, but rather explained what the

player had done wrong, leaving it up to the player to then derive the correct answer.

7.1.4 Design Changes Resulting from Participatory Design Session

Going by the fact that D1 immediately knew how to use the keyboard and mouse to operate the game (after being prompted with a brief explanation in the tutorial), and had no difficulty in doing so, the keyboard and mouse input was finalized as the chosen means of player input. D1 quickly grasped the fact that he was manipulating a virtual avatar in a virtual environment, and that the avatar corresponded to himself, and so this "perspective" was also kept. The far-fetched setting of training a robot was kept, as D1 commented that settings did not have to be realistic, and that more far-fetched settings may be more interesting to play. However, some realistic scenes were also discussed as being acceptable, hence the "modern office" setting for the tutorial.

7.1.4.1 Game Mechanic Changes

Players no longer gained or lost health during dialogues; only score was now gained this way, and could not be lost, as D1 commented that being penalized by losing score may be discouraging for players. The "degrees of preferredness" answer system was fully adopted, that is, there were few incorrect answers, and upon giving less preferred answers, players received a smaller score increase compared to a bigger one when they selected better answers. Incorrect answers now gave the player no additional score instead of decreasing it; no matter what, players would at least have as much score coming out of a dialogue as they did when they went in, but they could potentially get better scores by providing good answers, thus providing motivation to do so, and reducing players' reluctance to enter dialogues, because they could never be at a loss by doing so. The score system also helped guard against gaming the system, as if players were to select answers at random, or simply spam-select the first response every time, since the responses were presented in a varying order (e.g. the first response may not always be the best, or may not even be correct), such strategies would not score the player enough points to allow them to progress to the next level.

A combat mechanic was considered, in which, as per D1's suggestion, players could allocate sarcasm points (i.e. score) into stats such as attack and defense. These

stats would be used to probabilistically determine the outcome of battles, which, for the purposes of demonstration, would be left as a text log that appeared on the screen (i.e. there would be no combat animation, only a text log describing the battle). To keep in with the ASC child-friendly theme, battles would not be overly violent and there would be no blood or gore, instead the battles would involve humorous descriptions of what happened. Also, enemies would never be killed or badly hurt, instead simply running away upon losing, as would the player if they were to lose. The player could lose health by being attacked by enemies, and the player's defense stat determined how much damage they would take. Gaining or losing health would be restricted solely to combat. However, the combat mechanic also had some potential downsides, in that it might end up distracting players from the main point of the game, and might feel somewhat arbitrary or irrelevant, and perhaps not all players would enjoy it. There is also the matter of combat being inherently "un-child-friendly" and may instil bad behaviour or morals in more impressionable players, so there would likely need to be some non-violent alternative, e.g. a "battle of words", or some kind of quiz. For these reasons, the decision as to whether to include a combat system was left for further expert interviews.

In terms of the party of friendly NPCs, this was achieved by having Sarcbot follow the player around, essentially acting as the player's party. Sarcbot could be spoken to, and would provide commentary and information about the world and the player's current objective.

NPC dialogues consisting of more than one conversation were added, in keeping with the "quest" system. That is, players might speak to one NPC, and then be required to go and speak to another, located in a different area of the level. To enable players to see what their current objective was, a small notification was present on-screen, briefly telling players what they should do next. This was intended to keep players on track and reduce instances where they might not be sure what to do next, potentially becoming frustrated as a result.

There were also extra NPCs present in levels who were not required to be spoken to in order to complete the level, but could be spoken to regardless, and could reward the player. This marked the distinction between main and side quests. To help players see which NPCs were optional to speak to (i.e. side quests), a different looking bubble



Figure 7.1: The on-screen “Current Task” box showed the player what they currently needed to do.

icon appeared above the NPC’s head.



Figure 7.2: A main quest NPC (top left) and a side quest NPC (bottom right).

7.1.4.2 Dialogue Changes

Since D1 commented that there were lots of answers to pick from, and that it was somewhat overwhelming, the maximum number of answers was restricted to 3. One of the answers was the best answer, and would get the player the maximum possible points, another answer was correct, but not as good as the best answer and would not give as many points, e.g. it would be a lower data answer that missed details or mentioned irrelevant things. The final answer was incorrect and scored the player no points.

After the first expert interview session, the dialogue was changed to be simpler and less "wordy", but it was still noted during the participatory design workshop that D1, while being able to read and understand the dialogue, was quite slow in doing so, especially in cases involving longer or compound sentences with longer words. Therefore the dialogue was broken down further into smaller, simpler chunks, and the overall word count was reduced where possible.

7.2 Expert Interviews

In order to further inform any design changes to the prototype version of the game, semi-structured interviews were carried out with experts in various fields. These were to elicit any direct comments or suggestions for things to include or remove, as well as focusing on usability and accessibility for the target audience, while making the game educationally effective and engaging. Some experts also played one of the various iterations of the game (stated in their session's description) and gave qualitative feedback on it; experts who could not play the game were simply told about it by the researcher, and then had a discussion based on that. While playing the game, experts were instructed to verbalize their thoughts, comments and opinions, and that the session was not a think-aloud, as that would imply that they were being assessed, whereas the goal of these sessions was to get their opinions, not to measure their performance (although if they had usability-related issues while operating the game, these were noted as they could potentially be problem indicators).

Due to variable expert availability, it was necessary to interview different experts at different stages, rather than all at once.

7.2.1 Participants (Experts)

- E1: A lecturer at the University of Edinburgh. Specialist area(s): Human-Computer Interaction, Computer Security.
- E2: A PhD student at the University of Edinburgh. Specialist area(s): Human-Computer Interaction, building educational tools for individuals (both children and adults) with special needs, particularly autism.
- E3: A former MSc student at the University of Edinburgh. Also had experience in teaching and education. Specialist area(s): Linguistics, speech and language processing, education (with children), autism.
- E4: A former MSc student at the University of Edinburgh. Specialist area(s): The intersection of technology with interventions for ASC individuals, user experience design.
- E5: A lecturer at the University of Edinburgh. Specialist area(s): Human-Computer Interaction, education, developing game based technology to sup-

port social communication and interaction, particularly for children with special needs (including autism).

- E6: A PhD student at the University of Edinburgh. Also had experience in playing computer games, and to an extent creating games. Specialist area(s): Human-Computer Interaction, human factors, usable security.
- E7: A developmental psychologist with extensive experience in developing interventions for ASC populations, including technological interventions.

7.3 First Round of Expert Interviews

Since E1 and E2 were both mainly HCI experts, this first round of interviews focused mainly on usability and accessibility factors for the target population.

E1 noted that their expertise was not specifically with autistic children, but that they were experienced with general usability and accessibility for a variety of target populations, including TD children. E2 on the other hand was experienced with autistic children, and had previously developed educational tools for that population.

In terms of general comments and suggestions, both E1 and E2 commented that the interface needed to make things very clear, e.g. through large buttons and text. E2 stated that the game should not intimidate or humiliate the player, and also said that it would be good if the game could be customized (e.g. by educators) to a specific child's interests and needs.

In terms of making the game educationally effective, E1 noted that games are inherently advantageous due to their “regular” nature, that is, games are usually a lot more predictable and stable than human interactions (e.g. with other children), and allow for players to make and recover from mistakes with minimal repercussions, overall being a safe space for children to learn and practice. E1 stated that these were all factors contributing to why autistic children respond so well to computer games, and would inherently contribute to the learning process through higher engagement. E2 also noted this, but stated that this factor should not be overly relied on, or assumed in every case for the target population. Again, E2 mentioned that it would be beneficial to customize the game to a specific child's interests, and also to introduce in-game rewards, some-

thing that would encourage players to progress and do well in-game.

After discussing these initial questions, E1 and E2 played the prototype game's tutorial and gave qualitative feedback during and afterwards. During this time, the computer screen was video recorded so that expert comments could be more easily linked to events in the game, and footage could be easily reviewed to see points at which experts struggled or became confused, even if they did not say so out loud. Video recording was beneficial as a general means of capturing expert behaviour in the game.

At this point, the game's tutorial consisted of the player essentially being told how to play by two NPCs, Sarcbot and "Jim", and having the opportunity to practice moving the character around and having a mock sarcastic dialogue. The NPCs explained the game's mechanics, let the player practice them, and gave the player mini-tasks to do, such as talking to the other NPC.

Both experts immediately noted that, in order to play the game, the child would need to be able to read.

Upon viewing the first screen (where players are prompted for their name), E1 attempted to progress by pressing Enter after entering a name, however this did not work as the buttons were only set up to respond to mouse input. E2 suggested that the name entry text should be changed from "Enter name here" to "Enter your name here". E2 also noted that the text of the progression buttons could be changed from "Ok" to something like "Continue", as E2 did not like repeatedly saying "Ok", and also stated that the interface could be more visually attractive.

Upon reaching the main menu, E1 commented that the buttons on the menu looked more like labels than buttons, and while it was clear that they were interactable or not (in the case of locked levels), making them look more "clickable" would be of benefit. E1 commented that this may have been due to the menu background not contrasting very well with the buttons, making it harder to distinguish the borders of buttons from the background. E1 commented that usually, non-interactable buttons tend to look like normal buttons but with the text greyed out. Both E1 and E2 intuitively knew that "tutorial" was the obvious button to click.

E1 immediately recognized the hearts on the left of the screen, and referred to them as “lives”.

When in the tutorial, both experts commented that it was annoying to have to use the mouse to click to progress dialogue and choose dialogue options, and that they would rather solely use the keyboard in this case (for the PC version). E1 noted that using the mouse here would require high dexterity. Both experts stated that if the game was on a touch-screen device, then it would not matter since clicking (through touching) would be much easier, but for the PC version, using the keyboard alone would be preferred.

E1 interacted with the “quick options”, and intuitively knew what their function was. However, upon trying to increase the font size when it was already at maximum (i.e. the button will have no effect), E1 noted that the button should not still be clickable, as this would be confusing and seem to convey that the button is broken.

Both experts tried to move the character around during dialogue, but were unable to. They said that stopping movement during dialogue was fine, but that there needed to be some clear visual element showing the player whether they can or cannot currently move. Both experts were initially confused over the game telling them about WASD keyboard input for movement in addition to arrow keys, and agreed that movement should be restricted to arrow keys only. Both experts also tried to pause during a dialogue, but this was disabled. They suggested making this functionality available, and also suggested giving players other means of pausing and “escaping”, since players may wish to abruptly exit the tutorial and go to the menu to start playing levels.

Both experts suggested making the “Space Bar to interact” tooltip (when next to an interactable NPC) more prominent, e.g. by making it bigger, since they both initially did not see it.

In terms of the dialogue, both experts commented that the conversations were “too wordy”, and needed to be broken down into shorter, simpler statements. There was also some confusion over who was currently speaking in a dialogue – E1 commented that they only realized the purpose of the name label (to show the currently speaking

character's name) a few minutes in. E2 also had trouble distinguishing which character was currently speaking. E2 initially had trouble understanding the concept of the dialogue choices, e.g. when choices could be clicked compared to other spoken text that could not be clicked. E1 suggested that the name label could be changed from just a name alone to e.g. “<name> says:” or “<name> thinks:” to assist with making it clear that some character is speaking or thinking, suggesting that the detection and reasoning parts of the dialogues should be thoughts, and then the response should be speech. Both experts commented that the player character repeating their selected dialogue choice was unnecessary, and merely served as an extra click which could be removed. Both experts commented that it was hard for them to remember what was just said in a dialogue when it was time for them to make a choice (i.e. they could not remember what they were making a choice about). Upon discussing this with them, both experts agreed it would be good to have some sort of log or history or what was just said, so that players have a reference to it and can remember what they are making a choice about. Both experts agreed that having face portraits of speaking characters was good, as that is how one usually detects sarcasm. E1 suggested moving the face portrait to the left of the screen, since that is where a reader's eyes will be (reading from left to right), and that it was hard to keep looking over to the right to see the character's face. E1 pointed out that one of the sentences was grammatically incorrect, stating that it “would drive an autistic child nuts.” E1 stated that some of the dialogue choices for determining sarcastic reasoning had multiple potential correct answers, that is, technically none of them were “wrong”, just that some were “better” than others, e.g. a highly detailed answer compared to a much less detailed answer, but the less detailed answer was still technically correct, just not as detailed as the other answers. E1 commented that in some cases, more context was needed to determine whether a statement is sarcastic or not, using the example of an NPC saying that it was a nice day outside while it was raining, E1 said that some people actually do enjoy rainy days, and so it would be necessary in this case to make it explicit that the NPC in question does not like rainy days. Both experts liked that it was possible to get back to where they were before in a dialogue and see previously selected answers.

E1 stated that there were a lot of balloon icons to memorise, and that having quick access to a reference to what each icon corresponds to would be useful – this already existed in the help menu, and E1 suggested that, instead of having Sarcbot go through each icon one-by-one, it would be better to simply allow players to view the “all in

one” help menu reference whenever they wished. Both experts initially misunderstood the balloon icons; E1 thought that the exclamation point meant that a character was upset, and was confused over the “speaking” icon, thinking that it meant “pending”. E2 did not remember the exclamation bubble upon being asked about it by Sarcbot, mistaking it for the “speaking” bubble. E1 mistook the “grumpy” icon for “confused”.

Upon talking to the “Jim” NPC, E1 stated that doing a practice detect-response scenario there made sense. E1 also commented that they liked the health system and thought it was a good idea, and that the hearts fit with the video game aesthetic, and would likely be easily recognizable to children who have played other games. However, upon getting a correct answer and gaining health while already at maximum health, E1 stated that they would like to have some other additional effect, since the player’s health did not go up if it was already at the maximum. E1 stated that “no matter what choice I make, it needs to cause a change [to the health bar].” Upon discussing this with E1, they agreed that including a score in the tutorial would be beneficial in this regard, as it would serve as something that changes, even if the health bar does not. Both E1 and E2 noticed the “+5” or “-5” and heart icon upon getting an answer right or wrong, but commented that there needed to be a clearer visual effect; in this regard, E2 suggested fireworks and a clear sound effect, commenting that the current sound effects were too quiet. At one point, E1 tried adopting a strategy of quickly clicking through answers without reading them, but realized that this would not be effective since they were losing lots of health this way. E1 suggested referring to the hearts as just “health” instead of a “health bar”.

Overall, E1 commented that the tutorial “went overkill” on explaining basic game mechanics such as previously selected dialogue choices being a different colour, and knowing when the player can speak. E1 also commented that the tutorial was overly patronizing at times, and took too long to get to the point of what the game was about. E2 commented that players would likely be able to pick up a lot of in-game skills themselves without being explicitly instructed, but that it was still good to have some clear instructions, and to let players practice those skills. E1 suggested “scaffolded learning”, that is, giving players small chunks of information at a time, then letting them practice those skills, and moving on to other skills afterwards; this lets players commit smaller chunks of information to memory and build their skills up over time instead of being overloaded with too much information all at once. Both experts liked

the health system and thought that it was effective, but mentioned that it should not be overly punishing or demotivating.

E1 suggested changing Sarcbot's role from a mentor to a peer or student, that is, someone learning alongside or under the player, with the player's help. E1 stated: "*Use the bot as a third party that is confused and wants the player's help [to understand sarcasm].*" The point of the game would then become the player teaching Sarcbot over time, perhaps using some AI techniques, i.e. Sarcbot actually learns based on training data from the player. In the case that the player says something wrong and needs an explanation, the speaking NPC's behaviour coupled with suggestive feedback from Sarcbot would serve as this explanation. For example, upon the player giving an incorrect answer, Sarcbot might say something like "I think Jim looks confused. Maybe we should try explaining things to him." E1 suggested making the game more about the player, i.e. giving them a more important and meaningful role, since at the time the game mainly seemed to be about Sarcbot.

E1 also suggested having some sort of "game show" mechanic where the player competes, perhaps against Sarcbot or other NPCs by answering sarcasm-related questions. Whether this would be effective to implement, and questions about how it could be implemented, were left for future interviews for the time being.

In terms of difficulty, E1 commented that the game should get progressively harder as players progress through the levels, and that automatic difficulty scaling (within the same level) was a bad idea, since it would be hard for educators to know what the game is doing internally, and would also make the game's behaviour harder to predict generally.

Both experts commented that having sound and music was fine, and that the existing functionality to change the volume or mute it was good. E2 suggested letting players choose their own music, e.g. from a pre-defined selection.

In terms of stories and scenarios, E2 suggested making them personalized to a specific child's interests, and also suggested having a "default" mixture of selectable fantasy and realistic settings in case the personalization was not possible. E2 suggested allowing players (or educators) to customize Sarcbot, e.g. instead of it being Sarcbot,

it could be something like a child's favourite toy.

Upon being shown different visual versions of the dialogue box, e.g. one with it as a speech bubble, and different coloured ones, both experts said that they did not notice much of a difference, and thought that the regular one was fine. When asked about including full body character portraits (with poses) as opposed to just faces, both experts said that full body portraits were unnecessary since sarcasm is mainly detected in the face.

7.3.1 Design Changes Resulting from First Round of Interviews

It was assumed that since both experts were able to successfully complete the tutorial, anything not mentioned by them could be left as-is due to lack of evidence stating otherwise. This included the character movement controls via arrow keys, the 2D perspective, and the visual presentation style (E1 simply commented that it looked like an 80s era game). The dialogue box itself was also left as-is, since experts said that they felt no need to change it. The hearts were kept because they fit in with the game's visual style and were intuitively recognizable by experts, who also said that children would most likely also recognize them. The quick option functionality was kept the same, as well as the overall structure of progressing linearly through levels via unlocking them with high scores. The core aspects of the game were also left as-is, i.e. the dialogue system, choices, and the detect-reason-respond strategy.

7.3.1.1 Game Mechanic Changes

Players were made able to pause during dialogues, as this was requested by both experts.

Selectable music tracks were included on a quick bar, as per E2's suggestion, in addition to the existing mute button, which E1 noted as being a good idea, stating that music and sound effects could potentially get annoying for players or others nearby. On the quick bar, the currently playing track is highlighted to make it clear which one is currently playing. A button to mute only the music was also included (e.g. if players only want to hear sound effects).

The tutorial was changed to have its own short story for players to complete, as experts commented that players would likely want to leave the tutorial part-way through and start the "real" game, so in essence the tutorial was made into the first part of the "real" game, encouraging players to complete it - E1 in fact suggested that a lot of the tutorial could be interleaved with the first level. The level's setting was changed from a "VR simulation" to a modern office. The story introduced the characters and the player's role, as well as the point of the game early on, in order to speed up the time taken to reach this point, which was noted as being too long before. The story was now more about the player themselves and why they were needed in the game world (to help Sarcbot), since both experts commented that the game should be mainly about the player, not about Sarcbot. To aid in this, a story scenario was used where a team of scientists had created Sarcbot, but needed someone (the player) to help Sarcbot to learn about sarcasm. The player now took the role of a trainer for Sarcbot, working with the scientists. In this regard, Sarcbot's role was changed from that of a mentor to that of a student; the game now adopted the learning by teaching paradigm [Biswas et al. 2005]. The player's role in the game was now to help Sarcbot learn about sarcasm by exploring the world alongside Sarcbot and learning together. To this end, Sarcbot now followed the player around in the game world, and provided commentary and feedback during dialogues. There was also an added benefit in that if the player made a mistake, the "blame" no longer rested entirely on the player, as technically Sarcbot and the player were working together, and so mistake feedback essentially became "we (player and Sarcbot) made a mistake" instead of "you (the player) made a mistake". This form of feedback is much less de-motivating, and arguably provides a more supportive environment for the player.

The tutorial now only briefly went over basic gameplay mechanics, and gave players the option to view more detailed explanations, leaving it up to players to practice using skills and to figure out gameplay mechanics. The tutorial explanations were changed to focus more on the applications of newly learned skills through practice, rather than explicitly explaining obvious things, since E1 noted that some of the tutorial explanations were overkill, and covered things that E1 already knew through playing, such as explaining how to select a level from the main menu, when in fact that was how the player got to the tutorial in the first place; both experts commented that most likely, a child would also pick these things up relatively quickly. Instead of explicitly telling the player through a dialogue that they needed to use the arrow keys

to move, when players started the tutorial, an on-screen graphic appeared, showing the arrow keys with a message saying “Use the arrow keys to move!”. When the arrow keys were pressed, the corresponding parts of the on-screen graphic would change, showing the player that they had pressed that key. This was intended to provide a more intuitive means of explanation, one that lets players experiment for themselves and see the results of their input, rather than simply being told things and having to memorize them.

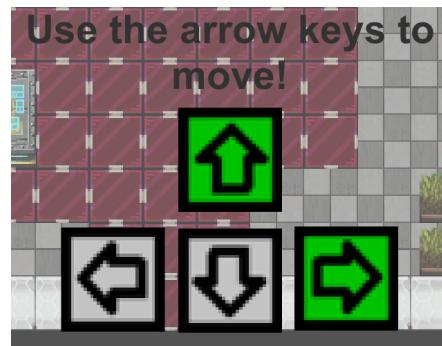


Figure 7.3: A graphic telling the player to press the arrow keys. Here, the player had pressed the up and right keys, which was reflected on the graphic.

Originally, when players selected reasoning about sarcastic statements, the dialogue choices were intended to consist of one correct answer among multiple incorrect ones - however, E1 pointed out that multiple choices were technically correct, just not as good or complete as the full answer. In this regard, two design options were available: to make the one correct answer clearly distinct from the incorrect ones in some way, and to ensure that the incorrect ones were actually incorrect and not simply "less correct". The other option was to introduce degrees of "preferredness" for answers. For example, there could be multiple correct answers, with some being better or "more preferred" than others; some may be very good and score the player lots of health and points, some may be less good and score the player less, and some answers may be incorrect and make the player lose score. Selecting between these design options was a question left for further expert interviews and to the participatory design sessions.

A "game show" mechanic was introduced, which took place in a separate level from the tutorial. The premise was that the player was challenging Sarcbot to a quiz to test how much Sarcbot had learned. However, further implementation of this mechanic was left until more information had been gathered about how to approach it effectively,

as this was a relatively new and unexplored mechanic.

7.3.1.2 Controls

For the PC version, the game now only prompted players to use the arrow keys for movement (instead of WASD). The Enter key was enabled as an additional means of progressing through the first name entry screen (as well as the mouse), as E1 first tried to do this. During dialogue, the arrow keys were used to highlight different dialogue choices, and the Enter key was used to progress dialogue or select a choice. The mouse functionality was still enabled in dialogues, to simulate touch-screen functionality, and to give players choice over their input modality. The "»" (i.e. "next") button for each dialogue statement was replaced with a small "Click or press Enter to continue" button to let players know to press Enter to advance the dialogue, while also serving as a clickable button. The mouse was still used to click things on the screen, e.g. when selecting a level or accessing the quick options or pause menu, as doing this with the keyboard would either require giving the arrow keys multiple purposes (which E1 noted as potentially leading to confusion), or mapping each on-screen function to another key, which would massively increase the amount of things the player would need to remember. Since the on-screen clickables will likely be used much less than the keyboard functions, this seemed a sound design choice, as players would only rarely need to switch input modalities.

7.3.1.3 Visual Changes

The buttons on the main menu were changed to pictures of each level, which were greyed out if not selectable, and changed colour when hovered over using the mouse. This was to make them look more like clickable buttons and less like labels. More information regarding the level unlock system was also provided by making it explicitly clear what levels were locked, and how they could be unlocked, as well as how close the player was to achieving that. This can be seen in figure 7.4, where the player's best score in the tutorial was only 78, whereas they needed 100 to unlock level 1. Note that the other level images in figure 7.4 were randomly selected images designed to act as placeholders (since the levels did not exist yet), while the "introduction" level image was an actual screenshot of that level. The other level buttons would ultimately also be screenshots of those levels.

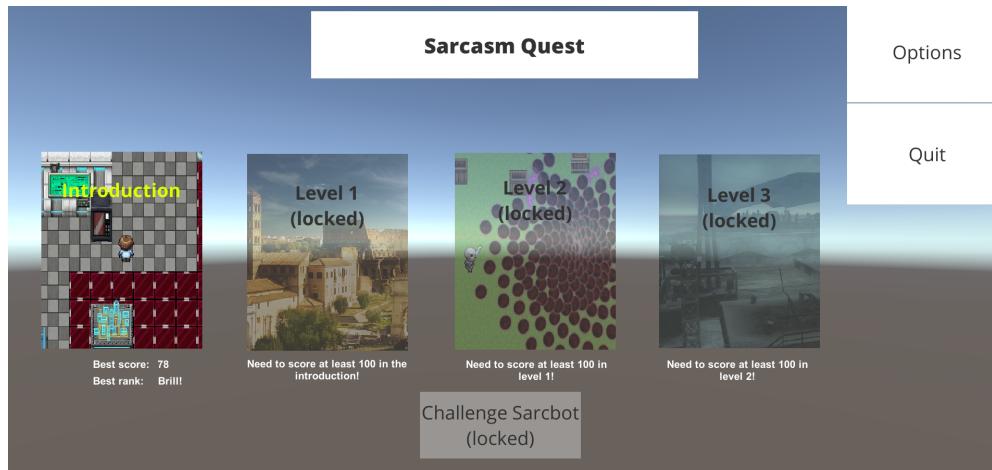


Figure 7.4: The new main menu, showing players what they needed to do in order to unlock further levels.

During dialogue, the face portrait of the currently speaking character was moved to the left of the screen, making it easier for players to see when reading text. This necessitated the health bar being moved elsewhere, so it was moved to the right of the screen. Per expert suggestions, the "press Enter to interact" tooltip for interacting with NPCs was made bigger and more prominent, so that it would be less easily missed. An icon of some arrow keys was included on-screen, being highlighted when the player could move, and being greyed out when the player could not move (during dialogues). This was to make it clear to the player when they could and could not move, since experts both initially tried to move during dialogue. The quick option buttons to increase or decrease the font size were greyed out when they were not interactable, to avoid users thinking that the buttons should have done something when they in fact should not.



Figure 7.5: The new UI.

7.3.1.4 Dialogue Changes

The name label was changed to "<name> says:" or "<name> thinks:" to make it clearer who was currently speaking (or thinking). The overall dialogue was altered so as to use shorter, simpler statements, and to be less patronizing. There was also less explicit explanation of basic game mechanics such as choosing dialogue options and the fact that old options were coloured blue. Grammar was also paid greater heed, and any incorrect or ambiguous grammatical statements, no matter how subtle the error, were consciously avoided.

When dealing with sarcasm, the first step of detecting was now changed to the player's thoughts rather than spoken out loud. The other steps of reasoning and responding stayed as spoken dialogue. This was due to suggestions from E1, who noted that it made more sense this way.

The previously spoken statement was now present on the screen while the player selected their response, to give the player a reference to what was just said in a dialogue, and remind them what it was they were responding to. The player character no longer repeated the selected dialogue choice, removing the extra unnecessary click that was there previously.

To avoid intimidating or humiliating the player (as per E2's comments), sarcastic statements were kept as being about some circumstances not involving the player, i.e. the sarcasm was not ever directed at or about the player. NPCs may make a sarcastic joke towards the player (e.g. to try and trick them), but the joke was never offensive or specifically demeaning to the player.

7.3.1.5 Rewards

Clearer visual and auditory reward signals were given via creating firework effects around a player when they got something right, as per E2's suggestion; the corresponding sound effects were also made louder. A score was also included in the tutorial, so that something always "changed" depending on player answers, which E1 noted as something to include.

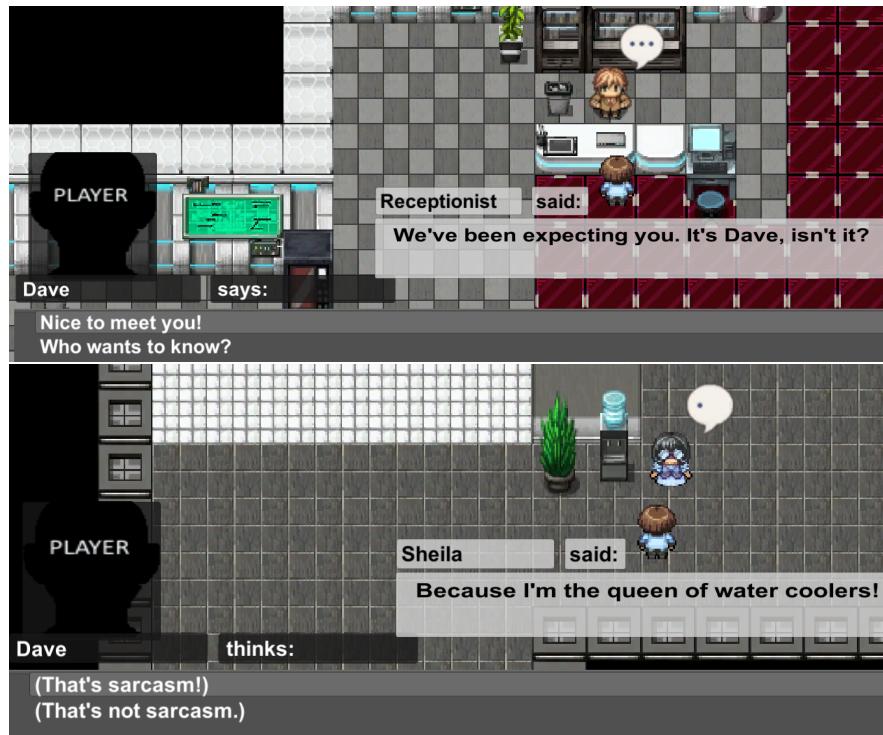


Figure 7.6: Examples of the new dialogue system.



Figure 7.7: The player getting +5 health and score.

7.3.1.6 Personalization

There already existed some superficial customization through altering sound and graphical options, as well as the player's name. E2 mentioned that the game ideally needed to be specifically tailored to individual children who play it, and so functionality was added enabling players to customize Sarcbot's name. However, overly specific customizations, such as specific characters (e.g. family or friends of the player) and scenarios, would have been impossible at design time, and so it was deemed preferable to continue making the game extensible and customizable by others, e.g. other developers and educators, rather than trying to make the game overly tailored at this stage. In this

regard, it still made sense to include a broad range of options and scenarios to try and accommodate a multitude of players, which E2 agreed with. E2 suggested that players be able to completely change Sarcbot (including visually) to e.g. their favourite toy, but these customizations were intended to be made possible by others using the game, through releasing the source code with comments and documentation.

7.4 Second Round of Expert Interviews

Here, E3 and E4 were interviewed, but could not play the game themselves due to the interview being conducted over Skype. However, the researcher explained the (then) current version of the game to them, which was the one with the changes from the first round of expert interviews implemented.

E4 stated that what practitioners of interventions for ASC children usually do when introducing a new game to an ASC population is to instruct the child how to play the game, as otherwise they may become discouraged or overwhelmed if they are unable to understand something. In this regard, E4 commented that usually in the first two or three sessions of ASC children playing games, the practitioners themselves will be present to ensure that the child understands the game. After the practitioners verify that the child understands the game, the child can be left to play it alone if they wish to do so.

E3 commented that ASC children like things to be predictable, stating that it would be good if the game was at least somewhat predictable. E3 then commented that a small amount of surprise was fine, but that excessive surprise could potentially set off negative behaviours (e.g. triggers), or make an ASC child get upset or frustrated.

E3 also commented that ASC children can find it frustrating if they are repeatedly unable to progress through tasks (e.g. within games), or are unable to understand what to do or how to progress. In this regard, E3 suggested having scaffolded learning and feedback, and agreed with the game's current method of doing so (through dialogue choices and feedback).

E3 stated that having a narrative was a good way to keep children engaged and interested, but that it should not be overly complex or drawn out, as this may cause

players to lose interest, particularly ASC children, who E3 noted as having shorter attention spans than those of TD children. E4 also commented that having a narrative was good, as it could help to keep players engaged, but again, it should not be overly long or complex, as this may have the opposite effect. In this regard, E4 agreed that the current game giving players the ability to select levels (i.e. replay them) was a good idea, and that the levels could together form an overall narrative, broken down into re-playable sections (levels), as children may like a particular level and want to replay it without having to go back through any previous levels. E4 also stated that the level unlocking system made sense. E4 noted that players always playing as themselves was a good way to make different levels more consistent and predictable for the player.

E3 gave warning about using cartoon-style faces, stating that ASC children can have difficulty transferring cartoon faces to real ones, i.e. recognizing expressions between them. However, it was mentioned by the researcher that the faces, while being cartoon-like, were still designed to be realistic and look like humanoid faces (with the exception of Sarcbot), and that the main point of having them in cartoon-style was to better fit with the game's aesthetic, which E3 agreed with.

In terms of the language (i.e. in dialogues), E3 stated that it was highly important to ensure the language was appropriate in terms of syntax, such that it could be successfully understood by the target players, and did not demand excessive cognitive resources to do so. In this regard, E3 suggested reviewing some storybooks or textbooks aimed at children of a similar age, in order to see what sort of language is used by professional authors who write for children of that age range (7 and up). E3 also mentioned that some readers, e.g. those with poorer reading ability or with a reading-related deficit such as dyslexia may read text in a “flat” manner, i.e. ignoring prosody, and so such readers may find it more difficult to derive a character’s emotion from written text. This coincided with what D1 said in the participatory design session. To remedy this, E3 suggested that the game suggest an adult (e.g. a parent or teaching assistant) be with the child as they operate the game, helping them to read dialogue, and perhaps also telling the child about the dialogue’s prosody, or reading the dialogue aloud in a “storytelling” manner, e.g. acting out the voice of the character. E3 also mentioned that having an adult with the child would be beneficial in terms of keeping the child engaged, as if the game is too word-heavy for the child, they may become disengaged, unless some rewards were present to keep them engaged. E4 also noted

that ASC children can have difficulty in deriving prosody from written text, and an idea was discussed in which “pseudo voice acting” could be included, as in instead of fully speaking out lines of dialogue, a short vocal clip could play of that character expressing an emotion. For example, a sad character might make a “sad groaning” noise. This clip could play at the beginning of a relevant line of dialogue, and could be clicked by players, should they wish to review the sound, or simply to listen again. This would also be more interactive for players, potentially providing more engagement. Alternatively, the clip could not play at the beginning of a dialogue line, but could be clicked by players if they wished, e.g. if they were stuck and needed a hint. E4 also mentioned that this could also be incorporated into the feedback given by Sarcbot, i.e. Sarcbot would suggest clicking the sound button.

E4 liked that the game adopted the learning by teaching approach, and commented that it is beneficial to give players customization (e.g. in terms of game options) and choices to suit their needs.

In terms of rewards, E3 liked the idea of the fireworks and the sound effects, and also liked that they changed depending on how good a player’s answer was, stating that ASC children highly enjoy sensory feedback. E3 suggested randomizing the fireworks so that the reward was not exactly the same every time, which may help to keep children engaged. In the same regard, E3 mentioned that care should be taken as some ASC children may not like the sounds associated with rewards, as some ASC children are highly sensitive to sound, and so E3 agreed that it was beneficial to enable players to alter volume levels or mute sounds if they wished. E3 also mentioned that ASC children can vary in what they like and dislike, and agreed that it is generally good to be able to customize game settings to accommodate these factors. E4 mentioned that players could exchange points for cosmetic items with which to customize their avatar, or to customize Sarcbot and give it some extra abilities, which would be an immediate reward, and would hold players’ attention.

E4 mentioned including a progress bar to show the current completion of the level, e.g. if there are five NPCs which need to be spoken to in the level, this could have a bar associated with it, which fills up depending on how many NPCs have been spoken to. E4 noted that this would give players a sense of “security” in their navigation of a level, and provide a means for them to track their progress and feel less lost. E4 also liked

the idea of a tutorial, and commented that ASC children are usually able to learn from experience and do not always need explicit instruction for simple concepts such as getting points for an answer, as long as it is made clear what the effects of their actions are.

E3 gave warning about introducing a combat mechanic, as they mentioned that it could potentially de-rail the focus of the game, and that if it were to be implemented, it would need to be done in such a way that made sense in the context of the game, and should not promote violence or other bad behaviour. E3 also commented that a combat system is inherently quite complicated, and while TD children may enjoy such a system, ASC children may find that it requires too much attention, and may become disengaged, and also that the “reward” from combat would be “delayed”, as players would get no immediate benefit by allocating sarcasm points into stats, only being able to see those effects when in combat, which could happen some time later. E3 stated that ASC children typically prefer more immediate rewards. Similarly, E4 also was uncertain as to whether including a combat mechanic would be a good idea, giving similar reasons to E3. E4 mentioned that combat might seem arbitrary and perhaps jarring to some players, and would not be coherent with a more narrative and dialogue-focused game, and would only serve as a disruption to the game.

When asked for feedback on the “game show” idea, E3 commented that it could be a good idea, although care must be taken to avoid making the competition overly competitive, and to avoid demotivating the player if they were to lose. In this regard, E3 suggested rigging the competition so that the player always wins, or in the case that the player were to lose, it would not be discouraging for them, as they would be told that they lost because they had taught Sarcbot so well (as they were competing against Sarcbot), so there would still be some positive encouragement for them. E3 stated that *“losing is fine, as long as it is presented in a way that is not going to be upsetting [for the player].”* It was also discussed as to whether to leave the outcome of the challenge ambiguous, or to not have the player explicitly lose, rather to get 2nd prize or some sort of rank. E4 liked the idea, and suggested having both the player and Sarcbot answer questions at the same time (instead of taking turns), as it might be frustrating for a player if they got an answer wrong, but would have gotten an answer to a question given to Sarcbot. E4 mentioned that this approach would also be more fair and balanced for players. When asked if this sort of competition would be intimidating for players, E4 commented that it would depend on how the competition

was “phrased”, as in not being a high stakes winner-takes-all-style competition, as this may evoke stress or intimidation, but rather have the competition be a friendly one. E4 also mentioned that some ASC children can be competitive and would enjoy such a competition, but that this would not necessarily apply to all ASC children, and so giving players the choice as to whether to compete or not would be good.

7.4.1 Design Changes Resulting from Second Round of Interviews

While previously, the game was intended to be played alone, but possibly with an adult present for assistance, now the game was intended to be played with an adult present. No design changes were necessary as a result of this, as adults should theoretically be able to understand the game and its interface, something which was observed from expert interview sessions. A message was included on the game’s startup screen, saying that an adult should be present (but obviously there would be no way to enforce this). Having an adult present would also be beneficial to keep the child on-track, e.g. by stopping them from spam-clicking buttons simply for the purpose of producing sound.

7.4.1.1 Game Mechanic Changes

The combat system, while perhaps being engaging for TD children, would likely serve as more of a seductive detail than a necessary game mechanic, and would potentially not be as enjoyable for ASC children, due to its extra attentional demands and less immediate feedback. Therefore, it was decided that the combat system would not be included; however, in the interests of making the score system seem less “immediately” arbitrary (i.e. its purpose is to unlock further game levels, which presents no immediate reward for the player), a “score bar” was included, which filled up over the course of a level. In this regard, a “combo” system was introduced, where upon successively choosing correct answers (even if the answer was only average), players would trigger a “combo”, i.e. getting two correct answers in a row would trigger a combo that multiplied the next score in the dialogue by two, and three correct answers in a row would give the player a combo which multiplied the next score by three (three was the maximum multiplier). Upon each combo increase, a more prominent visual and auditory reward signal was given, as well as a notification on-screen telling players what stage their combo was at, in addition to the regular effect from getting the correct answer. If, during a combo, players chose an incorrect answer, the combo ended, re-

setting the multiplier, and scoring the player 0 for that answer. This was designed to be more enjoyable to ASC children, who prefer more immediate sensory feedback, while providing motivation for them to keep the combo going by choosing correct answers, and to choose the best answers, since they will get higher scores that way due to the combo system multiplying their score. In the interests of keeping conversations realistic and ensuring the player cannot farm score or somehow escape the consequences of their responses, dialogue only progressed forwards.

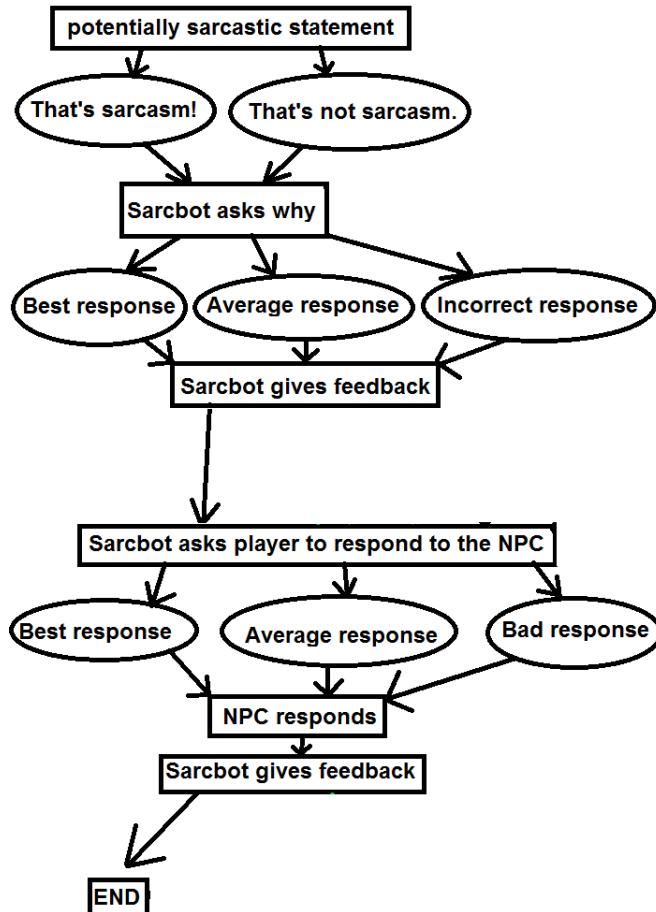


Figure 7.8: The logical progression of sarcasm-related dialogue. Player statements are in ovals, NPC statements are in rectangles. Players could potentially get points for each of their responses.

Without a combat system and due to the fact that players no longer lost health through dialogues, it no longer made sense to include the health system at all, and so it was removed. Gaming the system was still alleviated by the fact that, although levels could be played as many times as desired, individual dialogues within those levels

could only be attempted once, and so there was no way to e.g. “farm” points by repeatedly choosing the same options in the same dialogues. Players would have an incentive to score highly based on the sensory feedback from rewards and the fact that further levels could be unlocked with the points. Another benefit to removing the health system was that, previously, players would have had to pay attention to both their health and their score, placing extra attentional demands on them, something ASC children would likely find difficult, leading to disengagement. It was thus made simpler for them to see how well they were doing by only tracking their score, and providing a clear visual means of doing so through the bar and a displayed number. The removal of the health system meant that now, players could never “lose” a level, something E3 suggested for the final challenge, and which was applied to the whole game. The removal of the health system could also be said to make the game friendlier, less stressful and demotivating, as players were no longer penalized for mistakes, they simply did not score as well as they would have if they selected better responses.

Upon completing a level, the player was given the option to end the level, or to keep playing the level (even though there would be no objectives left in the level for them to do, but they could still explore, do any unfinished side-quests etc.) and return to the main menu later. This was to promote a feeling of control, while letting the player know the current state of the game.

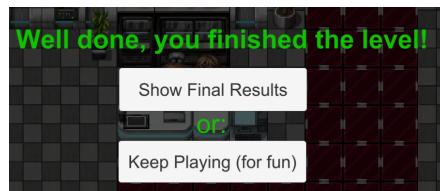


Figure 7.9: The player had the option to keep playing or to go straight to the final score calculation and return to the menu. If the player chose to keep playing, upon choosing to return to the main menu later, the final score calculation screen would be presented at that point.

After completing a level, when the player chose to end the level, a screen would appear which counted their score and gave them a corresponding rank, showing how well they did. The ranks never belittled or demotivated the player – feedback was always positive, while still showing the player that if they did badly, they could potentially do better another time, by showing any remaining score that could have been obtained via

an incomplete final score bar. The ranks given at the end of the levels were: “Decent” for a score of less than 20%, “Cool” for a score of between 20% and 40%, “Brill” for a score of between 40% and 60%, “Awesome” for a score of between 60% and 99%, and “Super-duper” if the player achieved the maximum possible score (100%) for that level. A corresponding audio “jingle” played depending on the final rank obtained, and some visual effects appeared on-screen (which changed depending on the rank), to further serve as a sensory reward.

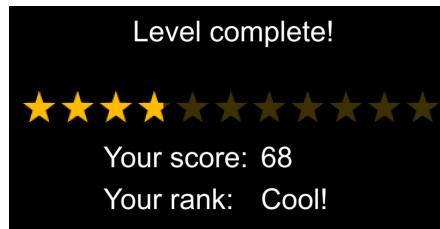


Figure 7.10: The “level complete” screen counted up the player’s score for that level, i.e. the star bar increased gradually up to whatever the player’s score was, and the rank changed as a result. After this, a final message was presented along with a jingle and visual effect, and the player could return to the main menu.

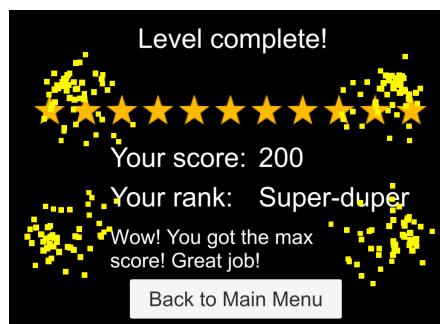


Figure 7.11: The screen showing the player’s final score, which here was the maximum for that level.

To assist with slower or less able readers potentially reading dialogue in a “flat” manner (i.e. without prosody), an “emotion sound” (i.e. pseudo voice acting) mechanic was added, where, instead of characters speaking entire lines of dialogue (which, for this research would have been too time consuming and potentially costly e.g. due to hiring voice actors in order to do it effectively), characters simply made a vocal noise to indicate their current emotion. For example, a happy character made a laughing sound, and a sad character made a crying sound. This system also tied into Ruiz’s

notion of vocal cues for detecting sarcasm [Ruiz, 2012], although instead of vocal cues within spoken dialogue (e.g. a change in prosody), the emotion sound system simplified it down to just the cue itself. Players interacted with the sounds by clicking on a speaker icon which appeared at relevant points in a dialogue; this interaction may be enjoyable for ASC children as it was another form of sensory feedback, this time under their control, as they do not have to listen to the sound if they do not want or need to. However, this sound could also be said to promote overly “stimulatory” behaviour, in that ASC children may become addicted to clicking the button to produce sound.



Figure 7.12: A clickable icon appeared when a character expressed an emotion. Clicking the icon played a short vocal clip of the character making a noise associated with that emotion, such as a groan for "grumpy/moody".

7.4.1.2 Visual Changes

The firework reward effects, while still varying between answers (e.g. in terms of intensity, to signify better or worse answers), were randomized, i.e. fireworks would (randomly) appear in different places and be different colours.

A “progress bar” was added to the on-screen UI along with a label showing the player how far they were through the level via a percentage and a corresponding bar that filled up. The bar could be modified by speaking to NPCs and completing their conversations, and produced a sound and visual effect upon doing so.



Figure 7.13: The level progress bar.

7.4.1.3 Dialogue Changes

The language in dialogues needed to be made more age-appropriate, and so as per E3's suggestion, storybooks aimed at children of ages 7 and up were reviewed, to get an idea of how this could be done. Such books included works by childrens' authors such as Enid Blyton, Dav Pilkey, and Roald Dahl. It was noted that these books tended to mainly use one or two syllable words, only occasionally using three syllable words, and when used, such words were simple and understandable e.g. "animals". Therefore, in the game, words such as "excellent" and "certainly" were changed to simpler, lower-syllable synonyms such as "great" and "yeah". It was also noted that the books used relatively short sentences, although compound sentences were still used. Some of the game's sentences were comparatively long, and so they were broken down into smaller chunks.

7.5 Third Round of Expert Interviews

E5 was interviewed, and E2 was interviewed again; both played a version of the game with all the previously discussed changes implemented, and also played a prototype of the final quiz challenge.

E5 commented that the first screen which prompts players for their name could be clearer in terms of letting the player know that they can click the buttons or press enter to continue.

Upon reaching the main menu and seeing the initially locked levels, E5 commented that children would likely want to try and go to those levels immediately (i.e. before unlocking them), and may become frustrated if they could not. In this regard, E5 suggested perhaps hiding the locked level buttons entirely, only having them visible when they were unlocked. E5 also suggested that instead of initially showing players the main menu, the game could take them straight to the tutorial, where some explanations and background would be given.

The main area of discussion with E2 was the user interface, which E2 now described as being "cluttered". This was noted as potentially being confusing and over-

whelming for ASC children. In this regard, E2 stated that they thought the UI functionality was good as it allowed lots of player control and choice, but that it needed to be laid out in a more intuitive way. E2 understood the functionality of the UI elements such as the level progress bar, and liked that there was a “current task” present to remind players what they were currently supposed to do, and also suggested that it could update depending on the player’s progression through a particular task, i.e. not just upon receiving a new task, which was what it did at the time. E2 commented that the current UI elements should be constantly visible to aid players in keeping track of their progress and achievements, but that they needed to be re-arranged. Some usability principles were then discussed, such as grouping UI elements by their functionality (instead of the current version where everything was grouped together in one panel). In this regard, E2 suggested grouping the score bar and the level progress bar together and having them distinct from the rest of the UI elements, putting the “quick options” alone in the top right corner, and the music selector bar along the top. E5 was also able to intuitively understand the UI functionality, such as selecting music tracks, and the purpose of the level progress and score bars, and commented that the functionality of these was good, giving similar reasons to E2.

E5 also mentioned some issues with the current user interface, mainly the colour scheme, as it mainly used various shades of grey which did not contrast well, making it hard to distinguish foreground from background, and hard to see the dialogue choice selections, as they were also highlighted in a different shade of grey. The level itself also happened to be coloured in mainly grey, which made it hard to distinguish the level background from the user interface in some cases. E5 had some slight difficulty involving the dialogue UI becoming de-selected when other UI elements were selected – this was due to how Unity handles having separate UI elements on-screen (i.e. only one can be active at a time), and so E5 suggested making it clear when the dialogue box was not active, such as having it slightly transparent.

E5 suggested putting some more explanations in the tutorial, such as explaining the level unlock system, and also explaining the manner of progressing through a dialogue, e.g. selecting responses. However, E5 stated that the explanations should try to be concise and clear, such that players would not be overwhelmed or bored by excessive information. E5 mentioned that navigation, i.e. making it clear where the player currently is and where they currently have to go, is highly important for ASC children.

In this regard, E5 liked the “current task” box, but also suggested putting in more explanations, e.g. telling the player that they are in the tutorial upon them entering it.

E5 liked the prominent “press enter to interact” text upon entering a zone in which the player could start a conversation with an NPC. E5 initially could not distinguish the main quest balloon icons from the side quest balloon icons.

E2 suggested making it more explicit which character was currently speaking in a dialogue. Suggestions included giving each character their own colour of text to better differentiate them, and putting multiple face portraits on-screen (relating to all participants in the current conversation), which were highlighted when the corresponding character was speaking. Upon discussion with E5, E5 also liked the idea of having different colours of text for different characters, possibly letting players choose their own text colour. E5 also suggested highlighting the sprite of the currently speaking character (i.e. the in-game sprite of the character in the level, not the face portrait itself).

E2 liked the reference to the previously spoken dialogue, but suggested also including the same for the player (i.e. including a box showing what the player had just said) for consistency’s sake. E2 also suggested potentially including the last two responses instead of only the previous response, or having a “chat history log”. E5 also suggested having a chat history log, as it was discussed whether to include the ability for players to go back in a dialogue in case they wanted to review old dialogue, but it was agreed that this would not work well in this case, as players received score for their dialogue choices; letting them go back and essentially “undo” their choices could lead to players gaming the system. In this regard, the chat history was discussed as being preferable. E5 mentioned that the history did not have to include the entire dialogue, only the last few statements. Both E2 and E5 intuitively understood that their previously selected dialogue responses were a different colour.

E2 suggested removing the “press enter to interact” prompt during a dialogue with a character (the prompt appeared when entering a detection zone in which a conversation could be triggered), as it served no further purpose once a dialogue had started and only served to clutter the screen, and actually could cause confusion by potentially misleading players into thinking they constantly have to “press enter to interact” (when

in fact they would already be interacting).

In terms of rewards, E2 liked the clearer and more intense visual rewards and the associated sounds. E2 also liked the combo system, stating that they had previously done studies with ASC children, and one of the feedback items they received was a reward system of increasing intensity based on player input (i.e. more consecutive “good actions” leads to more intense and better rewards). E2 also agreed that the combo system should be cut short upon a player giving an incorrect answer, as this would provide motivation for players to keep getting correct answers so that their combo did not run out. E2 also liked the new score system and the removal of the old health system (as the health or a similar “penalty” system could lead to frustration for ASC children), and stated that the fillable star bar for score would also provide motivation for players to fill it up as much as possible by getting good scores, and also served as a constant reminder of players achievements in-game. E5 also liked the visual and sound aspect of the reward, and liked that the score bar filled up. E5 also liked the final score counter screen (which counted up the player’s final score and gave them a rank at the end of the level).

Some smaller suggestions were for the game to be more explicit about specifying the keyboard as the input method upon players first being prompted to use the arrow keys, as E2 initially tried to click on the on-screen arrow graphics. Another suggestion was to change the position of the “click or press enter to continue” button for dialogues from the right to the left inside the dialogue box, as E2 stated that that was where their eyes naturally looked, and it would be better to have the button in a place that did not require “searching”. E2 initially had some trouble distinguishing the player character from other NPCs, as some of them looked similar. There was also some confusion due to ambiguity between the “enter” key and the “return” key – the game was mapped to prompt and respond to the “return” key, but labelled it as “enter” while the “enter” key on the numpad was not used, and this caused some confusion as E2 initially tried to use that. E5 commented that when the player exited the elevator (there was a section in the tutorial in which players entered an elevator, and then exited it facing the same direction) they should be facing in the correct direction.

E5 also suggested making the dialogue more explicit in terms of anaphora, e.g. instead of a character saying “I’m looking forward to it”, they might say “I’m looking forward to working together” (instead of referring to an arbitrary “it”). E5 mentioned

that the dialogue should also be more explicit in terms of its explanations, e.g. making explanations very clear in the context. E5 noted that one of the dialogues was quite long and did not require much involvement from the player, even though the dialogue was an explanation for the player; in this regard, E5 suggested putting in more examples and practice questions for the player to answer, to break up the longer dialogue sections and keep the player engaged.

E5 liked having the ability to review the emotion bubbles and their corresponding meanings in the pause menu, and suggested also having them play their corresponding sounds when clicked; E5 also suggested having those bubble explanations appear straight away in the pause menu, instead of having to access them by clicking “Help”.

E2 liked the emotion sound system. Upon discussing whether full voice acting would be good, E2 stated that it would be, but that it also may be disliked by some players, so there should be an option to disable it. In this regard, E2 liked the optional nature of the current emotion sound system. It was suggested to make the speaker icon more indicative that it could (or should) be clicked, e.g. by making it flash. E5 also liked the system, but suggested removing the speaker icon and instead letting players click on the emotion bubble itself to hear the sound (which would also need to be explained). E5 also commented that the sounds were fairly quiet, and while the sounds were still somewhat noticeable and understandable, E5 suggested making them very obvious, even exaggerated, in order to ensure that the sounds were heard and understood, as E5 initially did not hear the sound upon clicking the speaker icon. E5 also mentioned that having exaggerated and funny sounds could be more engaging and enjoyable for players.

E2 also liked the fact that players could customize their name, and the name of Sarcbot. E2 suggested replacing the placeholder player face portrait with an actual photo of the player (i.e. providing functionality such that this could be done). E5 also thought that putting a real photo of the player in the face portrait was a good idea. E2 stated that in any case, the player’s placeholder face portrait would need to be changed to reflect that it was actually the player speaking (since at the time, the placeholder was a silhouette of a face with the word “player” on it).

Overall, E2 commented that they liked the updated version of the game, and thought

that ASC children would also like it, and that it could be effective in terms of teaching and engaging for them. E2 mentioned that while they themselves initially may not have been good at playing the game (e.g. in terms of moving the character), but were able to pick it up eventually, ASC children would likely be better able to figure things out more quickly, due to likely being more experienced with playing games. E2 liked the dialogue and found it humorous. E5 commented that they liked the gameplay and the teaching strategy (i.e. detect-reason-respond through dialogues with choices).

Here, E2 and E5 played a preliminary implementation of the "quiz show" mechanic discussed previously. The mechanic introduced a villain into the game, who was the quiz master in the quiz show, with the player and Sarcbot being contestants. The villain asked the player trivia-style questions about sarcasm, as well as asking the player to detect and reason about examples of sarcasm. Although the questions were directed at the player, the player could still ask Sarcbot for hints. When the player got a question wrong, the villain lightly mocked them, and when the player got a question right, the villain begrudgingly awarded them points. It was essentially similar to the other levels, but it was all one big dialogue. No health or score mechanics were included, as this was something to be elicited from expert feedback.

In terms of the final quiz challenge, E2 liked it, and commented that its current implementation would likely not be intimidating for a player (having previously given warning of intimidation as something to avoid), and actually may be exciting for players. Upon discussing the potential health or score system (e.g. whether to include a health system in this case since the quiz was intended to be more of a challenge), E2 commented that it would probably be better to have a similar score system as in the other levels, as players may become frustrated if the health system makes it very hard for them to progress. E2 liked the idea of the game having a villain for the player to defeat in an over-arching narrative, and that the quiz was essentially the final battle between the player and the villain. E2 also liked the proposed story where the player had to uncover the villain's true identity, discovering that the villain was actually a character met previously who developed Sarcbot, and wanted to test how much the player and Sarcbot had learned; so there was no real danger or threat from the villain, it was all just for fun and more like a friendly competition than a "challenge". E5 also liked the quiz, and upon discussing how "mean" the villain should be, E5 mentioned that the villain could be made meaner in a humorous way, but not too mean,

for example playing with the player's expectations by asking them if they understand an explanation, to which if the player responds "no", the villain simply says "tough". E5 also mentioned that it would be better if the player did not have a health system (giving similar reasons to E2), instead using a similar score system to the other levels; E5 also suggested that upon the player getting an answer wrong, the villain would gain score instead of the player – that way, the player would never make a loss, but there would still be some tension and competition, which players may enjoy. E5 mentioned that the villain could even potentially gloat at the player and use sarcasm of their own. E5 mentioned creating and adhering to some principles, such as ensuring the player never loses, that there is always something positive in interactions, etc., and then tailoring the quiz around these principles, while still putting in some challenge. E5 also liked how the villain did reward the player for correct answers, but did so begrudgingly.

E2 gave warning that some children may become addicted to pressing buttons to trigger a sound. E5 also gave this warning, but upon discussion it was decided that not much could be done to mitigate that, save for having an adult present with a child playing the game, in order to keep the child on track, and having the sounds be optional.

In terms of running evaluation sessions with TD children, E5 suggested making the tutorial shorter, as it was noted that the evaluation sessions typically last for around 30 minutes, whereas some children may be slower at progressing through the game, particularly if they are slow readers. E5 also suggested potentially including different game settings such as a shorter version and a longer version of the tutorial, which, depending on the current player, could be changed by an adult to better suit their attentional capabilities and speed of progression. For example, the shorter version of the tutorial could simply have less characters needing to be spoken to in order to complete the level.

7.5.1 Design Changes Resulting from Third Round of Interviews

7.5.1.1 Game Mechanic Changes

The name entry screen now indicated that the enter and backspace keys could be pressed to navigate, in addition to clicking with the mouse. Upon entering their name, players were subsequently taken straight to the tutorial instead of to the main menu.

They could still access the main menu by pausing and selecting “return to main menu”, or by completing the tutorial. While previously, loading from the initial name entry screen to the main menu did not take much time (it was practically instantaneous), loading from the name entry screen to the tutorial now took a few seconds, as Unity had to load more objects in the background; the game would basically freeze temporarily during this time, becoming unresponsive to player input while the level loads, but still displaying on-screen buttons and such. Therefore, a simple loading screen was added during the transition between game scenes, which displayed text saying that the game was loading, along with an image of Sarcbot sleeping (implying that the player should wait). This was to provide more feedback to the player, letting them know that the game is in a "loading" state, and therefore cannot be interacted with, as otherwise, players may think that the game has crashed or is otherwise unresponsive for some reason (as the on-screen buttons would not work during this time), which may be upsetting or frustrating for some players.

Some more explanations were included in the tutorial, such as telling the player that they were in the tutorial, and briefly going over the level unlock system, how to use the dialogue system (e.g. making choices), how to tell who was currently speaking, etc. as these were all areas that experts initially struggled with. The on-screen “use the arrow keys to move” prompt was removed, since movement was now explained in a dialogue. These explanations were kept brief and simple, and where possible, required interaction from the player, so that they did not become bored or disengaged. The longer explanations were optional, so that players could skip different parts of explanations, such as using the dialogue system, or moving the character around. These explanations could also be optionally repeated. In the interests of one hand making the dialogue explicit enough to convey details clearly, but on the other hand not overly word-heavy or drawn out, it was necessary to strike a balance between the two. This was attempted by including player interaction through dialogue choices as often as possible, e.g. by asking the player quick questions to keep them focused, and by keeping NPC dialogue statements simple and as brief as was reasonable. Giving the player the option to skip sections of explanatory dialogue was also deemed beneficial in this regard.

When explaining the user interface to the player, the corresponding UI element was highlighted to draw players’ attention to it and provide clearer direction.



Figure 7.14: A highlighted UI element. While this highlight was active, an NPC would be explaining the bar's function.

Per E5’s suggestion, the colour of the dialogue boxes were changed from gray to blue, and per E2 and E5’s suggestion, NPC dialogue was now different colours (e.g. a player had one colour, NPCs had various other colours to better differentiate them). Players could now choose the colour of their spoken text (but not that of NPCs) from the options menu. Additionally, players could now change the colour of the dialogue box itself. All this provided more ways of differentiating which character was currently speaking.



Figure 7.15: The text colour and dialogue box colour could be changed in the options menu. More colours would technically be possible, but for the prototype these few were deemed enough.

Since some experts had trouble differentiating the in-game player sprite from the NPC sprites, the tutorial now explicitly pointed out the player sprite and told the player that it was their avatar, and also gave them a speech bubble icon when they spoke to NPCs, which was enabled when the player needed to make a dialogue choice, and disabled otherwise (because the player was not speaking at that time).

The “press enter to interact” prompt now disappeared upon the player starting a conversation with an NPC. This ensured that the player was only ever informed of one “press enter” occurrence at a time. Additionally, the prompt was changed to “press

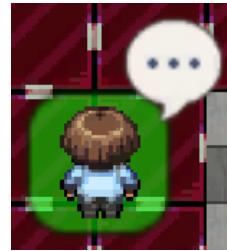


Figure 7.16: The player’s speech bubble (and green glow highlight), which was turned on when the player needed to make a dialogue choice.

return to interact” to avoid ambiguity between the enter and return keys.

The pause menu was altered to immediately display the bubble icon descriptions, and the icons produced their corresponding sounds upon being clicked. The regular functionality of returning to the main menu, quitting the game or accessing options was still present. The “Help” option (which was what previously showed the bubble icon descriptions) was removed since its functionality had now been included elsewhere.

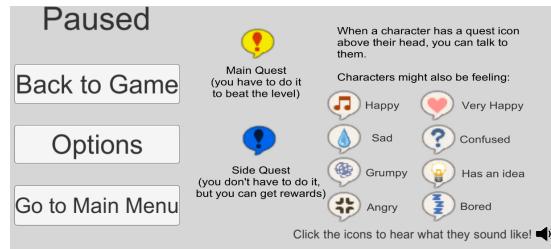


Figure 7.17: The new pause menu.

Per expert suggestion, a chat history log was added, replacing the previous reminder box (which only showed the previously spoken statement). The log contained the last 5 statements, and to save screen space, was made into a scrollable window that only displayed a few statements at a time. This enabled players to review previous dialogue without actually “going back” in that dialogue, as going back could lead to players gaming the system by essentially undoing their dialogue choices, utterly diminishing their realism and consequences. The dialogue in the chat history log corresponded to the colours of the player and NPCs dialogue in order to maintain consistency between the main dialogue and the chat history log. The chat log could be enabled or disabled by players. The chat log was also useful in that it easily enabled a

conversation log to be written out to a file (i.e. a log of all the conversations a player has had), which could then be reviewed by educators or parents, to see how a child is progressing, what mistakes they are making, etc.



Figure 7.18: The chat history log, with the player's selected text colour being green. This was placed above the regular dialogue box, and could be switched on or off.

Functionality was added enabling photos to be loaded into the game and used as the player's face portrait. This was optional, and if players did not load a photo, the default placeholder face portrait was used. The photo could be of anything, so e.g. if a player wanted to role-play as a certain character, this was possible. This extra step of personalization is something also used in Gray's social stories [Gray, 2014], meaning the game was really now about the player, and helped further solidify that the game was being played in the first person, something ASC children respond well to.

As the evaluation sessions with TD children were approaching, in the interests of managing time for those sessions (which were anticipated to last around 30 minutes each with room for discussion and a questionnaire), the tutorial was separated into “evaluation mode” and “full game mode”. Evaluation mode increased the character’s movement speed, enabling players to traverse the level faster, and also removed the longest NPC conversation, meaning players now had to do less to complete the level. The point of evaluation mode was to give players a decent understanding of the game and how it worked, enabling them to form opinions on it without it potentially taking a long time to do so. Full game mode was included to cover the case that some participants could be skilled game players and would be able to complete the level more quickly than other less skilled players. Separating the game this way could also be beneficial for educators who wish to provide children using the game with a mode that is suited to their skills and playing speed, and also to better fit any game sessions into their time constraints, e.g. a game session may be limited to 30 minutes before the child has to then do something else, so in this case, a shorter mode would be prefer-

able. In this regard, it was considered whether to re-balance the scores obtained from each mode, i.e. to make it so that players could achieve (the same) high scores on both modes. However, this was decided against (i.e. players would not be able to score as highly on evaluation mode as they would on full game mode) because otherwise there would be little incentive to do full game mode if players realize they can get just as good a score for essentially less effort. Therefore, while players could still get good enough scores to unlock further levels in demo mode, they would not be able to score as highly as they could in full game mode.

7.5.1.2 Visual Changes

The feedback on the cluttered UI may have been due to the small resolution of the screen on which the game was being played, but the comments were also taken into consideration, and E2's suggestions as to where to move certain UI elements were implemented. The colour of the UI was also changed to be more interesting and clear, as E5 mentioned changing the overly grey colour scheme. The UI was therefore redesigned to take up less screen space and also be more distinct from the background, by changing its colour from grey to multiple colours to contrast better with the background, and changing its transparency from semi-transparent to less transparent.



Figure 7.19: The old UI.



Figure 7.20: The new UI.

To make it clearer which character was currently speaking in a dialogue, their in-game sprite was highlighted with a green glow when they were speaking, in addition to the regular speech bubble.

The main quest and side quest balloon icons were altered to enable them to be more easily differentiated. A corresponding explanation was given stating the differ-

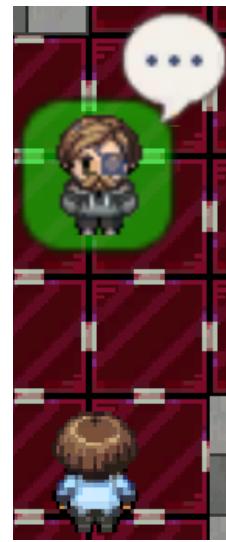


Figure 7.21: The currently speaking character (top) had a green glow and a speech bubble. Non-speaking characters (bottom) simply had no glow or speech bubble.

ence between the icons. For consistency's sake, all speech bubbles turned white when the corresponding characters were engaged in a dialogue.



Figure 7.22: The new main quest (top left) and side quest (bottom right) icons.

When interacting with the elevator in the tutorial, to make it clearer that players had exited the elevator, their sprite now faced away from the elevator doors upon exiting (whereas before, their sprite remained facing the same direction, which could be misleading in terms of making the player think that they had not entered the elevator).

7.6 Fourth Round of Expert Interviews

E1 was interviewed again, playing a version of the game with all the previously discussed changes implemented. Initially, E1 mentioned that on the start-up screen noti-

fication telling players they could click or use Enter to progress, and Backspace to go back, there should be another means of going back, or something saying “click to go back” instead of just Backspace. Alternatively E1 suggested making everything either press-able or clickable (i.e. not both).

E1 liked the initial tutorial explanation, but commented that it could provide more involvement and input from the player, as there were long, mainly one-sided dialogues where an NPC was essentially telling a passive player what to do, which may cause boredom and disengagement. E1 suggested incorporating mini-tasks for the player to do during the initial explanations, for example, upon being told how to move their character, the player could be instructed to go and fetch an item and bring it back. E1 noted that some of the explanations could be re-ordered, such as the dialogue system explanation, which E1 noted as making more sense if it was explained first, rather than after some other things. E1 agreed with having explicit explanations with regard to the target population, and that the explanations themselves were straightforward and clear, but disliked the fact that it took a long time to get through the explanations to a point where the game could actually be played. E1 suggested that instead of having long chunks of explanation, the explanations should be more interleaved with the gameplay itself, e.g. the score bar should only be explained (and should only become visible) upon the player receiving score, and there should be more player involvement, e.g. through the mini-task suggestion. However, E1 also noted that breaking up the explanations too much could considerably extend the time taken to reach a point where the player was free to play the game.

E1 suggested some minor sentence structure changes for the explanations, and again suggested making the sentences shorter, although E1 mentioned that the words and sentence structures themselves were appropriate for children (i.e. not overly complex). E1 also suggested a minor change to one of the dialogue statements, in this case saying that more words could be used. E1 noted that the statement made sense, but could be made to read better.

E1 noted that the “<Name> says” boxes should appear more like one statement rather than two separate statements (since they were in separate boxes at the time, i.e. [Name] [says:]).

At one point, E1 discussed something with the researcher, and then went back to the dialogue, but forgot what the previous statement in the dialogue was. While E1 noticed the chat log previously, E1 did not utilise it here (most likely because it defaulted to off at the start), and suggested having the previously spoken statement present while dialogue choices appeared. The researcher then prompted E1 to look at the chat log, which was initially turned off. E1 turned on the chat log and was then able to review what was said in the dialogue. E1 commented that they liked the functionality of the chat log and found it useful, but that they did not like its position on the screen. In this regard, E1 suggested incorporating the chat log more into the main dialogue box, instead of above it. E1 also suggested changing the chat log's name to e.g. "show our conversation so far". E1 also thought that the "on" and "off" buttons for the chat log were somewhat misleading, as the chat log did not actually turn on or off, rather those buttons showed or hid it. In this regard, E1 suggested changing the button names to "show" and "hide". E1 referred to the chat log several times throughout the course of gameplay, but only briefly, and then hid the log when it was no longer needed.

Upon being told by the game that a red box would appear around the object currently being explained, E1 immediately tried to look for the box, although the box was not yet present as no object was yet being referred to.

E1 was briefly confused as to the difference between "mute" and "turn all sounds off", but upon an explanation from the researcher (that "mute" turns off the music while still keeping the sound effects, whereas "turn all sounds off" turns all the sound off), E1 agreed that the functionality was good, but that it could be more clearly differentiated, e.g. by changing "mute" to "turn off music".

E1 liked that it was possible to customize the player's text and dialogue box colours, but suggested showing what the potential changes would look like before the options were selected, e.g. having different text colours corresponding to each of the colour choices.

Upon moving to an area of the game containing NPCs to be spoken to, E1 initially attempted to speak to NPCs who did not have bubble icons (i.e. they could not yet be spoken to), and was unable to. However, E1 was confused, as some text appeared saying "press Return to interact" (since the player character had entered the trigger area

to start the conversation, which showed the text, but the conversation was currently inactive). E1 suggested not having this text unless the player could actually interact with the NPC.

E1 wandered around the level searching for NPCs to talk to, and was initially unable to locate the correct NPCs. However, E1 then looked at the “current task” box, and remembered where they were supposed to go.

At one point, the speaker icon appeared, and although E1 noticed it, E1 did not click it. Later, the speaker icon was referred to in a dialogue, and E1 clicked it. The sound in that case was “sadness” (a crying sound), but E1 noted that they could not tell if it was crying or chuckling. Later, when another noise was encountered, E1 commented that they were unsure whether the noises were helping. E1 mentioned that they found the emotion bubbles more helpful than the associated sounds, as the sounds were happening so far out of context, in that the sounds were not fully accurate - for example, the “bored” sound was a snore, but E1 mentioned that the character’s face, while looking glum, did not match up with the snore sound. In this regard, E1 suggested having more of a sigh sound for boredom. E1 also commented that some of the other sounds, e.g. happiness, did not make sense either, as the happy sound was a short laugh, but E1 commented that one would normally not laugh in the middle of a conversation as soon as one became happy. Upon discussion, E1 ultimately agreed that they would prefer the text to be read instead of having a somewhat arbitrary sound played, as the text could incorporate the tone of the sentence. Upon being told that the game was intended to be played with an adult present for assistance, E1 suggested that the adult themselves could read the dialogue aloud, although this implies that the adult would need to know the appropriate emotion needing to be expressed. E1 mentioned that this could be a good way of fostering interaction between the child and the adult, using the game as a medium.

In one of the NPC conversations, players had the option to ask questions such as “what is sarcasm?”, or alternatively to say “I don’t have any questions”. E1 noted that they could foresee players simply clicking “I don’t have any questions” without going through the other questions, as they would likely want to experiment and figure things out for themselves, perhaps going back and talking to the NPC again if they wanted further clarification. However, in the current version of the game, once the conversa-

tion with that NPC had ended, it was not possible to re-do it (unless players restarted the tutorial). In this regard, E1 commented that players would likely be impatient by this point, and would like to play the game rather than being told what to do, but that they may want to get help later if they become stuck and need an explanation.

Upon reaching the point where it was necessary to choose a response to a sarcastic statement, E1 stated that it was hard, since all of the options seemed valid.

With regard to the score and rewards, E1 liked the system, but noted that there was not much visual feedback as to how good a given answer was (when it was chosen). At the time, the differentiation between rewards was the level and type of sound, the intensity of the firework burst effect, the number of points, and the colour of the points text (green for good answers, yellow for average answers, orange for wrong answers). However, the “good” and “average” effects could be said to be not easily distinguishable, as they looked somewhat similar, just with different intensities (of sound and visuals). E1 mentioned that it was not clear how good an answer was, as when a number (of points) appeared, it was not clear whether that was the maximum, i.e. whether it would have been possible to obtain more points with another answer. This was discussed further, and E1 suggested including another number to show how many points could have possibly been obtained for that question, e.g. instead of a number saying “3”, it would say “3/5” to let the player know that while their answer was correct, it was not the best possible answer. At one point, E1 got an answer wrong, but did not recognize the “0” as a 0, instead seeing it as an icon or a “data card”. This was most likely due to the font of the text.

On a similar note, E1 commented that there could be more feedback upon getting an answer wrong, and also suggested letting the player go back and re-attempt a question if they did not get the best answer. This was discussed, as E1 understood that it would not be good to allow players to continually go back and “farm” responses to cheat and earn lots of points, and so E1 suggested having the re-attempt not give the player any points, but still give them feedback. E1 liked the fact that conversations only “went forward” (i.e. that it was not possible to “undo” responses), mentioning that it gave conversations a greater sense of realism, although E1 was unsure how well autistic children would respond to this.

E1 noted that the current game seemed to heavily imply that sarcasm was equivalent to lying, stating that sarcasm is more subtle than a lie, as a lie is actively trying to deceive; sarcasm is similar, but is used more to convey a message or an emotion than to actively deceive. However, E1 did agree that for the target audience, a simpler notion of sarcasm would most likely be better understood by them.

Lastly, E1 commented that it would be fun to be able to interact with objects on the map (e.g. items or props in the background). E1 commented that the levels were fairly detailed and interesting, but that only a few sections of the level were actually important, i.e. those containing the NPCs.

7.6.1 Design Changes Resulting from Fourth Round of Interviews

In the interest of making it clearer to players how good their answers were, an extra number was added to the score reward, showing what score the player could have potentially got, and ideally letting them know how good their answer was.



Figure 7.23: Top left: The old player score reward, showing a lone number. Others: the new score rewards, showing a number “out of” another number. The colour change for different better or worse answers was kept (green for better, yellow/orange for worse).

7.7 Fifth Round of Expert Interviews

These interviews, conducted with E6 and E7, were done towards the end of this research, and so no design changes resulted from them. The version of the game E6 and E7 saw was the same as the one seen by the second set of participants in the evaluations (see chapter 8). E6 and E7 were asked some introductory questions (such as "what is your area of expertise"), and then played the game.

E7 mentioned that they had briefly investigated sarcasm in a previous research paper, noting that there could be quite a small distinction between sarcasm, irony, sarcastic irony, and so on, and that it was a fairly complex area, although one falling more into the category of linguistics. E7 also mentioned the potential complexity of sarcasm, stating that it is usually negative, but can also be positive in a roundabout way, e.g. when watching someone break the speed record for a hundred meter dash, one might jokingly say that the person is slow, however the statement is indirectly meant as a compliment.

Upon reaching the first screen, E7 commented that they liked Sarcbot and thought such a concept (of a friendly robot character) was a good idea. E7 also commented that the user interface was clear, and liked the loading screen.

E6 noticed the sound effects, and commented that it may be an area of concern when developing games for ASC children (as they are highly sensitive to sound). In this regard, E6 liked that there were options to change the sound levels, or turn sound off. E7 commented that the sound effects were good, as they provided clear feedback to user input, e.g. when pressing a button which produces a sound.

E6 initially saw the music selection bar, and listened to a few of the tracks before turning the music off.

Upon being given the first mini-quest (of fetching an item for the tutorial explanation NPC), E7 realized that it was essentially a "ruse" to get the player accustomed to the controls, and stated that this was a good idea.

E7 was initially confused upon being asked a question by an NPC, and stating "*do*

I press enter to say yes?", and then at another point asked how to say "no", but then pressed Enter and saw the corresponding dialogue choices, which were then understood.

E6 mentioned that it was good that the game had a narrative, and also that the graphics were good, saying that both of those factors can contribute to player engagement. E6 noted that having a narrative was a way to somewhat "trick" players into enjoying themselves in the game by getting them immersed in that narrative, and also that having different levels would be a good way to have a continuous narrative that children would likely be engaged with and want to follow. E6 also liked the game's available customizations (such as the text colour and name customizations), saying that such customizations can also keep players engaged.

E7 mentioned that they liked the "level progress" bar.

Upon first seeing the speaker icon appear, E6 immediately noticed it and clicked on it, and the researcher briefly clarified what it was, as E6 had not yet viewed the corresponding tutorial explanation. Throughout the session, E6 tended to make use of the speaker icons, not doing so in only a few cases. E7 also noticed it, and thought that it meant that the character would speak their line of dialogue. When its true functionality was explained by the researcher, E7 understood, and then used the speaker icons at various points during the remainder of the session.

When choosing a name for Sarcbot, E7 accidentally pressed Enter when the "name entry" box was blank, and because there was no safeguard against this, Sarcbot's name became a blank space in conversations (but was still stored internally as "Sarcbot").

During one of the practice sarcasm questions, E7 noted that the statement in question (asking the player how a person is likely to be feeling if they are saying something happy but do not look or sound happy) was more like an application of "display rules" than sarcasm, saying that "display rules" are essentially manners which are taught to children, e.g. if a child receives a present which they do not actually like, they should still show happiness out of consideration for the present-giver. The researcher then mentioned that the statement was simply meant to give an example of a situation in which sarcasm may occur, and that the player had to also figure this out, which E7

then understood.

Throughout the session, E6 and E7 had some issues with the dialogue box becoming de-selected when they clicked on other UI elements. E7 also accidentally clicked on the wrong dialogue choice twice (but then made use of "retry mode"). This was discussed with the researcher, and it was agreed that playing the game on a tablet would likely mitigate many such UI issues.

E6 mentioned that the explanations contained quite a lot of information, and suggested making the explanations more streamlined, such that they get the point across to the target audience without overloading them with information or causing them to become bored. Upon progressing through the tutorial explanations, E6 noted that the explanations were generally good in that they provided information telling players what they should look for when dealing with sarcasm, and why that is the case (making it seem less arbitrary). In this regard, E6 and the researcher had a short discussion on how the detail and "points" of the explanations could be kept, while making the explanations more engaging; E6 noted that it was a hard problem, and suggested an approach where, instead of having lines of dialogue that needed to be read through, players could hover over icon descriptions e.g. of faces or emotion bubbles, and see a corresponding short explanation. E6 also suggested delivering the information more slowly so as not to be overwhelming, essentially building up the player's knowledge in small chunks, rather than a big load of information all at once. E6 mentioned that the explanations could be incorporated more into the narrative (e.g. seeing an NPC's face change as a result of some choice), rather than simply told directly to the player. E7 also mentioned that the explanations contained a lot of words, and that some of those words were fairly complex, giving the example of "elevator", and that it could be changed to "lift". E7 noted that the contextual information could be fairly complex, giving the example of an NPC who almost immediately used sarcasm; E7 said that depending on the context, the intent of the person could be construed in a number of ways, e.g. perhaps the person is flirting with the player. E7 noted that there is usually more of a contextual "build up" to a sarcastic statement, and that it is not often used straight away, however E7 also agreed with the researcher's notion of trying to keep statements relatively simple, and avoid overly subtle or drawn-out contextual inferences; E7 mentioned that ASC children can struggle with reasoning about contextual information.

E6 and E7 liked that Sarcbot followed the player around.

Upon being able to freely move around and talk to different NPCs, E6 commented that it was good that the game gave players these options. E7 mentioned that the game reminded them of *Gauntlet*, an older game (made by Atari in 1985) with a similar visual and gameplay style. In this regard, E7 commented that they liked the retro style of the graphics.

In terms of the score rewards, E6 commented that they were good, and recognized that average answers were not as rewarding as the best ones. E7 also recognized this, and noted that they liked the score rewards.

E6 noted that, when choosing answers in sarcastic dialogues, the best answers tended to be the longer ones, mentioning that some players may also pick up on this, turning it into a way of gaming the system. The researcher made a suggestion of simply adding more text into the other answers, perhaps that was not entirely (but still somewhat) relevant, just to keep the answers at a similar length, which E6 agreed with. E6 also mentioned that it was good that some of the responses incorporated sarcasm (i.e. they allowed the player to be sarcastic back), as that was a way to allow players to play and experiment with sarcasm themselves, instead of simply being "recipients" of it - E6 mentioned that this gives players more ownership over their gameplay experience.

E6 noted that the current feedback for the player's sarcasm-related answers mainly prompted the player to look at situational context, and so E6 mentioned that it may be good to include more prompts to use the emotion sound system or look at the NPC's face portrait.

E7 asked how Sarcbot knew when the player got an answer right or wrong, since the player was supposed to be teaching Sarcbot. The researcher mentioned that it was assumed that characters in-game had some knowledge of the score system, i.e. they would see what the player sees upon answering a question, and so if the player got a question wrong, Sarcbot would also see the "0/5" score. However, this was not explained to players. The researcher then mentioned that when players answer a question, they need some explanatory feedback (so that they can learn from their mistakes),

and so the game tried to do this by not having Sarcbot explicitly reveal the answer (as Sarcbot was not supposed to know it), but rather give comments and suggestions which were intended to guide the player towards better reasoning and responses. In this regard, E7 agreed with the idea of using "Learning-by-Teaching".

When E6 made use of "retry mode" (see chapter 8.7), E6 noticed that the player got no extra score, but mentioned that this may cause some players not to make use of "retry mode", since they would get no benefit for doing so other than learning about sarcasm (which E6 commented that some players may wish to do). In this regard, E6 suggested adopting a "diminished score" system for retries, or implementing a hard limit on the number of available retries, or some combination of those. That way, there would still be some score-based incentive to make use of "retry mode", and learning from feedback would still take place. E7 did not make use of "retry mode".

E6 made use of the chat log, but turned it off at one point to see what was behind it. Later on, E6 commented that they would like a way to see the previous statement in a dialogue, at which point the researcher reminded E6 about the chat log, which E6 then used. E6 and the researcher also discussed players having the ability to go back in a dialogue such that emotion sounds and facial expressions that occurred at previous points in a dialogue could be reviewed. E6 commented that such a system would be good instead of simply having a log of the dialogue text, as players may wish to go back and review an NPC's facial expressions or emotion sounds. In this regard, E6 suggested a system where the dialogue box included both speakers in a conversation at once (instead of one at a time in a sequential manner), i.e. the player's face portrait would be on one side, and the NPC's on another, with the dialogue lines, emotion sounds and facial expressions changing accordingly. The current chat log would then be replaced with an overall log, containing a record of the lines of dialogue, and additionally the corresponding faces and emotion sounds, which players could then scroll back through. E6 mentioned that such a system would be beneficial if players became unsure of an NPC's previous emotions and wanted to review them. E7 immediately noticed the chat log, understood its functionality, and stated that it made sense.

Overall, E6 and E7 stated that they liked the game and were very impressed by it. E7 noted that it was good that the game took the approach of giving players a "working understanding" (of sarcasm), i.e. getting learners to actually apply the thing they are

learning about (in this case, engage in sarcastic dialogues) - the other approach being "reflective understanding", where learners are asked to give commentary and reflect on a subject after being taught it. E7 commented that for ASC individuals, and perhaps for any individual, "working understanding" is much more powerful and produces a better fidelity of results, because learners are actually applying their knowledge in context, which was the teaching approach the game endeavored to follow. E7 also mentioned that the game was good in that it provided potential to incorporate many more contexts, linguistic styles etc., perhaps going beyond just sarcasm and including other aspects of figurative language.

7.7.1 Discussion of Fifth Round of Interviews

As mentioned, since this was the last set of expert interviews before the research concluded, no design changes resulted from them. However, the results will still be discussed here, and expanded upon in the future work section (see chapter 9.1).

Both experts initially seemed to think that the speaker icon meant that the NPC would read that line of dialogue aloud, and that they did not feel a need to utilise it. However, upon being informed of the icon's true purpose, they both utilised it. Since they both encountered the first speaker icon without having seen the corresponding tutorial explanation, their assumption was sensible. In this regard, it may be better to explain the emotion sound system before it is seen by the player; the original idea was for the icon to appear so that the player could interact with it and figure it out for themselves, but this may also lead to the aforementioned misunderstandings becoming common, and meaning the emotion sound system may not get used as much as it could be, which may cause some players to miss out on useful hints.

Since E7 accidentally gave Sarcbot no name, it would be useful to implement a "guard" at that point, similar to the initial name entry screen, which did not accept a blank entry, and double checked with the player that the name they provided is the one they really want.

The answer feedback did try and indirectly prompt players to look at the contextual information, as well as the NPC's facial expression, emotion bubble and icon sound, but E6 commented that the feedback could do this more explicitly, i.e. directly telling

players what to look for instead of being vague and leaving them to figure it out. The tutorial explanations made this explicit, but they were left implicit in regular NPG conversations. The balance of direction and freedom was a tricky one; on one hand it can be said that players need explicit direction at times, but on the other hand, too much direction produces a "mechanical" and unrealistic experience, and may lead to players becoming over-reliant on such direction, which will not be present in real conversations.

E7 noted that some of the language was quite complex. The complexity of the language had been reduced where possible, but there were still some cases in which players may struggle to read or understand it - for example, the word "elevator" initially seemed quite simple (to the researcher), and so it was included and then overlooked. However, upon E7 pointing it out, the researcher realized that actually, the word "elevator" is a four-syllable word, and may be hard for some players to read. Therefore, simpler alternatives like "lift" should always be chosen. In this regard, it may be beneficial to conduct more specialized evaluations to focus solely on the understandability of the language by the target population.

E7 agreed with the current feedback system where Sarcbot did not directly reveal the answer (as he was not supposed to know it), but rather pointed the player towards finding the answer through comments and suggestions. E7 mentioned that it was strange how Sarcbot knew when the player's answers were right or wrong - this was never actually addressed in the game, it was simply assumed that there was shared knowledge of scores - Sarcbot "just knew" how good a player's answer was and gave appropriate feedback, but did not (in fact, should not) know why that answer was or was not the case, as that was for the player to figure out. However, some players may also pick up on this oddity, and while it is not inherently game-breaking, it may serve to lessen players' immersion, and so a new system could be devised in which it is explicitly stated how Sarcbot knows how good the answers are.

E6's notion of "going back" in a conversation could be altered into more of a "looking back", i.e. the conversation would not actually "rewind" (and so any player choices would still be in effect), rather the previous statements could simply be reviewed. Regardless, E6 commented that it would be useful for players to be able to see previous facial expressions, and hear emotion sounds that took place over the course of a dia-

logue, in addition to the words themselves.

With regard to E7's comments about incorporating more contexts and linguistic styles: that was the purpose of the levels, which would get progressively harder, and take place in different scenarios with different characters (or perhaps some characters could remain constant). E7 also mentioned that the game could go beyond sarcasm, perhaps teaching irony or other aspects of figurative language in a variety of contexts; while it would be possible to create these extensions within the game, doing so was beyond the scope of this research and was left for future work.

E6 and E7's generally positive comments indicated that the game was of a satisfactory standard.

8. Evaluation by Typically Developing Children

6 typically developing participants took part in these evaluations. Each played the tutorial alone (with the researcher present) for around 15-20 minutes, after which a semi-structured interview and final questionnaire were conducted. Each session lasted around 40 minutes. The version of the game played by participants was the one created after the participatory design session and expert interviews had been conducted, so all changes from the previous chapter were in effect at this time.

8.1 Participants

- P1: Age 8, male, self-reported as being a capable reader, but having little to no prior knowledge of sarcasm. Self-reported as being a skilled video game player and playing video games often.
- P2: Age 9, male, self-reported as being a capable reader, and also having some knowledge and understanding of sarcasm. Self-reported as being a skilled video game player and playing video games often, and also had experience creating simple games in drag-and-drop tools such as Scratch [MIT Media Lab].
- P3: Age 7, male, self-reported as being a capable reader, but having only little prior knowledge of sarcasm.
- P4: Age 9, male, self-reported as being a capable reader and game-player, and having some knowledge and understanding of sarcasm.
- P5: Age 13, male, self-reported as being a capable reader and game-player, and knowing and understanding what sarcasm is, how it is used and why, etc. Also

had experience using Scratch to develop simple games.

- P6: Age 12, male, self-reported as being a capable reader and game-player, and having a good understanding of sarcasm.

The focus of these evaluations was to elicit qualitative information about system usability, learnability, engagement and user satisfaction. While normally, one may choose methods such as the think-aloud protocol, this was not considered entirely appropriate in this case due to the young age of the participants; the protocol inherently demands extra cognitive resources from the participant, and young children may find this difficult and may end up becoming distracted from the game as a result. Therefore, a “pseudo” think-aloud was deemed preferable, where participants were instructed to talk about what was happening and what they were thinking as they played the game, as long as they wanted to do so (that is, they did not have to).

Participants (and their parents) were provided with appropriate information and consent forms, which had to be signed before the sessions could begin. These can be seen in appendix A.1. After these had been signed, participants were individually brought into the testing room where the session was carried out. After the session was over, participants received personalized certificates of participation.

P4, P5 and P6’s sessions took place several days after P1, P2 and P3’s, so several changes from the first sessions were implemented based on feedback from P1, P2 and P3. All participants played a highly similar game, and the changes which P4, P5 and P6 saw are documented in chapter 8.7.

8.2 Materials

Laptop PC with the game installed, larger (1920 x 1080) monitor on which the game was displayed, semi-structured interview notes (for researcher’s use), SUS questionnaire sheets, pens, video camera.

8.3 Procedure

8.3.1 Pseudo Think-aloud Protocol (15-20 minutes)

Participants were briefly instructed that they would be playing a game on the laptop in front of them, and that the game would be displayed on the larger monitor. They were informed that they could appear in the game by having a photo taken of their face, and asked whether they wanted to do this. If they agreed, the researcher would take a photo of their face, and upload it into the game files. If they did not agree, the researcher did not take a photo (and the in-game face portrait for the player would default to the researcher's own face).

Participants were told to talk about what they thought about the game as they played it, but only when they wanted to. This was to avoid placing high cognitive demands on them, as a regular think-aloud protocol would. They were also told that the researcher would help them if they got stuck, but would not “hold their hand” while they played, as the focus of the session was for them to play the game alone, so that the researcher could get an idea of how they interacted with it. There was no lower limit on the amount of time that participants could spend playing the game (as the remainder of time could be filled with the semi-structured interview and questionnaire), but in the interests of keeping within the time limit of 30 minutes, if participants had not finished the tutorial after 15 minutes had passed, the researcher moved the session on.

8.3.2 Semi-Structured Interview (10-15 minutes)

Participants were invited to partake in a discussion with the researcher, structured around several pre-prepared questions. They were told that they could also talk generally about what they thought of the game. The main questions were as follows:

1. How did you find the user interface? Was it clear? Was it useful?
2. What did you think about customizing the dialogue box and text colours?
3. How did you find the gameplay? Was it easy to play (e.g. navigate using the keyboard)?
4. What did you think about the rewards and the final level ranking screen?

5. What did you think about speaking to characters in the game?
6. Could you understand what the characters were saying, and what they meant?
Was the language easy to understand? Were the sentences too long or too short?
7. Were the explanations about sarcasm clear? Were you able to tell which statements were sarcastic?
8. What did you think about the graphics?
9. What did you think about the emotion sound system? Was it useful?
10. What did you think about the sound effects and music?
11. What did you think of seeing yourself in the game (i.e. the photo of themselves, if one was uploaded)?

These questions were intended to be worded in such a way as to discourage simple “yes or no” answers, and to encourage more thoughtful feedback.

8.3.3 Questionnaire (2 minutes)

After the interview had been completed, in the final few minutes, participants were presented with a modified System Usability Scale (SUS) questionnaire (see appendix A.4). It was modified to be better understood by the younger participants, as the original SUS questionnaire used somewhat advanced language and concepts which may have been difficult for younger participants to understand. In essence, the modified questionnaire was the same as the original, but worded in a way that was more understandable by the participants.

8.4 Results

8.4.1 Playing the Game

No participants had any difficulty entering their name on the initial screen and progressing to the tutorial. P4 asked if he should enter his real name, to which the researcher responded that any name was fine. P2 commented that he liked the fact that Enter meant “progress” and Backspace meant “go back”. P2 also commented that he liked the image of Sarcbot, saying that it looked like it fit in (with a general “game”

aesthetic). Upon seeing the “now loading” screen (which was the transition from the initial screen to the tutorial), P2 commented that he found the image of Sarcbot sleeping funny. P3 commented that Sarcbot should not be sleeping. P4 found the sleeping Sarcbot on the loading screen humorous. P6 commented that he liked the sleeping Sarcbot.

All participants quickly grasped how to operate the dialogue system, e.g. progressing through dialogue and making choices.

During dialogues with NPCs, the younger participants read the dialogue aloud, and were fairly quick while doing so, with P2 being the fastest reader and P3 the slowest. The older participants were fine with reading silently, and were also quick while doing so. P6 asked if he should read the dialogue aloud, to which the researcher responded that he could if he wished, but he did not have to. P1 immediately noticed that his current task was to talk to an NPC. P1 also commented that he liked the music, and did this again several times throughout the gameplay session. P2 initially looked around the screen at the UI elements and tried to understand them before progressing through the first dialogue. P2 also looked in detail at the background of the level, e.g. the objects and props, and commented on what he thought these were. P1, P2 and P4 found the face portrait for the first NPC (which was a real photo of the researcher wearing an eyepatch from a Christmas cracker) humorous.

P2 displayed a good understanding of the underlying game design choices. For example, P2 noted that when presented with dialogue options asking the player whether they would like things to be explained, the player could say no, which would be useful if a player was replaying the tutorial. This was actually the intent of those dialogue choices, which P2 explicitly verbalized. P2 also commented that he liked the fact that there were dialogue choices, and understood that previously selected responses were highlighted in blue. P3 recognized the dialogue choices, and asked whether it was possible to “make my own instructions”. The researcher then informed P3 that he could only select whatever options were available to him. All participants demonstrated an understanding of the dialogue choice system, as they were all able to select the correct choices to progress through a dialogue, which would not have been possible if they were mindlessly spam-clicking the first response, or repeatedly pressing Enter, as the dialogues contained loops which required the selection of other responses to get out of.

P5 commented that the level and its graphics were quite detailed.

Upon going through the first tutorial explanation, when the NPC showed a circle around the player sprite to point it out, asking the player if they could see the circle, P1 stated “I do, I’m not blind.” At one point, the explaining NPC mentioned that the player needed to move their character around and talk to people in levels, at which point P1 stated “how do I move?”. P6 asked the researcher what the explaining NPC meant when it asked the player if they wanted to learn about talking to people in-game, as P6 was initially unsure as to whether this meant the “physical” controls of doing so, or the game mechanics. The researcher clarified that it was about the game mechanics.

P1 and P2 mainly used the mouse to select dialogue choices and progress through dialogues, even when reminded by the researcher that they could also use the keyboard. P3 mainly used the keyboard to progress, but still used the mouse to select dialogue choices. P4, P5 and P6 used the keyboard to progress through dialogue statements, and used both the mouse and keyboard to make dialogue choices.

P4, P5 and P6 were all able to complete the added mini-quest designed to break up the initial tutorial explanation. All of them headed straight for the goal and were able to complete it quickly. P4 immediately commented “I see the red book” (the item needed for the mini-quest). Upon handing the book to the NPC that wanted it, and being presented with the option of not giving the NPC the book, P4 stated “I’m not going to be mischievous”, and chose to give the NPC the book. P6 commented that he liked the visual effect that appeared when the player picked up the book.

P6 actually uncovered a bug in the game, whereupon being presented with choices as to the player’s text colour, if the player chose “white”, no change would happen, as the text’s default colour was white. However, during the player choosing their text colour, since the game changed the colours of the response buttons to match their proposed colours (e.g. the button saying “green” was coloured green), since that colour change was not overwritten by the player selecting “white” (i.e. leaving it as default), the different colours stayed on the response buttons. This was a development oversight by the researcher, who then explained what had happened to P6, i.e. that it was a bug. The researcher then asked P6 whether he would actually like to have different coloured

response buttons, i.e. whether that could be a choice for the player's colour scheme, but P6 said that it may be misleading for players, as it would imply that some choices are better than others, e.g. if one choice is red and another is green (usually associated with "bad" and "good" respectively in Western media culture); some other games that P6 had played adopted such a mechanic for their dialogue choices. Therefore, P6 agreed that in this case, a uniform colour scheme was better.

P4 commented that he liked the layout of part of the level, which was a series of hedges arranged into a smiley face. P4 also commented that he liked the design of the first tutorial NPC's sprite.

When the first NPC mentioned that it would put a red box around the UI item currently being explained (but at that point in the dialogue, the box was not visible since no UI element was currently being explained), P1 commented that he did not see the box, but immediately noticed it when it did appear. All other participants simply progressed through the dialogue and paid attention to the box when it appeared. P2 briefly became confused when the explaining NPC referred to "this blue box" (i.e. the main dialogue box), as P2 was looking for the red box highlight, which was not present in this case. However, P2 quickly realized what "this" was referring to. Upon the red box highlight moving over the current task box, P3 lost track of it and asked where it was.

P2 and P3 immediately went to change the music upon being informed by the NPC that they could do so. P3 commented that one of the tracks was good, and kept it on throughout the session. P2 commented that he liked the functionality of changing the music, saying that other games usually have a set music track which can only be turned on or off, so it was good to allow the player more choice in that regard, as some players may want to listen to music, but find some of the tracks annoying, or have preferences as to which one they want to listen to. During P1's session, when the NPC was discussing the music selection panel, the fire alarm in the building went off and interrupted the session. P4, P5 and P6 did not immediately change the music. P4 changed the music part-way through his session, while he was in-between talking to NPCs. He briefly listened to all of the tracks, but ultimately went back to the default one.

P1 and P2 mistakenly thought (by stating it verbally) that they had to fill up all

of the stars in the score bar. The researcher chose not to correct them in order to see whether it had any effect on their gameplay, but it did not, and was not mentioned again.

P1 noticed the chat log upon being given an explanation by the NPC, but did not immediately open it. P1 did not use the chat log at all, and when asked by the researcher whether he wanted to use it, P1 said “not really.” P2 also noticed the chat log during the initial NPC explanation, but did not immediately open it. P2 opened the chat log later, but only after being prompted by the researcher after P2 mentioned that he could not remember what an NPC just said. After making use of it, P2 closed the chat log. P3 often forgot what NPCs said, and used the chat log often, keeping it open for most of the session. P4 occasionally used the chat log. P5 noticed the chat log, but mentioned that he did not often use it, as he was able to remember what had been said in dialogues, but mentioned that its functionality was still useful. P4, P5 and P6 left the chat log open throughout their sessions, and for them it defaulted to “on” instead of “off” as it did for P1, P2 and P3. P6 used the chat log occasionally when he needed to answer a question.

P2 commented that he liked the green glow and speech bubble around the currently speaking NPC, as it made it clear who was speaking, especially if the player could not associate the face portrait with the in-game sprite. P2 also commented that he liked having the ability to change the text and dialogue box colour, and what the available choices were. P2 mistakenly thought that the first explaining NPC was referring to themselves when they told the player to “speak to the man behind the desk” (when in fact another off-screen NPC was being referred to) - P2 commented that he could not see a desk. The researcher then notified P2 that this NPC was not the one being referred to. P2 understood this, and mentioned that he did not read the full dialogue line, which told the player to walk forwards until they reached the other NPC.

Upon being asked to select a colour for the player’s text, P3 thought that the game was asking them what their favourite colour was. P3 was also confused over the word “cyan”, which the researcher clarified as being “light blue”.

Despite being told about it by an NPC, P1 did not make use of the pause menu at all, but found it useful later when the researcher showed it to him, as he was able to

see what the bubble icons meant. P2 and P3 also did not use the pause menu, but later found the associated options menu useful, when the researcher showed it to them. P4, P5 and P6 did not use the pause menu, but all of them said that its functionality was useful. P5 commented that he was aware of the pause menu and how to access it, but did not feel any need to.

P1 was unsure of the meaning of the word “dialogue” when it was encountered in explanations. The researcher gave a definition. P1 seemed to understand the rest of the dialogue, and found certain statements humourous (e.g. one of the dialogue responses to an NPC was “because he smells”). P2 and P3 also found some statements humourous. P3 enjoyed selecting the “mean” responses, e.g. giving “because he smells” as one of his responses. P3 seemed to know that these answers were not going to produce good results, but wanted to select them anyway for fun.

At various points, P1, P2 and P3 de-selected the dialogue box either by pressing the arrow keys and trying to move during a dialogue, or selecting another UI element, meaning Unity was no longer listening for activity on the dialogue box, and so the box did not respond until it was re-selected by clicking on it, which had to be explained by the researcher. P4, P5 and P6 also did this, but were able to quickly grasp that the dialogue box needed to be selected to be operable.

All participants went through the entire first tutorial explanation, despite having options to say “no thanks” when asked if they would like something explained. P1 commented that the explanation was too long. P2 mentioned that it would be annoying for players if they accidentally clicked “yes please” (instead of “no thanks”) when asked if they wanted an explanation to be repeated, because they would have to press enter repeatedly to get back to where they were. Upon shortening and interleaving more player involvement into the initial tutorial explanation, it was noted by the researcher that P4, P5 and P6 all seemed to be much more engaged while talking to the NPC, and even seemed to enjoy doing so.

Upon getting through the first tutorial explanation and being allowed to move, P1 wandered around the area and did not head straight for the current task. When P1 reached the NPC he was supposed to talk to, he was initially confused over what the Return key was. This was explained by the researcher. After this, P1 had no difficulty

progressing through the dialogue with the NPC, and became excited when the NPC mentioned that the player would be training a robot. P2 mentioned that the character's movement speed was quite fast and hard to control because of this, and that it might be good to make it a little slower. P6 also made this comment. P2 briefly wandered around the level before heading to the NPC. When asked by the NPC if the player knew why they were here (i.e. the NPC is asking the player if they want to be told why they are in this level), P2 and P4 hesitated, and then selected "Yes, I do", skipping the explanation. P3 also initially wandered around the area, and did not head straight for the target NPC. P3 seemed to have some difficulty navigating the character to the NPC, as he kept walking into walls and other obstacles, and kept looking down at the keys to see which ones he was pressing. The researcher asked P3 if he knew what he was supposed to do, to which P3 responded correctly, and correctly pointed out the location of the NPC, but was still having difficulty navigating to the NPC. The researcher then stepped in and moved the character to the correct location. P3 was also initially confused over what the Return key was. P4, P5 and P6 immediately headed straight for their objectives, only wandering slightly.

All participants recognized that the bubble icons meant that NPCs could be spoken to.

Upon reaching the second area of the tutorial, P1 again wandered around the level instead of heading straight for their current task. P2 also wandered around, but was looking for people to speak to (while P1 seemed to be wandering aimlessly). P2 mentioned that he would like an animation of the player entering and exiting the elevator instead of simply appearing immediately in another location, as it was quite disorienting. Unlike P1 and P2, P3 headed straight for the objective this time, and recognized the "white room" from the NPC's explanation. P4 and P5 headed straight for the objective, while P6 initially wandered around and tried to approach the other NPCs, but quickly noticed the bubble icons above the goal NPCs' heads, and went over to speak to them.

P1 did notice that there were "*three people who need my help over here*", i.e. the three NPCs with bubble icons above their heads. P2 also noticed the NPCs with the bubbles, and recognized that there was a robot, which P2, P1 and P4 liked. P1 and P4 audibly became excited upon noticing the robot sprite. Upon being introduced to

Sarcbot, P1 and P2 recalled that they had seen Sarcbot at the very beginning of the game. When reading Sarcbot's dialogue lines, P1 put on a robot voice.

When the first speaker icon appeared, P1 noticed it and asked what it was. The researcher prompted him to click on it, and he did so, but did not make any comment. There was then a small problem with the dialogue box UI element becoming de-selected due to clicking on the speaker icon, and so the dialogue box needed to be re-selected. From then on, P1 only occasionally clicked the speaker icon, but seemed to understand what they meant, except for one case where a speaker icon for "idea" appeared, and P1 clicked it, but thought that the sound was more like hesitation, as the sound produced was an "ahh" sound (as in "ahh, that is the answer!"), but P1 interpreted it as more of an "uhh", which could signify hesitation or apprehension. P2 also immediately noticed the speaker icon, and asked what it was for, which the researcher then explained. P2 did not make much further use of the speaker icon when it appeared. P3 did not seem to notice the speaker icon initially, and when it was explained by the researcher, P3 did not use the speaker icon at all. P4, P5 and P6 all noticed the speaker icons; P4 clicked the icons when explicitly prompted to do so by the game, while P5 and P6 did not click them at any point.

Upon choosing a name for Sarcbot, all participants were able to do this, but there was some difficulty again with the dialogue box UI element becoming de-selected when the text entry UI element was selected. It was noted that P1, P2 and P3 seemed to choose highly similar names for Sarcbot; P1 called it "Mr. Robo", P2 called it "Robo", and P3 called it "Mr. R". All participants seemed to enjoy giving Sarcbot a custom name.

P6 uncovered something interesting while giving Sarcbot a custom name, as he chose to call it "<his name> 2.0", but since the music selection system was set up to respond to number presses on the keyboard (in addition to mouse clicks), when P6 pressed the number 2 key, the music changed to track 2. The researcher then clarified what had happened. This was due to a small development oversight by the researcher.

When talking to the next NPCs who explained other game mechanics such as the score system, P1 chose the questions: "How am I going to teach Sarcbot?" and "How do I get score?". P2 only chose "How do I get score?". P3 chose "What is sarcasm?"

and “How am I going to teach Sarcbot?”, but also tried to click on “How do I get score?”, but accidentally clicked “I don’t have any questions” and ended the dialogue. P4 chose “What are those bubbles above your heads?”. P5 chose “How am I going to teach Sarcbot?”. P6 chose “How am I going to teach Sarcbot?”.

No participant chose all of the questions.

When the second explaining NPC was speaking about emotion bubbles, P1 mistakenly thought that the NPC’s face portrait was the emotion bubble. The researcher pointed out that the face portrait was the NPC’s face, and that the emotion bubble was the animated bubble above the NPC’s in-game sprite, which P1 then seemed to understand. When the NPC offered to show the player what would happen when they answered a question and presented the player with some mock answers so that they could see the effects, P1 chose to move on straight away and did not click any of the mock answers. P2 also did the same thing. P2 intuitively understood the meaning of the combo system when it was explained to them by an NPC, and liked that the system was there. When viewing the dialogue explaining what sarcasm was, P3 was able to correctly answer the practice question. P4, P5 and P6 were also able to correctly answer their corresponding practice questions.

P1 only seemed to notice that the level progress bar had changed part-way through his gameplay session, as he verbally exclaimed that the bar had changed (some time after the change had taken place). After this was initially noticed, P1 noticed all further changes to the bar immediately. The other participants noticed all changes to the level progress bar.

When Sarcbot began following the player around, P1 and P4 responded positively.

After the second set of explanatory NPCs had been spoken to, P1 again wandered around the level passing by other NPCs with bubble icons, choosing to go back to the first reception area. P1 noticed that there was an NPC with a bubble icon who could be spoken to, and did so. P2 also briefly wandered around the level, but quickly saw that there were NPCs available to be spoken to, and did so. P3 asked “*where am I off to next?*”, but then saw the NPC with the bubble icon and spoke to them. P4, P5 and P6 all headed straight for their next objective. After speaking to all of the NPCs

in a certain area, P4 wandered around and did not seem to know where he was going. The researcher then stepped in and asked P4 if he knew what he was doing, to which P4 responded that he did not. The researcher then pointed out the “current task” box, and prompted P4 to go back to the first area, where the remaining NPC could be found.

During the sarcastic dialogues, P1 was able to detect sarcasm correctly, and also provided the correct explanations, as well as good responses (but not always the best possible responses). P1 did not get any answers wrong, but gave some average answers. When P1 got an average answer, he commented “*oh, so that was not a great answer*”. P2 was also able to correctly detect sarcasm in all but a few cases; in these cases, P2 commented that he was unsure about his choice, as the statement could have been construed either way, but that he agreed with the subsequent feedback from Sarcbot, and thought that it made sense. Upon providing reasoning about sarcastic statements, when one of the answers talked about the NPC’s facial expression, P2 commented that he did not look at the NPC’s face. All participants paid attention to the NPC face portraits, but only after it was clear that doing so would aid them in detecting and reasoning about sarcasm. Once participants started doing this, they commented that the face portraits helped them detect and reason about sarcasm. P3 was able to correctly detect sarcasm in all but one case, provided correct reasoning, and gave good or average responses. In the case where P3 did not correctly detect sarcasm, he then stated “*I can’t believe I got that answer wrong*”, implying he actually did know the correct answer intuitively. In cases where P3 correctly detected sarcasm, he did this quickly, and in one case stated that the answer was obvious. Upon giving an average response, P3 recognized that it was not as good an answer as the others, but asked what the best answer was. However, this was not available to be viewed in that version of the game (as “retry mode” had not yet been implemented). P4 was also able to correctly detect sarcasm, and found the sarcastic dialogues humorous. P4 got one answer wrong when reasoning about a sarcastic statement. P4 commented that for one of the options for sarcastic reasoning (when asked why people might avoid a certain NPC, one of the options was “because he smells”), he found this humorous and stated that it was offensive. P4 verbally exhibited his logical reasoning when picking reasoning about why statements were sarcastic or not. At one point, when an NPC was being sarcastic, P4 correctly pointed out that the NPC was lying. P4 also seemed to enjoy giving sarcastic responses to NPCs. P5 was able to detect, reason and respond well to sarcastic statements, giving the best or average answers. P5 did not get any answers wrong. P6 was

able to correctly detect sarcasm in all but one case, and give good or average reasoning and responses, demonstrating understanding about his given answers. At two points, P6 accidentally clicked on an unintended response (the average one instead of the best one), but made use of “retry mode” to go back and see what his original intended one would have gotten him. P6 also found some of the dialogues humourous.

P4, P5 and P6 all made use of “retry mode” upon giving an average or incorrect answer. When asked by the researcher, they demonstrated understanding of what “retry mode” entailed, despite not viewing the corresponding explanation. P5 mentioned that while he understood that his re-tried answer was better than his original one, he did not notice that it did not get him any extra points, while P4 and P6 did notice this. This was clarified for P5 by the researcher, and P5 then seemed to understand. P5 stated that “retry mode” was useful as it enabled players to see what else might have happened had they picked another response, in the case that their original answer was average or wrong. P6 occasionally chose not to make use of “retry mode”.

All participants spent the most time deciding on their responses to sarcastic statements. Some participants asked the researcher what they should pick, to which the researcher responded to pick whatever they wanted to.

Upon receiving a score reward, P1 responded positively, and also liked getting a combo and getting more points. P1 noticed that his score bar filled up when he got rewards. P2 also responded positively, and understood that better answers would get the player more points, and liked that system, as well as the combo system. P2 also liked the final score ranking screen, and understood that he did not get the maximum score. P3 understood the difference between scores for answers, and what wrong answers looked like (in terms of score). P4 also responded positively upon getting rewards. P5 commented that while he understood the score system and what the numbers meant, he felt that the visual reward disappeared too quickly, and that he would have liked it to remain on-screen for longer. P6 responded positively to score rewards.

P5 commented that Sarcbot’s feedback was a good way of letting the player know why their answer was worth the amount of points they got, mentioning that he disliked it when games do not provide feedback as to how well the player is doing.

When speaking to one of the NPCs from whom it was possible for the player to get score, P1 selected one of the initial choices, starting a conversation branch which P1 went through. However, upon this finishing this branch and returning to the box showing the potential choices, P1 did not select any further choices and ended the conversation, inadvertently missing out on some potential points. P2 and P3 went through all possible conversation branches.

P1 did not speak to the side quest NPC, although he explicitly pointed out the NPC twice. After completing the tutorial, P1 was offered the chance to replay it and speak to the side quest NPC, which he then did. P1 noticed that the NPC had a different looking bubble icon, and understood that the NPC was a side quest, and that that was what the icon meant. P2 initially thought that speaking to the side quest NPC would progress him to the end of the level, but upon speaking to the NPC and discovering that it was a side quest and did not contribute any level progress, P2 understood this. P3, P4, P5 and P6 spoke to the side quest NPC. P4 commented on the NPC's blue speech bubble.

P4, P5 and P6 all tried to speak to the explaining NPCs again, but due to a bug in the version of the game they played, they could not speak to those NPCs. The researcher then explained what the NPCs would do, and that the player was not required to speak to them to beat the level.

At various points, P3 mistakenly thought that hovering the mouse over his dialogue selection and then pressing Enter would select that option, but the Enter key would only select whatever had actually been selected using the keyboard; hovering the mouse merely highlighted that option without selecting it. Due to this, P3 sometimes selected options that he did not mean to select. This was explained by the researcher, but P3 continued to make the same errors.

In terms of gameplay, P1 suggested not having the character immediately stop moving upon the player releasing the arrow key, but rather to decelerate and then stop.

It was noted by the researcher that P1's gameplay behaviour was somewhat erratic, in that P1 seemed to roam randomly around the level, talking to some NPCs but not others, even though he had initially expressed interest in talking to an NPC he then did

not speak to.

Upon completing the level and returning to the main menu, P1 immediately stated that he wanted to go to level 2. However, P1 did not have enough points to unlock level 1 yet, which would have had to be completed before unlocking level 2 (and also, levels 1 and 2 did not exist anyway).

8.4.2 Post-game Interview

1. How did you find the user interface? Was it clear? Was it useful?

P1 commented that he liked the emotion bubbles. P1 also stated that the score and level progress bars were useful because they let him see how well he was doing and how much progress he had made, and that these bars were not easy to miss. P1 commented that he did not often make use of the “current task” box, and did not use the music selection panel or quick options panel at all. However, upon the researcher explaining the functionality of the music selection panel, P1 said that he thought it was a good idea, and he then used the panel and enjoyed changing the music tracks. It is likely that P1 would have noticed this before, had the fire alarm not gone off and served as a distraction while the NPC was discussing the music selection panel. P1 asked what the meaning of the music icon with a line through it (i.e. the mute music button) meant, which the researcher clarified, and P1 then understood. With regard to the “current task” box, P1 commented that it should be kept where it is as it may be useful, even though he did not make extensive use of it. For the emotion bubbles, P1 said that some of them were fine, but thought that the “angry” bubble was the logo for a bank. In this regard, P1 suggested changing some of the icons to little faces or emojis, but mentioned that some icons could stay the same, e.g. the question mark for confusion. P1 suggested changing the angry icon to an angry face, the happy icon to a smiling ice cream, and the very happy icon to a smiling flower.

P2 commented that initially, some of the UI functionality was not immediately clear, but that it became clear through explanations and gameplay. P2 mentioned that he did not make extensive use of the “current task” box, but thought that it should be kept in as its functionality may be useful; in this regard, P2 noted

that for the tutorial, it was mostly clear what the player should do and where they should go, but for more complex levels with multiple different tasks and objectives, it may be more useful. P2 commented that he did not look at the “progress” box at all. P2 mentioned that while he did not need to use the “quick options” panel, it was still useful to have that functionality available. In terms of the dialogue system UI, P2 liked and understood the dialogue choice system.

P3 commented that he thought the UI functionality was useful, especially being able to change the music. P3 mentioned that he did not use the “current task” or “progress” boxes, or the “quick options”. P3 recognized that the score bar filled up as the player gained points.

P4 stated that the UI functionality was useful and clear, although he did not make use of the “current task” box until prompted by the researcher. Despite this, P4 mentioned that the box could be useful as it could help a player potentially find clues about their objectives, but that he was not initially aware of it in the tutorial.

P5 commented that the UI worked well, and that it had everything a player would need or find useful, without being too crowded, and also that UI elements were easy to locate and did not require much concentration to do so. P5 commented that he noticed the “current task” box, but did not feel a need to use it as he was able to remember what he was supposed to do at any given time, and that it was easy to find his objectives in the tutorial level. P5 commented that the “current task” box might be more useful in other situations involving longer questlines or larger levels.

P6 commented that the UI functionality was clear and understandable, and although he did not use some of its functionality, e.g. the mute button or changing the text size, he still thought it was useful to have. P6 noted that he did not use the “current task” box, as he was able to figure out what to do by wandering around, but commented that the box may be useful on other levels where it may be harder to locate an objective. P6 also commented that he found the chat log useful, as sometimes he would click through the text too quickly, or forget what had previously been said in a dialogue, and so needed to use the chat log to help

him remember.

2. What do you think about customizing the dialogue box and text colours?

All participants stated that they liked being able to do this. P2 commented that it was useful, as some colour combinations may not contrast well, so it was good to be able to customize it and achieve high contrast so that the text was highly visible. P5 mentioned that the ability to customize the box and text made the game feel more personalized to the player. P6 commented that changing the colours was good for colour contrast reasons, and also for players who may be colour-blind and who would require high contrast in certain colours in order to read the text.

3. How did you find the gameplay? Was it easy to play (e.g. navigate using the keyboard)?

P1 commented that he would have preferred WASD, as he played a lot of games which use WASD instead of the arrow keys. P6 also commented that giving the player the option of using WASD would be good (actually, the game did allow players to use WASD, but only prompted them to use the arrow keys). P2 commented that the gameplay was fine, but that he would like the player character to move a little slower. P6 also made this comment. P4 commented that he thought the gameplay was very good and could not think of any issues with it. P5 mentioned that the gameplay was similar to other games he had played, and so it was intuitive to him. P6 commented that sometimes, he had some control issues with the touchpad and using the arrow keys to select dialogue options. P3 did not give much comment, even when prompted; it was noted by the researcher during the session that P3 struggled with the controls.

4. What did you think about the rewards and the final level ranking screen?

P1 commented that the rewards were useful, and that he liked getting them. P1 intuitively recognized that some rewards (and therefore answers) were better than others through the “out of” numbering system and the different colours and intensities of the rewards. P1 also recognized that the rewards corresponded to the score bar filling up. P2 mentioned that he liked the firework effects. P2 also understood that the different reward signals (e.g. the “out of” system) meant that certain answers were better than others. P2 suggested changing the star icon that appeared and floated up when players got score to a face, which would be happy when the player got higher scores, and sad when the player got low scores. P4

commented that he liked the rewards, especially the firework effects. P4 seemed to intuitively grasp what the score numbers (e.g. “3/5”) referred to, saying that it showed “*how many stars you could get*”. This implies that P4 saw points as “stars”, when in fact the stars were simply a means of expressing the player’s score. The researcher clarified what the stars meant, which P4 understood. P4 also understood that the “out of” numbering system meant that some answers were better than others, although there was a slight misunderstanding in that P4 thought that the points were affected by how sarcastic a player’s answer was. The researcher clarified this, and P4 then understood. P5 liked that the score system was “reactive” to the player, and stated that it made picking answers more rewarding than simply receiving textual feedback. P5 also mentioned that the different reward signals were a good way of training the player to pick better answers, as otherwise the player may keep picking average or incorrect answers repeatedly, without learning what they are doing wrong. P6 intuitively understood the score system, and that different numbers “out of” other numbers corresponded to how good a given answer was. P6 mentioned that he did not initially notice the combo system, i.e. he did not notice the “multiplier” icon and also did not view the corresponding explanation, but said that he thought the combo system was a good idea as it encouraged players to give good answers and keep their score up.

5. What did you think about speaking to characters in the game?

P1 mentioned that he liked speaking to the NPCs, and seeing what they had to say. P1 noted that it was easy to find the characters in the game, as they stand out from the background in terms of their in-game sprites, and the bubble icons. P1 intuitively recognized the main quest icon as signifying that the NPC should be spoken to. P2 commented that he liked naming Sarcbot, but suggested giving players an option to leave Sarcbot’s name as-is, rather than essentially forcing them to pick a name. With regard to NPCs, P2 mentioned that he liked the fact that the face portrait matched up to the in-game sprite. The researcher then asked P2 whether he would like the face to be animated, but P2 commented that the current face portraits were fine. P4 commented that the dialogues were not boring, and that he wanted to talk to all the NPCs and exhaust their dialogue, giving the reason that he was a curious person. The researcher then followed this up by asking P4 whether he thought the game catered appropriately to that

sort of curiosity, to which P4 responded that it did. P6 mentioned that he had previously played other games which used similar dialogue systems, and that he enjoyed playing those games, and so this one was intuitive and enjoyable for him. P3 and P5 mentioned that speaking to characters was good.

6. Could you understand what the characters were saying, and what they meant? Was the language easy to understand? Were the sentences too long or too short?

P1 commented that the language was easy to understand, but that some of the dialogues could go on for too long, namely the tutorial explanation ones. P1 mentioned that the dialogues could be made shorter or more interesting, and agreed with the researcher's idea of interleaving more tasks and player involvement into dialogues.

P2 suggested including a "skip" button during dialogues, if the player wanted to exit from a dialogue, but still complete it (i.e. by skipping it).

P3 said that the language was fine.

P4 stated that he could understand the characters' language and what they meant.

P5 commented that the language was understandable and the dialogue length was appropriate, and also mentioned that he liked the game's ability to skip through dialogue (by quickly clicking or pressing Enter, or choosing not to hear tutorial explanations), as P5 mentioned that some games do not allow this, and that it can be boring when replaying a game and wanting to skip dialogues, but being unable to. P5 commented that some of the text was hard to read against the background. The researcher then prompted P5 to look at the pause menu, which P5 did, noticing that he could change the colour of the dialogue box, and saying that that functionality was useful. Despite this, P5 commented that he was aware that he could pause and change the dialogue colours, but that he did not feel a need to do it, as although some of the text was harder to see, it was still readable.

P6 commented that he could understand the language, and that the dialogue

lengths were appropriate. When asked by the researcher why P6 did not choose to pick most of the tutorial explanations from the second set of explanatory NPCs, P6 commented that he thought he would be able to figure those things out by playing. P6 did mention that initially, he did not think that the emotion bubbles would be important, but commented that if he had read that explanation initially, he would have realized that they were important a lot sooner.

7. Were the explanations about sarcasm clear? Were you able to tell which statements were sarcastic?

P1 commented that he was mostly able to understand the feedback given by Sarcbot, but not always, however he could not specify any particular explanations which did not make sense to him. P1 commented that detecting sarcasm was straightforward, giving the example of an NPC who was clearly joking; P1 stated that they asked the NPC an easy question to which the NPC's response was to pretend it was hard, and as P1 noted: "*they had a really cheeky smile on their face, so I knew they were being sarcastic*". P1 also commented that in that case, he used the emotion sound system, and heard a laugh, which made sense to him in that context. P2 and P3 stated that the explanations made sense. P4 mentioned that the explanations mostly made sense, except for one near the end, which was the question P4 answered incorrectly. P5 and P6 both stated that they understood Sarcbot's feedback about sarcastic statements.

8. What did you think about the graphics?

All participants commented that they liked the graphics.

P1 mentioned that he liked the amount of detail in the graphics, giving an example of an NPC's in-game sprite and face. P1 did note that the floors could be made more "artistic" as they were fairly plain. P1 also suggested changing the colour of Sarcbot, and the researcher then discussed an idea of letting the player customize Sarcbot's colour, which P1 thought was a good idea, and mentioned that he would make Sarcbot rainbow coloured. P1 commented that he would make the NPC's mouths (in their face portraits) wider, as currently the mouths seemed quite small.

P2 noted that he would have liked the elevator to have had an animation when the player used it, as it was somewhat jarring to immediately end up in another place by using the elevator. P2 also discussed with the researcher a system of

customizing the player's in-game sprite, e.g. by changing the player's clothes, but that this should not be overly complicated, as this would be overwhelming for players.

P3 said that the graphics were good.

P4 commented that the graphics were reminiscent of Minecraft-style graphics. P5 commented that the graphics were similar to other games he had played. P6 mentioned that the graphics were on-par with other games he had previously played.

9. What did you think about the emotion sound system? Was it useful?

Upon reviewing some of the sounds, P1 was able to distinguish what they were e.g. a groan meaning a character was grumpy, but also commented that the groan could also mean disappointment. When asked what sounds he would like for the emotions, P1 suggested having a “hulk roar” for anger, a growling sound for grumpy, some short, positive statements for happy and very happy, and a “meh” sound for bored. P1 mentioned that he would like some words in the emotion sounds, as he did not know what “being bored” (a somewhat abstract concept) would sound like.

P2 mentioned that he did not make extensive use of the emotion bubble system, only using it once; the very first time the speaker icon appeared.

P3 said the emotion sound system was fine, although he seldom used it.

P4 mentioned that he noticed the speaker icon, but only used it when prompted by the game to do so. P4 correctly realized that the speaker icon corresponded to hearing that character's current emotion. P4 commented that he did not feel much need to use the emotion sound system, because he was looking more at the face portraits and emotion bubbles.

P5 did not use the speaker icons at all, but did notice them. When asked by the researcher, P5 thought that the speaker icons would read out the corresponding

line of dialogue, and mentioned that he did not feel any need to do this, and also mentioned that he was unsure whether the speaker icon could be clicked or not. When the functionality was clarified by the researcher, P5 still maintained that they did not feel any need to use such a system, as they were instead looking at the face portraits, and using the situations' context to deal with sarcasm. P5 commented that other players may find the emotion sound system useful.

P6 mentioned that they noticed the speaker icon, but did not feel a need to click it, saying that he thought it would read out the line of dialogue. When the researcher clarified the functionality of the emotion sound system, P6 maintained that he still did not feel a need to use it, but that it may be useful for other players.

10. What did you think about the sound effects and music?

P1 commented that he liked the default music and so did not change it. The researcher then asked P1 if he would like to hear the other tracks, to which P1 said yes. P1 then listened to the other tracks, and said some were good, and others not so good. One of the tracks was quite intense, and P1 commented that it made him want to “run around the game”. P1 then suggested having the music tracks change the player’s speed, e.g. a fast-paced track would make the player go faster.

P2 commented that he liked the music system, and thought that its functionality was necessary and welcome.

P3 said that he liked the music system.

P4 also commented that he liked the music system, and the fact that players could choose their own music. P4 also commented that he liked the sound effects, and that they fit in with the game’s aesthetic.

P5 commented that he liked the music, and that the sound effects worked with the game’s style. P5 mentioned that he realized that he could change the music, but that he did not feel any need to, as he liked the default music. Regardless, P5 mentioned that he liked the functionality being there.

P6 noted that the music system was good as it could allow players to pick a track to set the mood of where they are, or what they are currently doing in-game.

11. What did you think of seeing yourself in the game (i.e. the photo of themselves, if one was uploaded)?

All participants chose to upload photos, and commented that they liked seeing themselves in the game. P2 and P6 mentioned that it would be good to include functionality for players to update their photo in-game if they wished.

As a follow-up question during P4, P5 and P6's sessions, the researcher discussed with them the possibility of allowing the player to customize their sprite. P4, P5 and P6 all thought that this was a good idea.

8.4.3 Modified System Usability Scale Questionnaire Results

Using the regular SUS calculation [usability.gov] of:

1. Subtract 1 from each of the odd numbered questions
2. For each of even numbered question, subtract its value from 5
3. Take these new values, add them together, then multiply that sum by 2.5 to get the final score out of 100

For each participant's questionnaire, their individual SUS score was calculated, and the overall average was obtained by averaging all of the participants' scores. The raw data can be viewed in appendix A.4.1.

P1: 80, P2: 90, P3: 95, P4: 90, P5: 77.5, P6: 92.5

Overall average SUS score: 87.5. Anything above 80 is typically considered very high [usability.gov], meaning the system is highly usable by (close to) the target users.

8.5 Summary and Discussion

All participants reported that they enjoyed the game overall. P4 even commented that he would like a copy of the game when it was complete, as he could give it as a gift to

his school.

Towards the end of P3 and P4's sessions, it was clear that they had become tired (having also done another game testing session immediately prior), and thus it was difficult to get them to articulate their responses beyond "yes" or "no".

Although some participants reported that they did not know much about sarcasm, when they played the game, they seemed to intuitively understand that certain statements were sarcastic, and were able to select the correct answers and reasoning. It may have been the case that these participants intuitively knew what sarcasm was, and had likely been exposed to it and perhaps used it themselves, but were unable to "formally" define it when asked.

The initial tutorial explanation was clearly too long to keep many participants engaged. Despite being able to choose not to hear the explanations, all participants chose to, perhaps because they thought that they "should" (for the purposes of the evaluation), not because they wanted to, although they did skip further explanations later on. Regardless, the tutorial explanations could be made shorter, or broken down into chunks, interleaved with more involvement from the player, rather than a relatively one-sided discussion of an NPC talking at a player for extended periods of time. In terms of the dialogue itself, this seemed fine, as participants were all able to understand what the NPCs were saying, and use that information to help them detect and reason about sarcasm. When the initial tutorial explanation was shortened and interleaved with more player involvement and input, P4, P5 and P6 responded much more positively and were much more engaged than P1, P2 and P3. Despite the fact that some of the explanations were simply removed (e.g. certain excessive details about talking to NPCs), this did not inhibit P4, P5 or P6's ability to play the game effectively in any way whatsoever. It can therefore be said that these explanations were excessive and unnecessary, and removing them made a positive impact on participants' engagement.

The fact that P4, P5 and P6 chose to head straight to their objectives instead of wandering around aimlessly may have been because they were older (and likely more sensible and focused), but also could have been due to the fact that they were allowed to move much sooner compared to P1, P2 and P3, who had to wait for a long dialogue to finish before they could move. Since P4, P5 and P6 were able to move much sooner,

and had to navigate their way around obstacles to find an item and bring it back to the tutorial NPC, this could be said to have made them less “antsy” about wanting to move and explore, as they had already been given the freedom to do so early on, and the intervals at which they were not allowed to move were comparatively shorter.

While some participants seemed to think the movement controls were fine and were able to navigate around the level successfully and with ease, other participants struggled to do so, and commented that they would like the character’s movement speed to be slower. This implied a need for allowing the player to customize the character’s movement speed, as making it default it to either extreme (either too fast or too slow) would likely cause frustration for some players who sit on either side of the fence.

The chat log was hardly used at all by some participants, while other participants used it heavily. For P1, P2 and P3’s sessions, the chat log defaulted to “off”, and some participants may have simply forgotten it was there. However, those who did not make extensive use of the chat log did not seem to need to, as they were able to correctly respond to sarcastic statements and choose answers. Those who did use the chat log would often forget what had been previously said in a dialogue. This implies that it is useful to have the chat log, even if it is not used by all players, as some players would likely find it useful. It was beneficial to make the chat log default to “on” (as was done in P4, P5 and P6’s sessions), so that players immediately see it, and can turn it off if they wish - P4 and P6 found it useful.

Similarly, the pause menu was hardly used by the participants, but upon being shown the pause menu functionality, many participants agreed that it was useful. From a game design perspective, it makes sense to give players a means of changing options such as volume, or leaving the level through the pause menu. The pause menu was not intended to be used heavily, but it was still useful to include it to give players that functionality, which is common to practically all games.

The “current task” box was seldom used by any participants; some did not use it at all. However, when asked about it, most participants agreed that its functionality was useful, and would likely get more use in bigger levels with more tasks to do. The tutorial was quite constrained in that manner, such that players were able to figure out what to do by walking around and finding NPCs to speak to, and so they did not particularly

need to use the “current task” box in this case.

The emotion sound system was hardly used at all by the participants. Some participants used it, but only infrequently; however, when those participants did use it, they commented that it helped them to reach a decision about detecting or reasoning about sarcastic statements. This implies that, while not all players may find the emotion sound system useful, some might, so it makes sense to include it. However, the participants who did use the system commented that they would like different sounds, implying that they may misinterpret the sounds. If players misinterpret a sound, it could potentially lead to them deriving incorrect conclusions about sarcastic statements. Therefore, the sounds would need to be completely obvious, such that it would be highly unlikely for players to misinterpret them. Keeping the sound system optional is beneficial, as not all players may want or need to use it, but it may still help other players. Despite the fact that the emotion sounds were changed to be more exaggerated in P4, P5 and P6’s sessions, the participants hardly used the emotion sound system, so it is unknown whether the more exaggerated sounds were better or not.

The emotion bubbles were mostly understood by participants, except in two cases: grumpy and anger. One participant suggested changing the emotion bubbles to faces or emojis; younger participants who often make use of social media or smart devices may be highly familiar with emojis, moreso than, for example the emotion bubble icon of a squiggly cloud meaning grumpy, which may not be immediately obvious (and would require players to have played the game before and seen the icon previously).

Participants all understood the score system, and understood that certain answers were better than others, but P1, P2 and P3 mentioned that they would like to have known what the best answer was, in cases where they did not get it. This implied a need to include a system for going back and being able to re-select answers, as was discussed with E1 in their second interview, but done in such a way that while players would be able to re-select answers, they would not get any extra score for doing so, as this could lead to players cheating. Therefore, “retry mode” (see chapter 8.7) was introduced for P4, P5 and P6’s sessions, who all commented that they found it useful.

Participants also responded positively to the visual and auditory stimuli of gaining score, and were able to tell that their score bar filled up as a result of them getting score.

However, some participants initially thought that they had to fill up the entire score bar. While this did not cause any problems for those participants, it may be something to consider, as some players may be misled by this, and may become upset if they do not manage to fill up the entire bar.

The face portraits, while not initially being paid much attention to, were deemed useful by many participants, as they commented that the facial expression helped them to detect and reason about sarcasm. In regular dialogues, there is not much reason for players to look at the face portraits other than purely out of interest, but once sarcasm becomes involved, looking at the face portraits is highly important, as many participants realized. This implies that the face portraits are a necessary part of the game.

All participants responded positively to the customizations available, such as changing the dialogue box and text colours, and choosing their own music. Participants and experts also thought that further customizations, such as cosmetic changes to the player or Sarcbot sprites would be a good idea. Based on the fact that participants commented that they had individual preferences as to the music, this implies that the preliminary choice of music itself may not matter, what matters more is the fact that players are allowed to choose their own music (or turn it off).

The younger participants seemed to be more inclined towards trying to experiment and haphazardly move around, whereas the older participants were more content to read the explanations and try to gain a better understanding before diving into situations. It could therefore be said that older players may be fine with playing the game alone, whereas younger players would likely need an adult with them to keep them on track. Since all participants were able to complete the tutorial in a reasonable amount of time, it can be said that the game accommodates a variety of playing styles, from haphazard to more methodical.

In cases where participants were not sure of the meaning of something (e.g. the fact that "retry mode" did not get the player any extra points), when these things were explained by the researcher, participants understood. It can be said that participants would likely have understood these mechanics beforehand, had they chosen to view the corresponding explanations. Since they could not do this in the version of the game that they played, but since most participants attempted to speak to the explanatory NPCs

again, it can be said that it is likely that they would have reviewed explanations about things they were unsure of, and subsequently gained an understanding.

There is also the matter of prior game playing experience factoring in to how well participants did; it was noted by the researcher that those participants who self-reported as being experienced game players generally performed better in-game in terms of movement and understanding the UI than participants who were less experienced game players. Again, it would make sense to let experienced game players play the game alone, as they would likely be able to figure things out and progress on their own, whereas less experienced players may need adult assistance (although the given explanations could help in this regard).

In terms of the P2's suggested skip button with respect to the scoring system: if the player skipped a dialogue in which they could receive score, they would not receive any score, and this would not make much sense from a gameplay perspective. In this regard, the "skip" button could only be present on non-scored dialogues. P1's suggestion of music tracks changing the player's speed depending on the track intensity was deemed inappropriate for the target audience, as they may wish to listen to a certain track, but then if choosing that track had an unintended side-effect, they may become upset due to the game's lessened control and predictability.

The difficulties P3 had with operating the dialogue system in terms of mouse clicks and keyboard input were due to common UI traits also included in the Unity UI system (and many other UIs e.g. the Windows operating system). Many of these issues could be resolved by playing the game on a touch-screen device, as these would likely be more intuitive for younger participants to operate, as they may not yet have fully developed computer operation skills. Using a touch-screen device would also likely mitigate the movement issues P3 had with the keyboard, as while children who are experienced game-players would likely find using the keyboard natural and intuitive, less experienced players could find it difficult. Touch-screen devices use only one method of input (touch), which may be less confusing for some than having two (keyboard and mouse).

P4's misunderstanding about the score system could have potentially been mitigated had he chosen to view the corresponding tutorial explanation. Unfortunately,

due to the bug in which players could not speak to the explanatory NPCs again after the first time, it is unknown whether P4 would have gone back and viewed this explanation.

P6 uncovered some interesting development oversights, such as the text colour change bug and the music selection number change. The former could be fixed fairly easily, and while the latter was not a “bug” as such (as it was exhibiting intended behaviour), it was decided to remove the number key functionality, as the target audience may become upset if they accidentally change the music by pressing a number key.

8.5.1 Discussing the SUS Questionnaire Results

The only “positive” question for which participants gave less than an “agree” or “strongly agree” was “I thought the game was easy to play”, which two participants scored as a 3. These were the participants who did not like the movement controls, or were not able to use them easily. The only “negative” question for which participants gave less than a “disagree” or “strongly disagree” was “I needed to learn a lot of things before I could get going with the game”, which one participant scored as a 5, the worst rating in that case, and two other participants scored it as a 3. The participant who scored it 5 also commented that the tutorial explanations were quite long and somewhat overwhelming, which most likely contributed to their given rating.

This implies that the game may not be easy to play in terms of its controls, and also that there may be a lot to learn before it is possible for participants to really get going with the game. However, all other usability-related areas of the game were deemed by participants to be good. The control issues could likely be mitigated by playing the game on a touch-screen device, and the learnability could be improved by shortening the explanations and interleaving more player involvement (as was done in P4, P5 and P6’s sessions).

8.6 Summary of P1, P2 and P3’s Sessions

In summary, it can again be said that the tutorial explanations were too long and drawn-out, and it would be better to shorten them and interleave more player involvement. The younger participants, while still completing the tutorial explanations, clearly became

bored, whereas while they were actually playing the game, they seemed much more engaged and lively.

The difficulties some participants had with the movement controls could be mitigated by following one participant's suggestion of making it slower, or perhaps changing the movement to clicking the mouse on the intended movement location.

A lot of the game's functionality (e.g. the UI elements), while not being extensively used by participants, did get used more often by some participants, and all participants commented that the functionality was useful to have, even though they did not use it in the tutorial. The only UI element which less participants commented on as being useful was the "current task" box, but arguably this still had its place in terms of common game mechanics, and especially for the target audience, who may need more direction than their typically developing peers, and who usually have shorter attention spans (potentially leading to more occurrences of "what was I doing again?" which the "current task" box could help with).

Porting the game to a touch-screen device may be preferable for less experienced game-players, as the touch interface would likely be more intuitive for them to use. However, it also makes sense to keep the desktop PC version, as more experienced game-players may prefer using the mouse and keyboard.

8.7 Design Changes Taking Place Between Evaluation Sessions

As a result of P1, P2 and P3's feedback, certain changes were implemented before the sessions with P4, P5 and P6 took place. These changes are detailed here.

A mechanic was added allowing players to re-attempt their answers if said answers were incorrect or average. Sarcbot asked the player if they would like to retry their last answer, and if the player selected "yes", they were taken back and presented with the same dialogue choices as before, with the one(s) they picked last time highlighted in blue. Upon the player entering retry mode, a "rewind" sound played, letting the player know they had "gone back" in the dialogue. The player could retry as many

times as they liked; the means of getting out of retry mode was either to say “no” when asked about retrying, or to select the best answer. While in retry mode, text appeared on the screen, telling players that they were in retry mode. Retry mode meant that the player could re-select answers, but would not get any points or combo modifications (good or bad) for doing so (i.e. players could pick incorrect answers for no penalty); it was only a means of allowing players to see the effects of other responses they did not pick. Thus, players still had to deal with the consequences of their initial choices, as they would have whatever score they got from their first response, and so conversations were kept somewhat realistic, while enabling players to see which answers were better and why. For consistency’s sake and to allow players to see which answers were better, the same visual and auditory feedback for answer rewards were present in retry mode, although the player’s score for re-tried answers was always 0, and showed up as such in the visual reward. Retry mode was not enabled for the sarcasm detection answer, as players could only select one of two options (“that’s sarcasm” or “that’s not sarcasm”), so it was obvious that, if a player’s answer was wrong, the other answer was actually the case, the explanation for which was then found in the reasoning answers.

Most of the emotion sounds were changed to be more exaggerated. “Anger” was changed from a low growl to an angry yell, “sad” was changed from a few sobs (which some participants and experts mistook as coughing or laughing) to a bawling sound, “bored” was changed from a snore to a deep sigh, “idea” was changed from an ambiguous “ahh” to a more pronounced “a-ha!”, “happy” and “very happy” were changed from laughs to “woo-hoo” sounds, and “grumpy” was changed from a low “hmm” to an “ugh” sound. “Confused” was left as-is (a “huh?” sound) since participants and experts were able to identify it.

While increasing the player’s movement speed for evaluation mode was intended to let players traverse (and therefore complete) the level faster, this ended up causing some movement control issues for some participants, so the speed was reduced back to normal.

To ensure players would see the chat log initially, its default state was changed to enabled. The “on” and “off” buttons were also renamed to “show” and “hide” to be more transparent about the chat log’s operation, i.e. that it was always on and recording the conversation, but could still be shown or hidden.

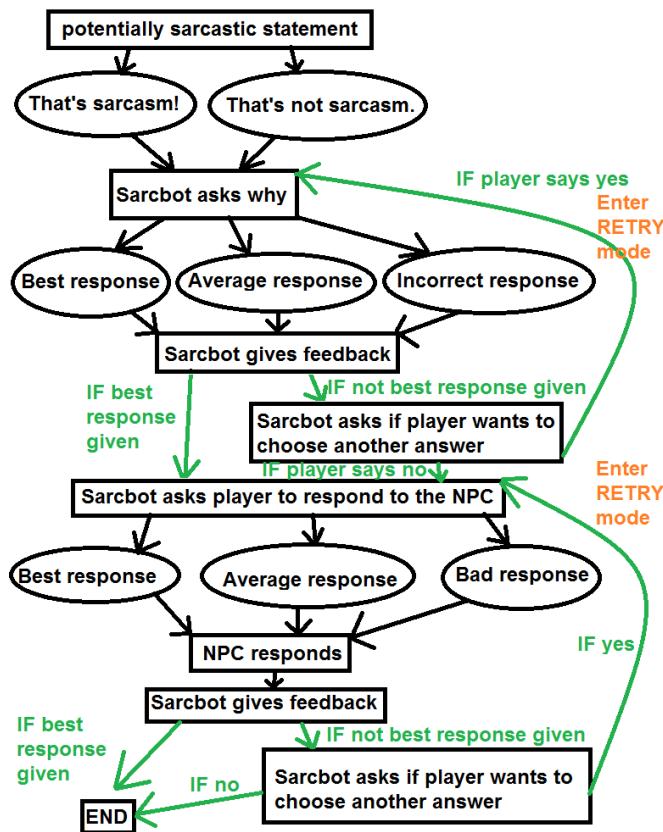


Figure 8.1: The new logical progression of sarcasm-related dialogues. Player statements are in ovals, NPC statements are in rectangles.

Since one participant did not know what “cyan” was, the effects of choices of text colour were shown in the corresponding response buttons. This enabled the game to be more transparent about what effects certain players’ choices would have, something E1 also mentioned as being desirable.



Figure 8.2: The colours of the response buttons temporarily changed to show players what effect their choice would have.

The initial tutorial explanation was changed to involve more dialogue from the player, and was broken up into segments revolving around fetching an item for an NPC - the “mini quest” was that the tutorial NPC had forgotten what he was supposed to say, and that it could all be found in a book he left lying around somewhere, which was clearly made visible to the player by placing a large sprite of a book nearby, and making it animatedly shine to clearly stand out. This meant that the movement controls were now only briefly explained (as participants were quick to figure it out). Some of the less useful explanations, such as the dialogue choice explanation, were removed, since all participants were able to immediately figure them out without an explanation. Removing these statements was intended to have benefits for mitigating player boredom and disengagement, while keeping the tutorial at a reasonable length, as by including the fetch quest segment, the tutorial had become lengthened as it could take players longer to do that than to simply read dialogue. Most of the explanations were kept optional, despite the fact that participants chose to go through all of them. The optional nature was mainly intended for players who had previously completed the tutorial and who were replaying it, but who did not want to read the initial explanations again.

The second set of tutorial explanations were also edited to be shorter, and were also changed so that the NPC could be spoken to again, and provide the same explanations, should the player wish. A short explanation about “retry mode” was added inside the larger explanation about getting points. E1 mentioned that, here, many players would likely pick one or two (if any) of the explanations, and then go off and play the game, wanting to figure things out for themselves. This was confirmed when all participants in the evaluations did exactly that, and so it was deemed beneficial to let players come back and talk to that NPC again if they wished, rather than essentially leaving them stranded without any further explanations available.

To make clearer the functionality of the music mute button, its button text was changed from “mute” to “music off”.

8.8 Summary of P4, P5 and P6’s Sessions

It was clear that shortening and interleaving more player involvement into the tutorial explanations was beneficial, as the second set of participants seemed much more en-

gaged and willing to hear the explanations than the first set of participants. Those participants were also able quickly grasp the game mechanics whose explanations were considerably shortened, or even removed, meaning that these extensive explanations may not have been necessary. The participants who did the mini-quest in the updated tutorial explanation all did so successfully and quickly.

“Retry mode” proved a useful addition, as all participants made use of it.

Again, many participants commented that they did not make extensive use of the “current task” box, nor felt much need to use it.

Many participants also did not extensively use the emotion sound system, either due to misinterpreting its functionality and not reading the corresponding tutorial explanation, or simply because they did not feel a need to. Therefore any potential improvements of the more exaggerated sounds would be purely speculative.

Making the chat log default to “on” can be said to have been beneficial, as while some participants still commented that they did not need to make much use of it, others did, and so for them, it was useful.

8.9 Overall Discussion of Evaluation Sessions

All participants commented that they highly enjoyed the game. While the older participants were very successful in completing the game in good time, the younger participants were likely more representative of the target audience in terms of their user characteristics and somewhat less advanced game-playing abilities.

All participants exhibited positive emotions and enjoyment at different parts of the game, whether it was the score rewards, the dialogue, or both. This implies that the game is linguistically and “conceptually” appropriate for a younger age group, and that younger players, even those with ASC, would likely find it understandable, enjoyable and engaging. All participants were also able to successfully complete the game with little or no prompting from the researcher; in cases where participants were prompted, it was mainly in the interests of keeping the evaluation sessions within their time constraints, and it is likely that participants would eventually figure out what to do without

prompting, as evidenced by their quick grasp of the game mechanics and their goals within it.

All participants responded positively to many of the game mechanics and found them useful and welcome, mainly the music selection system, the score system, seeing themselves in-game, and the other available customizations. It could be surmised that the target population would also enjoy such customizations, as they endow the player with a high sense of control and empowerment, as well as contributing to player enjoyment. Due to the sensitivity of the target population to sound, having options to turn off the music or sound effects is likely beneficial, while still enabling them to listen to (and customize) said music and sound effects if they wish. The participants reported enjoying seeing themselves in the game, and due to the fact that ASC individuals often associate better when playing as themselves in games (as opposed to other arbitrary characters), it could be said that the target population would also enjoy this functionality. Another customization which players might find useful would be changing the player's movement speed, as this would allow for more personalization to individual gameplay preferences.

The “current task” box, while having not been often used by the participants in the evaluations, can be said to be a useful feature nonetheless, which said participants agreed with, especially in the case of longer levels and quest-lines. Having that functionality provides useful navigation for the target population, and in conjunction with the level progress bar, can be said to help players feel less lost, and may also be beneficial in providing direction for ASC children, who usually have shorter attention spans and may forget what it is they are supposed to be doing.

Having the chat log default to “on”, while still enabling it to be toggled on or off, would likely be beneficial for the target population, as their (usually) low attentional capabilities may lead to them forgetting what has been said previously in a dialogue. The ability to toggle the chat log would also be beneficial in giving the target population more control over their gameplay experience. If the chat log defaulted to “off”, players may forget that it is there, as evidenced by the initial participants who did not extensively utilise the chat log, but found its functionality highly useful – therefore, it seems sensible to have it default to “on”.

In cases where participants did not understand the feedback given to them upon giving average or incorrect answers, it is difficult to say whether this was due to the feedback itself being unclear, or whether participants initially misunderstood the statement (which could cause any resulting feedback to make less sense). Since participants commented that they understood the language, it is more likely that the feedback itself was unclear, and could be improved.

The emotion sound system remained an area of uncertainty. While some participants used it occasionally, others did not use it at all, despite noticing it - although some participants also misinterpreted its functionality, as did several experts in the interviews for the same reason of seeing the speaker icon without having first viewed the corresponding explanation, and therefore misunderstanding the speaker icon's purpose and not making use of it. Some participants commented that they did not particularly feel a need to use it, as they were usually able to detect sarcasm through other means, such as the context, facial expressions, and emotion bubbles. However, for the target ASC population, they may find it more useful as an extra clue to help them detect and reason about sarcasm. Keeping the emotion sound system optional is therefore good in this regard, as not all players may want or need to use it.

“Retry mode” was clearly a welcome addition. It may be frustrating for players if they pick an incorrect or average answer, but are then unable to see which one(s) would have been better (and why), and so “retry mode” was highly useful in this regard. The reason it was not originally added was to try and avoid the problem of infinite loops; that is, if a child continuously makes the same error and gets stuck in a loop. However, “retry mode” can be resolved in a number of ways, including choosing the best answer, or saying “no” when asked about selecting another answer. The pre-existing dialogue highlighting old responses functionality also helped in this regard, allowing players to see what they have already picked. It could be argued that a limit should be put on the amount of attempts a player has to retry, however it could also be argued that some players may genuinely want to re-visit a previous explanation a few times to try and digest it more. The current system is set up so that while infinite loops are technically possible, players are also presented with highly obvious means of escaping said loops. The only way for players to be stuck in a loop is if they themselves willingly do so, which cannot be prevented without implementing a hard limit.

Since many participants experienced minor control issues due to using a cumbersome laptop touchpad to control the mouse, and due to some issues with the Unity UI, it can be said that porting the game to a touch-screen device would be useful in mitigating these issues. Occasionally, participants selected something they did not mean to; while this did not greatly impact their emotions, the target ASC population may become more upset in these situations. Therefore, a touch-screen device seems like a rational means of presenting the game to the target population.

9. Overall Discussion

One of the trickiest issues during development was creating the tutorial explanations, i.e. striking a balance between being explicit enough such that the explanations were understood and provided sufficient detail, but doing so in such a way that was not boring or disengaging for players, especially considering the target audience and their attentional difficulties. In this regard, some experts commented that the tutorial explanations were too long and excessive and that some could even be removed entirely, while others said that they preferred the idea of longer and more extensive explanations (while still agreeing that the explanations should not be overly long-winded). In the end, by incorporating suggestions from both viewpoints, it can be said that this balance was somewhat achieved through interleaving more player involvement and making the explanations optional, giving players the ability to skip or review them if they wished, as well as generally trying to keep the explanations succinct. This was evidenced by the second set of participants in the evaluations being notably more engaged during the explanations than the first set, and said participants were also able to play the game just as well as the first set.

While experts certainly gave lots of useful information, suggestions, and feedback, some of the design choices may have ended up being tailored more towards experts than by the target audience. For example, the decision to no longer prompt players to use WASD when two experts became confused over it, having never used WASD in that context before, while two participants in the evaluations commented that they would prefer to use WASD. However, all changes were made in the interests of making the game more usable, engaging and effective, and although some expert-specific changes may not have been necessary for the target population, they were still made, documented, discussed, and then removed or refined based on participant feedback, so they can be said to be just as valid as the other design changes.

In terms of the game's teaching strategy (i.e. detect-reason-respond), this can be said to be effective, as all participants, even those who reported knowing only little about sarcasm, were able to successfully complete the tutorial and get good scores at the end, which required them to correctly detect, reason about, and respond to sarcasm. Participants also commented that in most cases they understood the feedback given by Sarcbot in cases where they gave an average or incorrect answer. Of course, in order to more accurately determine the effectiveness of the teaching strategy, a larger sample size and more thorough and extended summative evaluations would be necessary, however for this proof-of-concept version, it can be said that the strategy seems to work well.

Participants also responded positively to the game's method of presentation, i.e. the fact that it was a game, and its corresponding mechanics. Since participants generally did well in the tutorial, it can be said that they were engaged; if they were absent-mindedly clicking through dialogues, or simply picking choices at random, they would likely not have done as well as they did. This provides qualitative evidence that this format of technological intervention is appropriate, and would likely be enjoyable and engaging for the target population.

While ASC participants were not directly involved in the design or evaluation processes, the TD proxies who were involved provided many useful insights and good feedback. This enabled the game to be developed and refined in a manner appropriate to the proxies, while also bearing in mind the target audience, and theoretically making the game appropriate and enjoyable for them.

9.1 Suggested Future Improvements

Currently, only the tutorial is fully completed. Therefore, an obvious future improvement would be to implement further levels and turn the current proof-of-concept into a fully fledged game. This would require programming knowledge and having read the documentation, but would not be overly complex if one knows what one is doing. These yet-unimplemented levels could be made into whatever one wishes, e.g. creating personalized levels for a certain player. In this regard, a worthwhile future improvement would seem to be the creation of a "level editor", such that one can create levels without needing extensive programming knowledge. This would be useful

for educators and other less technical people, and perhaps also for children themselves who may wish to create their own levels, perhaps jointly with an adult.

Voice acting could be implemented relatively easily using the current “emotion sound” system, that is, upon clicking the speaker icon, instead of having a sound such as a groan play, a line of dialogue would play, ideally acted out in a manner that conveys the associated emotion of the dialogue. This system could be set up to be initially silent, only being activated when a player clicks on the icon, or the sound could play immediately and also be clickable via the icon. This could be left as a choice for the player. It may also be beneficial to show the player the tutorial explanation for the current emotion sound system before they are exposed to it “for real”, as this could help to alleviate the misunderstandings as to the speaker icon’s functionality. Alternatively, a different approach could be used, one that does not use the speaker icon, perhaps some other visual cue that better conveys its meaning.

It would also be easy to include real faces as NPC face portraits, as the current system simply takes whatever face images it is given and uses those as portraits. In this regard, it is possible, but less easy to create corresponding NPC sprites for the player to interact with. This would require one to create the sprite and then load it into the game, set up animations, etc. However, if one knows what one is doing, then this process should not be terribly difficult or cumbersome. This would enable the NPCs to be customized, e.g. to reflect people the player knows in real life, or fictional characters they are familiar with, etc. It is important to ensure that NPCs with which the player converses all have varying face portraits to reflect their emotions - this was not the case for the initial tutorial NPC, however since that NPC’s purpose was solely to explain the game to the player, arguably its face was less important in that case.

Further customizations seem like a beneficial improvement, as all TD participants in the evaluation responded positively to the idea of being able to customize aspects of the game such as their character’s aesthetic (e.g. clothes, hair). Such “cosmetic” customizations were also discussed with some experts, who also thought that it would be a good idea. These customizations could be interwoven into the score system, in that a player could build up a “balance” of points, which they could then spend in-game for cosmetic items. This may provide more motivation for players to score highly (and therefore do well in-game). In fact, many modern games adopt this approach -

the games themselves are free to play, but they provide incentive for players to keep playing by including such cosmetic items, which can be purchased using the game's currency, or even real currency in some cases. Since this approach is already fairly widely used, some players may already be familiar with such systems, and would find it intuitive and understandable, perhaps also enjoyable. Another customization could be to allow the player to change the position of the UI elements on-screen, e.g. by dragging them around to more preferred locations. In any case, further customizations can be said to produce a greater degree of personalization, which ASC children would likely find highly enjoyable. Currently, it is also possible for one to make the game very personalized (e.g. by creating stories and characters specific to a certain player), although this would require programming knowledge, and the documentation to have been read. Another customization could be to allow players to upload their own music tracks into the game, and switch between them at will, making use of the existing system. This keeps the functionality of track choices, while allowing players to select from a range of tracks they may be more familiar with, or which they simply like more, again adding to a more personalized experience.

Some argue that NPCs in games should not simply stand around aimlessly, waiting to be interacted with; they may walk around or interact with the environment. This promotes a sense of realism, and makes the game world and characters feel "alive" instead of unnatural and robotic, and hence unbelievable [Alvarez-Napagao et al. 2011]. Including this functionality in future versions of the game may help contribute to a greater sense of immersion and presence in the game world, and potentially heighten player engagement.

With regard to mitigating players spam-clicking buttons to produce sound, this could be mitigated by coding in a check to perhaps temporarily disable the button should players have clicked it more than a certain amount of times within a small time window (i.e. in such a way that it is clear that the button is being spam-clicked).

During the interviews, some experts mentioned wanting a way of "going back" in a conversation; this ultimately manifested in the form of the chat log, but one expert discussed a system in which previous facial expressions and emotion sounds of NPCs could be reviewed. The current chat log could be modified to incorporate this: for example by making it larger, and putting the corresponding face portrait and speaker icon

next to each spoken line of dialogue in the log, so instead of just seeing a name and a line of text, players would see the name, the text, and the face portrait and emotion sound that went with that statement. This may help players to better remember past information make inferences based on that. Of course, such a system is not realistic, but it may help players practice (and could perhaps be made a feature only available on easier difficulty levels).

Approaches from Adaptive Learning Environments were not extensively used in the current game (save for the Learning-by-Teaching paradigm and a few others), and so these could be implemented in the future, if appropriate. While adaptively scaling difficulty was deemed as inappropriate in this case due to the game needing to be highly predictable for the target users, other approaches such as a more intelligent Sarcbot agent could feasibly be implemented. The agent could actually "learn" and change its feedback and level of knowledge appropriately, perhaps using reinforcement learning approaches, although such implementations would need to be tested and deemed appropriate for the target users, i.e. they must not cause the game to become unpredictable, or cause Sarcbot to become unhelpful due to e.g. learning to only give average responses to questions. The balance between explicit feedback (telling players exactly what indicators they should look at) and vague feedback (indirectly prompting players to do the same, letting them figure it out for themselves) needs further investigation, as the target ASC population can be said to benefit from highly direct feedback, but doing this too much could lead to them becoming dependent on such feedback, which will not be present in real conversations.

In terms of player affect, this is likely an area that could be focused on more, e.g. in Affective AutoTutor [Graesser et al. 2012], which adapts its teaching strategy based on perceived learner affect. Since this is a dialogue-heavy game, and some players may become disengaged due to being overwhelmed by dialogue, the game could detect this e.g. through checking whether the player is spam-clicking something, or is always selecting the first available response, etc. Once detected, the game could somehow try to re-engage the player. However, this would also require testing to determine what in-game behaviours actually correspond to the target population becoming disengaged. Another means of adapting to the player's affect could involve tailoring the manner in which Sarcbot and other NPCs address the player, e.g. perhaps some players may prefer if Sarcbot and other NPCs are very friendly and never say anything bad, while

other players may enjoy some more abrasive personalities. These approaches would enable more automated customizations to take place, but again, would require testing and evaluation to determine their effectiveness in this case.

Since the current game is essentially all scripted, it is therefore possible for players to simply memorize answers to questions in order to maximize their scores. For example, a player could simply adopt an approach of trial and error, exploiting "retry mode" to discover the best answers to all of the questions, then re-playing that level and essentially gaming the system by already knowing what all the best answers are, without having actually learned anything. In this regard, it may be beneficial to introduce some randomness into NPC dialogues, for example, instead of having NPCs always give the same scripted dialogues, they could randomly select dialogues from a pool, which would at least reduce players' ability to game the system in a trial and error manner. However, this would also lead to the game becoming less predictable, which may not be preferred in this case. Another means of mitigating the trial and error approach could be to code in a check to detect whether players are making excessive use of "retry mode", and perhaps disabling it if so - this does not have to make the game unpredictable, as the player could be explicitly told that if they over-use "retry mode", it will become (perhaps only temporarily) unavailable to them. This also ties into the discussion about whether including a hard limit on the amount of retries would be good - it could perhaps be made a feature of higher difficulty levels, although it still requires further investigation. Lastly, since the order of responses is always fixed, players may be able to memorize which responses to pick at given points in a dialogue, e.g. "first, then third, then second", as another means of gaming the system by memorizing dialogue choices (here, memorizing the order instead of the choices themselves). In this regard, a possible mitigation would be to randomize the order that dialogue choices are presented in. This helps mitigate gaming the system while not making the game too unpredictable, as the responses will be the same, just in a random order.

The quiz challenge mode, only being partially implemented, was not explored in evaluation sessions, therefore it is unknown whether this mode would be suitable or enjoyable. Experts commented that it could work, but that it would require careful balancing so as to not be overly punishing or demotivating for players. However, experts commented that some ASC children may enjoy such a challenge, as they may be highly competitive people. Therefore, it seems sensible to investigate the inclusion of

such a mode in the future.

The game's language likely needs to be simplified further, as some relatively complex words such as "elevator" were overlooked and left in the dialogue. While this did not seem to cause any problems during the evaluations, it is still something worth investigating, in order to see what effect that language has on the target ASC population.

Some mechanics in the current game were left unexplained, such as how it is possible that Sarcbot knows how good a player's answer is. Leaving this up to the players' imagination may not be a problem, but some players may find it odd, resulting in them having a less immersive experience. Various workarounds are possible, such as giving the player some sort of in-game wearable device that looks at their answers, and gives back points based on how good a given answer was. This way, it would be made explicit how Sarcbot knows how good a player's answer is, since Sarcbot can see the player's wearable device. However, it could also be said that introducing such mechanics to try and account for these oddities means that players would have to remember more "things", perhaps causing more cognitive load, which is perhaps unnecessary.

Something to note is that one expert who was interviewed mentioned that ASC children can have difficulty mentally transferring expressions of overly cartoon-y faces to real ones. For the most part, this was not a problem, as although the NPC faces were cartoon-y, they still clearly resembled human faces and were not over-exaggerated etc. The only NPC for which this was not the case was Sarcbot, whose face essentially consisted of a gray square with eyes and a mouth. Therefore, it may be better to change that face portrait to a more humanoid one, perhaps making Sarcbot into a humanoid-looking android instead of a metallic robot, or making Sarcbot's face a screen which displays a human face (mounted on a robot body). However, Sarcbot's facial expressions were not terribly important in-game, they were mainly there to make players feel like they had a reactive companion who felt things like they did and reflected it via facial expressions; the player technically did not need to pay attention to Sarcbot's face. Another expert mentioned giving players the ability to customize Sarcbot's face (in a manner similar to customizing the player's face portrait) to something the player is familiar with (e.g. a toy), in which case, the companion's varying facial expressions would not be included unless whoever sets up the game for that specific child makes it so.

One question that remains is whether this format of game, i.e. a 2D RPG in which the player can walk around and undertake quests, is truly the best method of approaching this task and enacting the given teaching strategies for the target ASC population, as that idea essentially came from typically developing children during the design workshop (see chapter 5). One could implement a similar game as little more than a sequence of scenarios, similar to a visual novel, and get the player to detect and reason about sarcasm there, and perhaps also responding if the player is a character in the game. However, arguably this format of game would be less engaging for players, and they would have much less control over their gameplay experience, as essentially all they would get to do is read text and see images changing on-screen, and be unable to explore or initiate conversations NPCs at will. This is not to say that such alternatives should not be considered; after all, they were not investigated in this project, and may turn out to be effective, a counter point in their favour being that a more restricted approach may be better in terms of minimizing seductive details and other distractions that may arise from more exploration-based games, and would also basically ensure that the player never becomes lost, wandering around aimlessly.

Of course, since ASC children were not directly involved in the design or testing of this game, future work would be to do evaluations with them, similar to the ones done in this study using TD children as proxies. Involving the real target users may uncover some yet-hidden necessary design changes.

With regard to more accurately assessing the current game's teaching strategy and any learning gains it provides, it would be beneficial to conduct a more summative evaluation (instead of the more formative one used previously), for example conducting a transfer test to measure how well any knowledge and skills gained in-game transfer to the real world (as that is essentially the ultimate goal of the game).

Lastly, as one expert mentioned, the game could feasibly be extended to go beyond only teaching about sarcasm, perhaps moving into the territory of irony or other figurative language. The core of the game could remain as it currently is, with modifications to the situational contexts and NPC dialogues. Perhaps instead of a "That's sarcasm!" button, players could click a "That's irony!" button, or perhaps an entirely new system could be implemented, using the current game as a base. These design choices would

have to be left to whoever implements them, should they wish to make such extensions.

10. Overall Summary and Conclusion

This research investigated the potential of a technological intervention for teaching ASC children an understanding of sarcasm. Initially, a game had not been decided upon as the best method of achieving this goal, but upon reviewing relevant literature, it was decided to be so, along with a teaching strategy of detect-reason-respond.

Based loosely on Scaife and Rogers project methodology [Scaife & Rogers, 2001], starting from an initial design, the game underwent several design iterations (see chapter 3), each being informed by feedback from the previous iteration(s). A highly user-oriented design approach was adopted, involving experts and proxy users as much as possible. This was beneficial as it allowed the researcher to go beyond a broad understanding derived from researched literature, to a more "ethnographic" and realistic knowledge of the target users and their characteristics, as well as how to appropriately design for them. In this regard, usability design and evaluation practices were utilised, including design workshops, participatory design, semi-structured interviews, think-alouds and questionnaires.

The initial hypothesis was that, theoretically, an educational game can assist ASC children in learning to detect, reason about, and respond to sarcasm. While ASC children were not directly involved in this study, it can be said that the initial hypothesis holds, due to promising feedback from TD children and experts, and adopting a strong participatory and user-oriented design approach, involving the proxies as much as possible. The game's design was informed by this feedback, as well as by researching relevant literature. It can thus be said that theoretically, the game would succeed in teaching ASC children an understanding of sarcasm, and would also be enjoyable for them. Of course, proving this is beyond the scope of this project and is left for future work.

In conclusion, it can be said that the initial hypothesis holds, that is, based on designs, evaluations and feedback from TD proxies and feedback from experts, theoretically, the game should facilitate ASC children being able to detect, reason about, and respond to sarcasm.

11. Appendices

A.1 Parent and Child Information and Consent Sheets for Participation in Design Workshops and Evaluations

It should be noted that the researcher for this research also shared information and consent forms with a researcher doing other research being conducted at the same time under the same supervisor - although the two pieces of research were different, they were both also similar in that they were both creating games to assist ASC children in some manner (the other research focused on emotion recognition). Therefore, it was sensible to combine information and consent forms, and conduct design workshops etc. with participants at the same time. These sheets were for the initial design workshop, the evaluation sheets were highly similar but essentially talked about "game testing" instead of "game design". While it should be noted that the sheets state that the researcher will not use the participants' age, this was an oversight by the researcher when writing these sheets, as the age was actually used - in this regard, participants were contacted again and asked to confirm that the researcher had permission to use their age (as they would still be anonymous).

Child Information Sheet

This sheet will tell you about a study you can choose to take part in, to help us create a game. This is us:



Dave Halperin Chen Huang

Why are we making games?
Some children need extra help understanding certain things about language or social situations. We are creating games to help these children learn about such matters. You can help by taking part in game design sessions, where you can come up with ideas and designs for the game and talk about what you like and don't like about games. We will use your ideas and designs to inspire the final games we make.

What sort of games are they?
That depends on the session! The main goal of one of the games is to teach children how to understand sarcasm, but it's your ideas and designs that will be used to create the final game.

What happens afterwards?
You'll get a personalized certificate as a thank-you for helping!

Your ideas and designs from the session will be used by us when we create our final games. We will also write about what happened in the session's workshops, but your personal details won't be written down.

Thanks to you, we will have learned a lot about what makes a good game and how children like you understand the things we want to teach!

If you have any questions about the session, feel free to contact us (or get your parents/guardians to do so).

Our contact details:
Dave Halperin
Email: s1680855@sms.ed.ac.uk
Phone: 07790071893

Chen Huang
Email: s1658283@sms.ed.ac.uk
Phone: 07421883585

Prof. Helen Pain
Email: helen@staffmail.ed.ac.uk

What happens if I agree to help?
You'll sign a consent form that tells you about your rights when taking part in the session, and makes sure you're ok with taking part.

Once that's done, you'll be invited to a game design session (possibly with a few other children), where we will give a brief introduction, ask you some questions, and then let you draw designs of what you think would be a good game, and give ideas and feedback. There will be paper and drawing materials for you to use.

We will be video-recording the workshops because we need to remember what happened and what designs and ideas you came up with. We might also take pictures or separately record sound.

You can choose to stop taking part in the session and any of the studies at any time. You can also take a break or go to the toilet at any time, please let one of us know.

We will listen to any ideas you have, and all designs are welcome, so don't be shy! There are no good or bad ideas, and no right or wrong answers. The point of this session is to collect information from you, and we want you to have fun (that's what games are for!).

Child Consent Form
Please circle YES or NO for each question.

1. I know I'll be taking part in a game design session.
YES / NO
2. I know that taking part in the session is optional.
YES / NO
3. I know that I can leave the session whenever I want.
YES / NO

We will be video-recording the session so that we can remember what happened and write about it. The videos will only be seen by us. What you say and do may be used in the study, but your name, age, or any other personal details won't be.

4. I agree to being video recorded during the session.
YES / NO
5. I know that I, or someone else for me, can contact Dave, Chen or Helen at any time and ask for any information about me to be removed from the study.
YES / NO

Please write your name on the line below if you circled YES to all questions, to show that you're happy to take part in the session:

Thank you!

Figure 11.1: The child information sheets, and the consent form (bottom right).

Parent Information Sheet

This information sheet is for parents or guardians, and explains research studies in which we would like your child to participate. Note that this information sheet covers two projects in total, each running design and evaluation workshops that are all highly similar to each other, and that will take place at the same time (i.e. on the same day).

This document provides an overview of the studies, an "FAQ" to address some questions you may have, and contact details in case you should like any further information.

The researchers for the projects, along with their contact details, are as follows:

David Halperin, postgraduate student at the University of Edinburgh

Phone: 07790071893

Email: s1680855@sms.ed.ac.uk

Chen Huang, postgraduate student at the University of Edinburgh

Phone: 07421883585

Email: s1658283@sms.ed.ac.uk

Prof. Helen Pain, project supervisor

Email: helen@staffmail.ed.ac.uk or helen.pain@sms.ed.ac.uk

This study is carried out within the School of Informatics within the University of Edinburgh, at address: University of Edinburgh, School of Informatics, Informatics Forum, 10 Crichton Street, Edinburgh, EH8 9AB

If you give permission (by filling out the parent consent form) for your child to participate in the study, please return the parent consent form to one of the above three people.

ability. This project aims to develop an educational game to help autistic children recognize and use facial expressions and gestures appropriately using a touchscreen device.

How can my child help?

In order for us to gain a thorough understanding of how children understand and apply the concepts we want our games to teach, as well as what sort of games would be fun and effective in teaching this understanding, we will conduct a participatory design session and evaluation with your child along with potentially several other children. During the sessions, children will engage in activities such as drawing designs for the games, answering questions about how they understand certain concepts, and contributing ideas and feedback.

What happens during the design session and evaluation?

We will answer any last-minute questions you may have. After this, your child will be taken to a room where they will be briefed by us on the session and what their role is. The session will then be carried out under our supervision, and will involve your child being asked questions about their understanding of certain concepts, as well as them giving feedback on some preliminary design ideas from us. Then, your child will be given various arts & crafts supplies with which to create their own design for the game. Evaluations may conduct somewhat different activities, such as having your child play a game and give feedback on it. Each session is anticipated to last for around 30-40 minutes.

The session will be video-recorded in order to provide a record of the session for us to use during the write-up of the study. The video will only be seen by us and will only be used within these projects, and no personally-identifying information about your child will be used in the studies. The video may be used in academic presentations or articles. All that will be used from the session will be your child's answers to questions; their comments and feedback; their game designs; and records of their participation, comments, or behaviors in playing a study's game.

I. Overview of the study, the design and evaluation sessions, and your ability to help

In this document and any others you see, the term 'studies' is used to refer to the overall set of projects being conducted by the researchers, each creating an educational game to assist children with special educational needs in some manner. The term 'session' is used to refer to the set of game design workshops and/or evaluation sessions in which we would like your child to participate, the results of which will be used to inform the study. This document is designed to cover both a game design workshop session and an evaluation session under a 'workshop' umbrella term per project, both of which will consist of similar activities with the purpose of eliciting feedback to inform the games' designs.

What is the goal of the projects?

As mentioned, these projects seek to create educational games to assist children with special educational needs, specifically autism spectrum disorders. Part of creating all of these games involves conducting a participatory design session and evaluation with children in order to gain an understanding of how they understand various concepts, as well as to understand what sorts of games would be fun for them to play and effective in teaching them.

What does each project entail?

Dave's Project: Children with autism spectrum disorders (ASD) often have difficulty comprehending non-literal language, such as sarcasm, where the surface words and their actual intended meaning are not the same. This can lead to said children being less able to interact with other children or adults, and becoming less social as a result, with other knock-on effects with potentially harmful consequences. This project aims to help ASD children understand sarcasm, so that ideally they will be better able to participate in more advanced dialogues with others.

Chen's Project: Children with autism spectrum disorders often have problems using and understanding non-verbal languages like facial expressions and gestures, which could negatively influence their social

Can I be present for the session?

You can, although we would prefer if you were not in the room while the session is taking place so as not to disrupt the activities. You are welcome to sit outside the room and look inside, although bear in mind this may lead to you appearing on the video recording.

What happens after the session is over?

Your child will be given a laminated certificate to thank them for participating. The results from the session will be reviewed by us, and the aforementioned information will be used to inform the design of the actual games in order to make them fun and effective for teaching children. The project report may be presented in scientific journals or conferences. When referring to your child in the report, we will use an alias such as "P1" or write "one participant commented that..."

How will personal information be protected?

We will take every precaution to ensure that no personally identifying information leaks outside of this project by following the guidelines of the new Data Protection Act. The only people who will see the video recording are the researchers and Helen Pain, and the video will be stored on secure, password-protected computers. The video will not be uploaded online to any cloud storage services or the like. If necessary, it will be transferred via USB to another secure computer. Any physical media, e.g. consent forms containing a child's name, will be stored securely in locked cabinets and will be destroyed after the study is completed. We understand that we are fully accountable for protecting you and your child's data.

Can I see the project reports and have a copy of the games when they're finished?

Yes, although you must ask us directly, as we will not distribute this to you otherwise. Bear in mind that each game is very much a proof-of-concept and, as such, will likely not be as polished or robust as you might expect for a commercial game. The game's source code will be released to the scientific community, however, so that it may be built

Figure 11.2: The parent information sheets.

upon in the future. Your child's data will not be added to nor able to be derived from these games, should there be any concern therein.

Who is funding this research?

These studies are part of our dissertations as part of our MSc degrees. Expenses such as stationery costs and Basic Disclosure Scotland fees are paid for by the School of Informatics within the University of Edinburgh, thus there is no "project funding" per se. This project does not bring any financial gain to the researchers nor to the University.

II. Participation

Having read this sheet, if you understand it and agree to let your child participate in this study, then please read and fill out the parent consent form and return it to Helen Pain.

After this has been received by us, we will invite you and your child to meet us in person at the University. We will talk to both of you and explain the session and study to your child, including telling them that they will be video-recorded, before asking them if they want to participate. Your child must give consent before we allow them to participate. Your child's consent is received by them filling out a consent form upon this visit, which you may also see. We will remind them that participation is voluntary; that they can withdraw at any time from the session or any specific workshop without giving a reason; and that they may ask us (themselves or through an adult) not to use their data in the study, even after the session is completed. We will respect any decisions taken by you or your child with regard to their participation in the session and how their data is used.

If you DO NOT want your child to participate in this study, you do not need to return the parent consent form. We will not contact you again regarding this study.

Figure 11.3: Next part of the parent information sheets.

Parent Consent Form	
Please circle YES or NO for each question.	
1. Have you read the parent information sheet, the child consent form, and the child information sheet?	If you give permission for your child to participate in this session of workshops, please return this form to Helen Pain.
YES / NO	If you DO NOT give permission for your child to participate in this session, you do not need to return this form. We will not ask your child to participate, and we will not contact you again regarding the studies.
2. Have you received enough information about the session?	Full name of participating child:
YES / NO	Child's date of birth (DD/MM/YYYY): _____ / _____ / _____
3. Do you understand that your child's participation is voluntary, and that they can choose to leave the session or any of its workshops at any time, without providing a reason?	Your relationship to the child:
YES / NO	_____ Your name: _____
4. Do you understand that you have the right to withdraw your child from the session or a particular workshop at any time without providing a reason, and also that you can ask for your child's information not to be used in the study, even after the session is completed?	Your contact telephone number:
YES / NO	_____ Your contact email address: _____
5. Do you understand that the session will be video-recorded, that the workshops' videos will only be seen by David Halperin, Chen Huang and Helen Pain, that the videos will only be used within this study, that no personally-identifying information about your child will be published, and that information from the video may be used in academic presentations or articles?	If you answered YES to all questions and have filled out all other required details, please sign this page on the line below to signify that you understand and accept the conditions of this workshops, including video-recording during the session. By signing, you agree that we may explain the session to your child and invite them to participate in the session.
YES / NO	_____ Signature: _____ Date (DD/MM/YYYY): _____ / _____ / _____
6. Knowing this, do you give permission for us to video-record the session with your child, and to use information such as their design ideas and feedback in the study?	
YES / NO	

Figure 11.4: The parent consent form.

A.2 Credit for Graphics not Created by the Researcher

Many of the graphics were generated in Microsoft Paint, or using RPG Maker's character generator or taken from RPG Maker itself (e.g. the balloon icons).

The icons for the level 1, 2 and 3 buttons were screenshots of other games, or images taken from google search. The level 1 icon can be found here: <https://selectitaly.com/tickets/museo-and-roman-forum-pass-rome/194>, the level 2 icon is a screenshot of another unrelated game made by the researcher, and the level 3 icon can be found here: http://metalgear.wikia.com/wiki/Liberty_Icon.

The faces for the receptionist character were created by a user of Deviantart named "CommandoCherry": <http://commandocherry.deviantart.com/art/Face-Set-Spain-RPG-Maker-VX-Ace-429344128>.

The background tiles used to create the levels were part of the "futuristic tile set" for RPG Maker created by "Celianna": <http://www.rpgmakerweb.com/a/celianna/futuristic-tiles>

The elevator sprite was created by a user of Deviantart named "nicnubill" (see <http://nicnubill.deviantart.com/art/Sci-Fi-Gates2-467531375>)

The in-game sprite of Sarcbot (not the face portrait) was part of a spritesheet created by Enterbrain, found at: <https://forums.rpgmakerweb.com/index.php?threads/eb-tsukuru-blog-resources.31793/#post-309623>

The music note icon and the speaker icon were obtained from Freepik and the Wikimedia Commons respectively (see http://www.freepik.com/free-icon/musical-note-symbol_737427.html for the music note and https://upload.wikimedia.org/wikipedia/commons/2/21/Speaker_Icon.svg for the speaker icon)

A.3 Participation Certificates for Children

These were given to children upon them completing a game design or testing session (modified appropriately). The certificates were initially generated using the site kidscerts.com, and then modified to be more tailored to the session at hand.



Figure 11.5: The certificate given to participants.

A.4 Modified SUS Questionnaire

	I Strongly Disagree	I Disagree	I don't agree or disagree	I Agree	I Strongly Agree
I think I'd like to play this game often.					
I found the game too complicated.					
I thought the game was easy to play.					
I think I'd need an adult with me to help me play the game.					
I found the buttons I could use in the game made sense.					
I thought the game didn't make sense from one part to another.					
I think other children could learn to play the game quickly.					
I found playing the game difficult and unclear.					
I felt confident playing the game.					
I needed to learn a lot of things before I could get going with the game.					

Figure 11.6: The modified SUS questionnaire given to participants.

A.4.1 Raw Data from Modified SUS Questionnaire

Please refer to the questionnaire sheet in appendix A.4 as a reference to the corresponding questions.

P1:	Question	1	2	3	4	5	6	7	8	9	10
	Score	5	2	5	1	4	2	5	1	4	5

P2:	Question	1	2	3	4	5	6	7	8	9	10
	Score	4	1	3	1	5	1	5	2	5	1

P3:	Question	1	2	3	4	5	6	7	8	9	10
	Score	5	1	3	1	5	1	5	1	5	1

P4:	Question	1	2	3	4	5	6	7	8	9	10
	Score	5	1	3	1	5	1	5	1	5	3

P5:	Question	1	2	3	4	5	6	7	8	9	10
	Score	4	2	4	2	4	2	4	1	4	2

P6:	Question	1	2	3	4	5	6	7	8	9	10
	Score	5	1	4	1	5	1	5	1	4	2

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