Developing an Interactive Game that Employs Mindfulness Techniques to Support Children with Autism Cope with Anxiety

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Abstract

Many children with Autism Spectrum Conditions (ASC) experience anxiety due to their core traits acting as possible sources of stress. The most relevant of which being reliance on routine and rigidity of thoughts and behaviour forming anxiety due to resistance of change, and additional difficulties in social situations creating social anxiety. This research explores how technology can be used to support children with autism cope with anxiety using mindfulness. Previous research revealed that technology based interventions are effective in supporting children to aid them in their daily lives, and how mindfulness can be used to aid children with autism in particular dealing with challenges specific to anxiety. Using a design process involving typically developing children and experts in the fields of Human-Computer Interaction (HCI), ASC and Mindfulness, a game called "Settling the Snow" was developed. This was then critically evaluated to reveal its potential in helping children with ASC cope with anxiety.

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Chapter 1

Introduction

1.1 Autism Spectrum Conditions

Autism Spectrum Conditions (ASC) are neuro-development conditions characterised by impairments in verbal and non-verbal social communication and interaction, restrictive interests and rigidity of thought, as specified in DSM-V (Diagnostic and Statistical Manual of Mental Disorders, American Psychiatric Association, 2013). [6] Due to the increase in awareness of autism and improvements and changes made to the diagnostic criteria, the estimates of occurrences of ASC is higher than in previous years at 6-7 in 1000 individuals and is typically diagnosed at a young age. [35]

Multiple psychiatric disorders coexist with autism and occur frequently, the most common of which is social anxiety followed by attention-deficit hyperactivity disorder (ADHD). [34] Anxiety related concerns are common among individuals of all ages with ASC, existing as a co-occurring disorder that interacts with the core traits of ASC. [11] One potential approach that has been shown to be effective in addressing stress, anxiety as well as depression is mindfulness based practices, which is the focus of this dissertation.[16]

Anxiety is an extremely challenging set of symptoms to deal with and often causes disruption to their daily lives, especially due to its inherent relationship with the core traits of ASC. Based on previous research, technology-based tools seem to be effective forms of interventions to help individuals with autism overcome their difficulties, as well as being an attractive source of engagement.

1.2 Research Goals

The main aim of this research is to design and implement a technology-based tool which uses mindfulness to aid children with ASC cope with anxiety. This takes the form of a video game that can be played that uses criteria grounded in theory of teaching mindfulness to young people with the aim of reducing stress and anxiety in particular. In order to achieve these research goals, the following questions have to be addressed.

1.2.1 Research Questions

RQ1. How can mindfulness techniques be applied in an interactive game setting to aid children with ASC experiencing anxiety?

RQ2. What are the current strategies being employed to help children with ASC experiencing anxiety?

RQ3. How can mindfulness techniques be used to help children experiencing anxiety and are these feasible for children with ASC?

RQ4. How can these strategies be implemented on an interactive smart tool or game suitable for children with ASC?

1. Are the activities appropriate to help children with ASC cope with anxiety?

2. Is the tool perceived as engaging for the target population?

1.2.2 Proof of Concept

This research acts a proof of concept to discuss whether it would be possible to implement mindfulness activities in an effective way for children with ASC. Evaluating if it is actually possible to decrease anxiety in children with autism is outside the scope of this research due to feasibility and lack of access to appropriate resources. Taking up the time and effort of children with autism at this early stage would not be ethical and access to such children is also limited. This research bases its discussions and conclusions based on more extensive experience from literature and experts and acknowledges the limitations of this approach.

1.3 Structure of the Dissertation

This dissertation is presented with the following structure:

Chapter 2: This chapter presents the literature review on autism, anxiety and mindfulness that was conducted that serves as a background to this dissertation. It discusses the characteristics of autism and how they may cause anxiety symptoms, how mindfulness can be used to address these symptoms and the relevance of technology based interventions.

Chapter 3: This chapter presents the design methodologies of the dissertation used to inform the design requirements. The design requirements are based on design workshops held with typically developing children acting as proxies for children with ASC and interviews with experts in the fields of HCI, ASC and mindfulness.

Chapter 4: This chapter presents the implementation of the game developed using in Unity 5 2019 for the Apple iPad running iOS 11. The design decisions for each mindfulness activity implementation is discussed.

Chapter 5: This chapter presents the evaluation of implementation based on workshops with typically developing children acting as proxies for children with autism. The limitations of the evaluation are also discussed.

Chapter 6: This chapter presents the results and limitations of the research overall and discusses different possibilities for future work and the plan for continuing to the second part of this research in 5th Year.

Chapter 2

Background and Literature Review

Chapter two presents the general characteristics and behaviours of Autism Spectrum Conditions (ASC) that pose particular challenges for these individuals, with an emphasis on their different experiences in social interactions, with sensory perception and repetitive behaviours. It then presents how this results in experiencing anxiety and similar comorbid symptoms and how this is particularly relevant to this group of individuals. The chapter then proceeds to discussing how mindfulness techniques can be used to aid individuals with these conditions experiencing anxiety, and looking how this can be implemented using current technology approaches for autism. These derive the design and criteria and provide the motivation for the game. This chapter aims to answer the second research question, **RQ2 What are the current strategies being employed to help children with ASC experiencing anxiety?**

2.1   Autism

2.1.1   Description of autism

Autism Spectrum Conditions (ASC) are a neuro-development conditions characterised by impairments in verbal and non-verbal social communication and interaction, restrictive interests and rigidity of thought, as specified in DSM-V (Diagnostic and Statistical Manual of Mental Disorders, American Psychiatric Association, 2013). [6]

Individuals with ASC often misread and avoid hidden social cues and find it difficult to build friendships appropriate for their age. Some may also be overly-dependent on consistent routines, highly sensitive to changes in their environment and intensely focused on items relevant to their restrictive interests but not appropriate to the current task or activity. [6]

ASC describes a spectrum of considerably heterogeneous conditions meaning it can manifest with varying degrees of severity with a range of different associated symptoms. [17]

2.1.2   Prevalence and impact

These symptoms vary widely across individuals and across different ages; they are often identifiable within childhood. It is widely acknowledged that ASC often appears in conjunction with other developmental deficits and psychiatric conditions. Presence of symptoms must appear in the early stages of development, even if these symptoms are not diagnosed until later. Intellectual disability or developmental delay are not root causes of ASC, but rather symptoms to be addressed. [6]

Overall ASC is estimated to occur in 6-7 in 1000. These estimates are higher than in previous years, most likely due to the increase in awareness of autism and improvements and changes made to the diagnostic criteria. [35]

2.1.3   Deficiency of Social Behaviour and Communication

Verbal and non-verbal communication difficulties manifest in ASC in varied and complex forms. This can develop in a range from complete failure of expressive and receptive language skills to specific pragmatic and semantic impairments. Individuals with the fluent speech abilities often show such semantic errors or miscommunications in social contexts such as sustaining or initiating reciprocal conversation or understanding subtleties of language.[35]

2.1.4   Sensory Sensitivities and Overload

Individuals with autism can also exhibit sensory difficulties which include any of oral, tactile, visual and auditory. [6] A study conducted by Kern et al shows that of 39 children with ASC, sensory difficulties were one of the most common associated features amongst the children. These may manifest as hypersensitivities which develop avoidances to loud sounds, bright lights or wearing clothes with certain textures or hypersensitivities where the individual shows an unusual attraction to lights or specific sounds and objects. [21] Too much exposure to these sensory sensitivities can result in overloading the individual.

2.1.5   Rigidity of Thought and Repetitive Behaviours

The most widely studied and stereotyped forms of behaviour in autism is repetitive motor behaviours commonly including finger-flicking, hand flapping, body rocking, self-spinning, or running in circles. This is most likely due to the fact that it is easy to quantify and observe and high levels of repetitive motor behaviour are also observed in other psychiatric and developmental conditions. [31]

Repetitive behaviours are suggested to offer some sense of control to the individual with ASC or allow withdrawal from the world, as it appears frightening due to its unpredictability. This behaviour occurs more often in the event of a change or an unpredictable situation, and this can cause challenging behaviour such as aggression, non compliance and tantrums which can be potentially harming to the individual or others. [36]

Leo Kanner suggested that many of the core symptoms of ASC, especially the reliance on consistent routines and rigidity of thought, were related to and driven by anxiety. Anxiety may not play a fundamental role in their difficulties but play a secondary role, compounding the phenomenon to make the situation all the more stressful. [19]

2.2 Anxiety and Autism

2.2.1 Anxiety

Anxiety is defined as excessive anxiety and worry (apprehensive expectation) which the individual finds difficult to control. Characterised by restlessness, being easily fatigued, difficulty in concentrating, irritability, muscle tension and sleep disturbance. Represents one of the major groups of disorders seen in psychiatry as defined by DSM-V. The anxiety disorders group does not include obsessive-compulsive and related disorders nor does it include trauma and stressor related disorders and panic attacks are now symptoms of all DSM-V disorders.[6]

Anxiety related concerns are common for both children and adolescents with ASC. Rise of anxiety symptoms being expressed in people with ASC. Young people face increasingly complex social situations which lead them to become more aware of their differences, interpersonal difficulties and increasing pressure on social behaviours leading to rising anxiety levels. Anxiety is not a product of ASC but rather a co-occurring disorder which can compound existing anxiety such as fear of social interactions and this makes it critical to understand how it interacts with core traits of ASC is important. Individuals with autism display higher levels of social anxiety as it directly addresses one of the core traits.[11]

Another core trait of autistic individuals is the reliance on consistent routines, which causes individuals to struggle coping with change and anticipation or engagement of new events. This source of stress causes the individual to experience more anxiety. The individual will also feel more incapable of handling their own demands, the higher their anxiety is.[12]

2.2.2 Prevalence of anxiety in autistic children

Multiple psychiatric disorders coexist with autism spectrum conditions and occur frequently. Looking at the prevalence of comorbid psychiatric disorders based on DSM-IV criteria in a population with children with confirmed ASC, the most commonly co-occurring psychiatric disorder was social anxiety followed by attention-deficit hyperactivity disorder (ADHD), present in up to 70% of individuals with ASC. Anxiety disorders are common in the broader ASC population and not just clinical cases.[34]

White et. al discusses the reports published between 1990 and 2008 to identify the prevalence of anxiety within autistic individuals as well as other disorders. Some of the most frequently reported anxiety disorders and symptoms seen in children with ASC are simple phobias, generalized anxiety disorder, separation anxiety disorder, obsessive–compulsive disorder, and social phobia. These are present through all levels

of cognitive functioning. Specific to children with ASC, the anxiety is most commonly related to acting out specific behaviours. This could be due to the co-occurring social anxiety which is a core deficit of ASC. [39]

Up to 71% of individuals with ASC, dependent on gender and race, expressed suicidal ideation or attempts, due to the high comorbidity with depression.[24]

Table 2.1 shows the potential correlation to anxiety symptoms that can be caused by the characteristics of the Autism Spectrum Conditions.

Characteristics of ASC	Characteristics of Anxiety
Difficulties in social skills can make it hard to maintain friendships, due to issues with social empathy and the perceived unpredictability of other people	Finding it hard to maintain a social circle and meeting new people, not understanding the social behaviours of those around you leading to a rise in pressure and experiencing anxiety
Difficulties in terms of language and communication skills, due to what they understand, as well as what they are able to express	Difficulties with communicating and expressing yourself and any needs you may have
A rigidity of thought processes that makes it challenging to deal with change or accommodate the needs of other people	Preference to do or act in a particular way leading and heavy reliance on structure and routine leads to increased anxiety when an unforeseen change occurs or thought is fixated on a hypothetical unwanted change
Difficulties with processing sensory information including being hypersensitive	Sensory sensitivities can lead to overload which is stressful and can provoke stress and anxiety to the point of a panic attack

Table 2.1: Correlation of core characteristics of anxiety and ASC

2.3   Mindfulness

2.3.1   Definition of Mindfulness

Mindfulness is the fundamental attentional stance underlying all streams of Buddhist meditative practice. The most widely accepted understanding of mindfulness in the social sciences comes from Jon Kabat-Zinn, the creator of Mindfulness-Based Stress Reduction (MBSR). Mindfulness is defined as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment". This is understood to be the result of paying attention with intention, centredness and absence of judgement to one's experience. Mindfulness practice has been shown to be effective in addressing stress and anxiety as well as depression.[16]

Mindfulness is the fundamental attentional stance underlying all streams of Buddhist meditative practice. MBSR is a stress reduction strategy employing Buddhist meditation to engage the understanding of what Buddhists call the untrained mind and offers potential transmutation that can calm and clarify the mind, and enhance attention and perception.[18]

2.3.2 Mindfulness and Autism

An analysis of six mindfulness studies on individuals with ASC show reduction in symptoms of anxiety and depression and support producing positive psychological effects. This stems from greater adaptation to social environments through promoting increased self-awareness and empathy for others through meditative practices, broader psychological well-being through increased attention in the present and reduced aggression. [3]

Mindfulness intervention studies in the field of ASC can be discussed according to three types of intervention - supporting children through supporting their parents, supporting both the children and the parents and supporting either the parent or children exclusively. [30]

Parents are able to support their children with ASC by learning patience, and conscious attention and acceptance through mindfulness. The parent can cultivate a supportive environment that is not overloaded with emotional changes, by creating a breathing space before responding to difficult behaviour. This cultivates a more non judgemental approach towards accepting their child. Children are then placed in a more supportive environment during their developmental years. [5]

Mindfulness practices being used to engage with children, especially those experiencing anxiety, often focuses on attention. Children may either have difficult shifting attention between tasks or have difficulty focusing on a particular rumination. Their attention may be fixed on themself in social situations, giving them minimal awareness of external events. Focusing on the present discourages focusing on past or hypothetical events that may cause anxiety for the child, and accept their current state of mind instead. [15]

When engaging with these practices it is evident that there is a bi-directional experience for both the parent's stress and the child's behaviour. [20]

2.3.3 Mindfulness in Technology

There is support to suggest that mindfulness techniques presented without an instructor (i.e via apps, websites and other online programs) can still provide similar benefits without losing quality of face-to-face interactions when aiming to mitigate anxiety, depression and other symptoms. Implementing mindfulness programs in technology allows for it to become more cost-effective, accessible and flexible based on the user's requirements and preferred methods of engagement with the practice, such as offering a choice of text, audio and video. This needs to be balanced with the preservation of integrity and authenticity that would be found in in-person mindfulness sessions. [8]

2.4   Technology Based Interventions

In the field of autism research, computer-based interventions are being used to improve social skills, communication skills, fine motor skills, functional life skills, organizational skills, and promote independence. In particular individuals with autism are attracted to the lack of social interaction, predictability and consistency when engaging with technology. [22]

The development of these new technologies are aimed to enhance both the individual with disabilities as well as the work of carers and parents. This is a quickly growing field in the treatment of autism and there exist a variety of different technologies such as mobile computers, virtual reality and robotics.[13] Conceptual minigames for learning are one such approach shown to result in an increase in enthusiasm. [37]

Children with autism spend twice as much time playing video games than typically developing children. One of the primary reasons this may be the case is that video games promote stress relief, and can act as a management system for mood and anxiety in addition to being an entertainment system. [25]

2.4.1   Design Principles in Video Games for Children with Autism

The privacy of game environments provides a safe and non threatening context to practice and acquire new skills. This also has the advantage of clearly defining the task and having reduced distractions from unnecessary sensory stimuli, addressing some of the core deficits of ASC. Computers have the ability to permit concurrent or cooperative use, which typically results in benefits such as increased motivation, increased attention and occasionally increased learning. [23]

Cause and effect gives children a sense of control over the environment, as they are also in control of the pace of the activity. In order to represent experiences for children with autism in a way they can understand them, the environment must be constructed such that it reinforces the cause and effect relationships. These environments offer controlled emotional stimuli that allow children to correct their mistakes and overcome challenges while also offering well defined rewards. [38]

Due to to particular deficits, of individuals with ASC, they may be more prone to failure when participating in activities and it is also apparent that intrinsic motivation may not be sufficient to complete the activity and extrinsic rewards to supply a sense of completion and accomplishment are required. Customisation features make the creation of tailored narratives, environments and rewards to suit an individual's interests possible, which is more motivating for the individual. [4]

Additionally, sensory feedback can have a positive influence on the performance of autistic children in a game based environment as it encourages them to focus on the events occurring on screen. For individuals with ASC that have particular sensory sensitivities, it is possible to create an adaptable tool to meet the needs of the individual such as having adjustable graphics and using both verbal and non-verbal means of communication. [22]

2.5 Motivation

The difficulties experienced by individuals with autism include social interaction, communication and reliance on repetitive behaviours and routines. The requirements for social interaction (eye contact, body language, interpretation and responding appropriately to people's actions, emotional states, conversation) can be particularly stressful as this places significant pressure in social contexts. This is especially true for children and adolescents as they are expected to engage in new activities and develop adaptive skills. Rigidity of thought can manifest the need for routine and repetitive behaviours, which develops a resistance to change and the ability to adapt to different environments and people. Not accounting for these needs can otherwise result in sensory overload or feeling stressed and anxious to the point of experiencing a panic attack. Strategies for aiding them when they are experiencing or in order to prevent anxiety or dealing with overloaded information are crucial to help them cope with changes in their social or daily lives.

ASC is a heterogeneous set of conditions and its symptoms varies amongst individuals and this includes the set of symptoms and severity in which individuals experience anxiety. There are a range of different techniques and activities in mindfulness and other fields that can be used to help cope with anxiety but these may differ in effectiveness for each individual. Designing an interactive game becomes even more challenging that can be used to meet the needs of different users.

Implementing mindfulness into technology based interactive tools to aid individuals coping with anxiety and other disorders is an arising field of research, and one that can be applied to individuals with autism based on the positively influencing factor technology has in their daily lives. The purpose of this research is to create an interactive game to extend the current work on interventions on ASC using mindfulness techniques designed to help cope with anxiety.

2.6 Summary

This chapter presented the current research on ASC and identified the existing methods and technologies that help children with autism cope with anxiety. From the literature, mindfulness was identified as a possible technique to help individuals with autism cope with anxiety and stress. This enabled the motivation behind this research to design and create an interactive game. In the next chapter, the design of the interactive game is discussed based on workshops held with eleven typically developing children and four interviews from experts or practitioners in ASC and mindfulness.

Chapter 3

Design Phase

This chapter describes the Design Phase, which discusses the design methodologies and stages of development considered in this research. The following consisted of using the constructed game requirements from the literature review to create design workshops with children which were conducted in early November. The game requirements were then refined into early design decisions based on the outcome of these workshops which were presented to experts which was used to conduct an initial design evaluation on how the game meets the proposed criteria and its possible use case contexts and hypothetical applications and further adapting the design to meet these criteria. The finalised design was used to inform the implementation of the game. This chapter aims to answer the research question **RQ3 How can mindfulness techniques be used to help children experiencing anxiety and are these feasible for children with ASC?**

3.1 Design Methodologies

3.1.1 User Centered Design

User Centred Design (UCD) focuses on putting users at the center of product design and development in each phase of the design process. The game is being designed for children with ASC aged 6 - 12. The design process involves identifying the most salient features required for children with ASC, the possible contexts where and when a child may play this game and the choices of hardware for this game. [27]

UCD is defined by four interdependent processes that inform the structure of the work. [9]

1. Specify potential context of use

2. Specify requirements

3. Produce design solutions

4. Evaluate designs against requirements.

3.1.2 Participatory Design

Participatory design (PD) is the approach of involving users during different stages of the design process by using interviews and workshops during the requirements gathering and evaluation stages. This is an iterative process that can lead to products well suited to the users needs. This is illustrated using the typically developing children and researchers of Human-Computer Interaction (HCI) and ASC we worked with. [1]

The design criteria derived from the literature informed the creation of the Design Workshops. These designs will help us create a prototype for the game subject to expert and group evaluation in a followup workshop. At all times we must consider the target user, which makes the participation of the children particularly important. [7]

The typically developing children act as proxies for children with autism, as these evaluations may cause them stress which is to be avoided. Previous research suggests that using typically developing children can be crucial when informing the designs of technologies for children with disabilities. [10]

3.1.3 Stages of Development

The methodology followed in this research is an adaptation of (Scaife & Rogers, 2001). This is illustrated by the following stages of development. [33]

Establishing Requirements

As outlined by the first step of UCD, the first step requires establishing what needs to be built and why by understanding how children with ASC experience anxiety and how mindfulness can potentially be implemented into an interactive game suitable for the target population. This was achieved by reviewing the literature on individuals with ASC and exploring the current research on these particular topics.

Informing the Design

We established the initial requirements for the game by carrying out collaborative design workshops with typically developing children. These requirements were then presented to experts of HCI, ASC and Mindfulness to incorporate additional requirements relevant to the method of delivery and target population's preferences and limitations. In addition to this, the exploration of how mindfulness is currently implemented to teach children in schools and through popular apps is also considered to inform our design.

Designing and Prototype

Based on the results of previous stages, initial design decisions are made before implementing a prototype. This prototype is then evaluated by children to test its suitability to the target population with the principal goal of delivering mindfulness. In this evaluation stage, more appropriate alternatives are considered and usability problems are identified. This allows us to refine the design of the game based on the new requirements.

Implementation

The implementation of the game is created on the defined platform of use using the specified technologies. This is done in an iterative manner as first a prototype is built based on the initial requirements before being further modified to address all the additional requirements from the evaluation.

Evaluation

To identify possible usability problems, test the suitability of the game to its target audience and test the effectiveness of implementing mindfulness in a game based environment we held evaluation workshops with four typically developing children. Further feedback and any requirements not addressed is discussed for potential future work.

3.2 Design Workshop

Design workshops with typically developing children of similar ages to the target population acting as proxies for children with ASC were held, as per the methodology in Section 3.1.

3.2.1 Aim

The aim of these workshops was to gather informed design decisions to create a game for autistic children that would incorporate mindfulness techniques which can be used to ease the symptoms of anxiety. This involves answering the following questions:

1. How can these mindfulness techniques be implemented into a game?

2. Which of the activities are more appealing/engaging to the children?

3. How can you track your progress or completion of a task or level?

3.2.2 Participants

Workshop	Participant	Age	Participant Gender
1	P1	6	Male
	P2	8	Female
2	P3	12	Female
	P4	10	Female
	P5	12	Male
	P6	12	Male
3	P7	10	Female
	P8	11	Female
	P9	8	Female
	P10	10	Male
	P11	10	Male

Table 3.1: Design Workshop Participants

3.2.3 Materials

The materials used to setup the room in preparation for the workshop included:

- Name labels for all participants and researchers

- Consent form and information sheet for parent/guardian

- Consent form for children

- Two audio recording and playback devices for audio recording, ensuring a backup was available in case one failed

- Audio playback device for meditation bell sound

- Snow globe for demonstration

- Fidget spinner for demonstration

- Plain white sheets with colouring pencils and pens

- Laminated sheets with images and simple text for each mindfulness technique

3.2.4 Procedure

These workshops were done in partnership with Mourad El Sherei, who is researching how mindfulness can aid children with autism. This was done under the assumption that both projects can benefit from longer more focused workshops oriented around mindfulness with the children.

- The study underwent the ethical procedure as defined by the School of Informatics at the University of Edinburgh.

- Parents and children were contacted by email with information sheets on the study and consent forms if they were willing to participate

- If the children and the parent submitted their consent forms they were invited to participate in the study.

- We held 3 workshops over the course of 2 days

- Each workshop ran for 45 minutes

- After completion of the workshop, certificates were presented to each participant to show they are great game designers to show appreciation for their participation and input

3.2.4.1 Introduction (5 Minutes)

We first introduced the different mindfulness techniques [14], allowing all children to familiarise themselves with the activities and also asking if any of them had been introduced to mindfulness previously. Krupa Patel supported the use of these mindfulness techniques which can be engaging and effective specifically for children with autism. [28]

Inviting Happiness

Imagine what Happiness looks like to you and draw or write freely on the paper in front of you, using any colours you like. Imagine you are inviting happiness into your home for a favoured activity. This is a simple exercise that shifts their attention to the present moment and the environment only existing on paper. They are encouraged to let any thought pass by freely and to engage as much as they would like.

Bell Listening Exercise

Ring a meditation bell, using an application or website or a physical bell, and ask the children to close their eyes and listen to the vibration of the bell. Tell them to raise their hand once the ringing stops. This is a simple and powerful exercise that shifts their attention to the present moment and immediate surrounding environment.

Mindful breathing and meditation

Ask the child to close their eyes and sit comfortably with their feet on the ground. Direct their attention to the sensation of breathing in and out. Ask them to put their hands on their stomach and feel the rise and fall of each breath.

Snow globe

Using a snow globe or a glitter jar, ask them to shake the globe and observe the swirling chaos of pieces of glitter. Each piece of glitter correlates to a thought in the mind and when the snow globe is left, watch as the glitter settles and the image in the centre becomes clear. This technique is a powerful metaphor that relates the internal state of mind to a visual and tangible object.

Fidget Spinner

Hold the fidget spinner between your fingertips and spin the toy. While the toy is spinning, focus all of your attention onto the toy. This is an engaging tool to shift their attention to the present moment.

Observations

The Fidget Spinner attracted the most attention, with most children immediately able to zone in on the object while they had the chance to play with it. The snow globe was equally attractive as they enjoyed watching the glitter. Some children were familiar with the concept of mindfulness due to them learning it in school and participating in mindful breathing and eating exercises.

3.2.4.2   Activity 1 (10 Minutes)

The children were tasked with describing through image or text what represented the idea of happiness to them at that moment, and were then asked to invite this character to a tea party. The participants worked individually for this activity.

Observations

Figure 3.1: P9 Representation of Happiness

Most children enjoyed and engaged fully with this activity. Fewer children had more concrete examples of happiness such as the figure representing sunshine in Figure 3.1, as a lot of the ideas were abstract as shown in the observations below. Due to this less children involved their happiness character in their actual game designs and just enjoyed drawing as an activity in itself.

Figure 3.2: P4 Representation of Happiness

Figure 3.3: P3 Representation of Happiness

Fewer children chose to write instead of draw, and some children enjoyed the sound of scribbling rhythmically using different colours on the paper more than drawing itself which encouraged the idea of background sound design. This is represented in Figures 3.2 and 3.3.

3.2.4.3 Activity 2 (20-25 Minutes)

The children were tasked with designing a game that would incorporate the different mindfulness techniques of their own choice with the option of combining mindfulness techniques together. Some of the children chose to work in pairs while some chose to design individually.

Observations
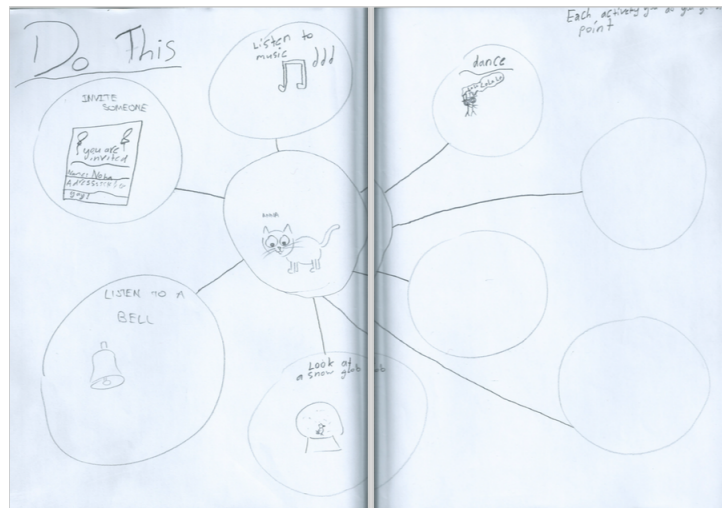
Figure 3.4: P4 Game Design

There were common design elements that arose over the course of the workshops which are discussed below, with most children isolating each activity individually instead of trying to fuse them as represented in Figure 3.4.

3.2.4.4   Discussion

After each activity the children were asked to share their ideas and each game could be played by the participants and the researchers.

3.2.5   Results

Aim 1: How can these mindfulness techniques be implemented into a game
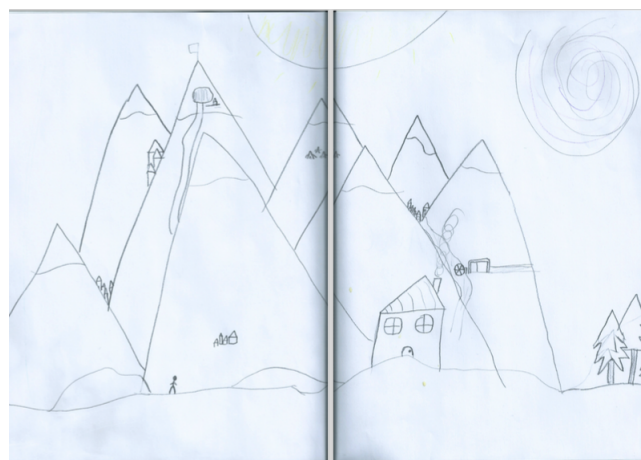
Figure 3.5: P5 Game Design

One of the common design elements discussed below, uses each technique in a unique way as an isolated activity like a minigame or singular level. These activities would be completed as the environment is traversed as represented in Figure 3.5, which depicts mountains that the user would travel through and participate in activities.

Aim 2: Which of the activities are more appealing/engaging to the children

Many children engaged with the fidget spinner and snow globe, both physically during the workshop demonstration and implemented in their test games. The least engaging activity was the breathing exercise as few chose to implement it during their games. The activities themselves would sometimes take different forms more relevant to the environment as in Figure 3.5, the Fidget Spinner activity is depicted using a water wheel, which focuses on the act of spinning.

Aim 3: How can you track your progress or completion of a task or level
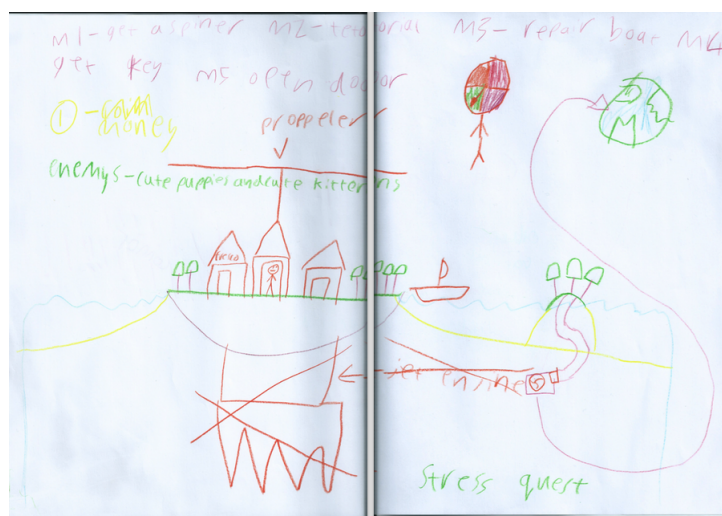
Figure 3.6: P10 and P11 Joint Game Design

One of the common design elements discussed below, is including a stress meter to keep track of the completion of a task and time of play and serve as a reward when the stress meter is empty. This is referenced in Figure 3.6 as a man whose head represents a circular stress meter.

3.2.5.1 Summary of Common Design Elements

As the workshops progressed we noticed some common design elements in the games presented by the children.

- Splitting each mindfulness technique into several different minigames or levels

- Having a stress meter with the aim of reducing it, via the minigames

- Sound design based including relaxing background noises, aside from the ringing of a meditation bell, such as rain or the passive sounds of inside a classroom such as the sound of pen or pencil on paper

- Journeying through a themed environment with all mindfulness techniques present but contained in their own area, completion of the technique would have its own unique effect on the environment.

3.2.5.2   Initial Design Requirements
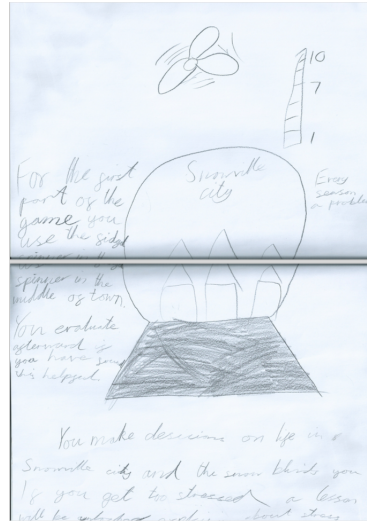
Figure 3.7: P6 Game Design

Based on the common design elements that the children presented from the workshops, we can use these initial design requirements as a basis for the game design. The full environment is an enclosed area based off of the different techniques, where each technique has its own dedicated area composing an individual minigame. The environment itself is set inside a snow globe based on Figure 3.7, and the island within is the playable area, based on Figure 3.6. The snow reflects how much stress is present at the current moment. A stress meter is present to indicate the current status and reflect how much snow is in the area. Each section of the island is a minigame dedicated to one of the mindfulness techniques and completion of each task reduces the stress meter.

- Tapping to spin the fidget spinner

- Ringing the meditation bell at timed intervals

- Breathing in time with a visual animation and text on screen

- Drawing activity

3.3   Evaluation of the Design

The initial design requirements with simple prototypes obtained from the design workshop were presented to four different experts in the form of semi-structured interviews. These experts work in the fields of HCI, ASC and mindfulness. These additional requirements gathered were used to refine the design, as per the methodology stated in section 3.1.

3.3.1 Aim

The aim of these interviews is to inform the technical and educational aspect of this application which requires expert input to create an effective environment for delivering mindfulness with the particular goal in mind of aiding individuals with anxiety, specific to individuals with ASC. This study also helped evaluate possible design alternatives and considerations. Specifically we wanted to answer the following questions:

1. What are suitable rewards for children with ASC?

2. What is the best way to present mindfulness techniques to a younger audience for their understanding?

3. What are the game design considerations that need to be considered when designing for children with ASC?

4. Are these techniques suitable for addressing anxiety?

3.3.2 Participants

Expert	Profession/Occupation	Area of Specialisation
E1	Lecturer at University of Edinburgh	Researcher in HCI and ASC
E2	Carer of Autistic Family Member	Working with young individuals with ASC
E3	Mindfulness Chaplain at the University of Edinburgh	Mindfulness Practitioner
E4	Lecturer at University of Edinburgh	Researcher in Psychology and Mental Health

Table 3.2: Experts in the fields of HCI, ASC and Mindfulness

3.3.3 Materials

The following materials were used to conduct the interviews.

- Smartphone for recording audio and transcription

- Laptop for displaying prototype screens and for taking written notes

3.3.4 Procedure

The interview with Expert 1 and 3 was done in partnership with Mourad El Sherei, following on from our results from the Design Workshop. The interview with Expert 4 was done in partnership with Brogan Miller, who is researching how emotion recognition is relevant to children with autism.

- The study underwent the ethical procedure as defined by the School of Informatics at the University of Edinburgh.

- Each expert was emailed information sheets related to the study and consent forms for participation

- Each interview ran for approximately 30 minutes and was tailored to the expert's particular background

- After completion of each interview, the expert was emailed thanking them for their input and offering further option for interview if they wish to see the outcome of study for evaluation

3.3.5 Results

3.3.5.1 Customisation

Answering Aim 3: What are the game design considerations that need to be considered when de-signing for children with ASC?

E1 and E2 both highlighted the importance of having customisable environments that would be specific to the particular autistic child playing the game at that time. This could be implemented in the form of profiles for each child playing the game, setup simply (or in an ideal world automatically as stated by E1) by the carer. E2 specifically stated:

"If you know one autistic child, you know one autistic child."

This highlights the heterogeneous nature of ASC, where each child interacting with the game is likely to have different needs in place. Framing the game using the specific interests of the child also increases enthusiasm and engagement as noted previously in the literature. [4]

3.3.5.2 Game Design specific to Designing for Children with ASC

Answering Aim 3: What are the game design considerations that need to be considered when de-signing for children with ASC?

Following on from customisation of the environment to suit the child's interests, the game should also be customisable when handling different functions. E1 and E2 both suggested possible forms this could take such as providing verbal and non-verbal forms of communication, offering colour profiles which include levels of saturation and the ability to toggle on and off particular colours, and if sound or animation is included.

The app should also allow the child to feel in control of the environment, they should be able to exit and switch activity at any point. While including all of these options the design should also be simple not to overwhelm the child. E2 discussed how autistic children take instructions literally so when presenting instructions for the mindfulness techniques, it should be as direct as possible.

3.3.5.3   Suitable Rewards

Answering Aim 1: What are suitable rewards for children with ASC?

Rewards are another area of customisability as stated by E1, allowing the child's interests to be the reward for playing the game. When discussing mindfulness, E3 noted that mindfulness is not about getting it right or wrong and specifically stated:

"I think where games are built on reward (the dopamine hit), you kind of need to turn that around in some way, because mindfulness as you say sits outside the usual binary of getting it right/getting it wrong. It's about building self-awareness – and right/wrong binaries as you say tend to just increase anxiety and self-monitoring in an unhelpful way."

There isn't a clear indicator for completing a specific activity and each activity is engaged with to the extent the user is capable at that particular moment. With regard to the stress meter that was suggest during the Design Workshops, E1, E2 and E3 agreed that it would likely increase the anxiety the child is facing if a task is being performed 'incorrectly'. The reward should instead try to focus on rewarding if the player engages with the task and not punishing if they do not.

3.3.5.4   Possible Contexts of Use with Intent of Coping with Anxiety

Answering Aim 4: Are these techniques suitable for addressing anxiety?

When tackling anxiety specifically, it can be very difficult to handle an individual with autism when they have already experienced enough stress to cause a meltdown, as noted by E2 and E4. After this has occurred, the child can potentially have violent reactions or other difficult behaviours. Close to the point of meltdown if noticeable, the child is best left to a carer or to their own devices. E2 goes on to state:

"Having anxiety when you're autistic is like shaking a can of coke. Every difficult moment in the day, from the school being too loud to having to change your routine results in you shaking the can of coke. What happens when you shake a can of coke too much? It bursts - that's a meltdown."

As highlighted from the statement, it can be very difficult to notice when an individual with autism is experiencing anxiety, and it can also be very difficult for the individual to completely engage and express before a meltdown. The best use case for an app designed to cope with anxiety is in a preemptive measure for relaxation in a quiet space, in school or at home as suggested by E1 and E2. Implementing this as a tablet application broadens the possible contexts for use due to the mobility of tablet devices.

3.3.5.5   Gamifying Mindfulness

Answering Aim 2: What is the best way to present mindfulness techniques to a younger audience for their understanding?

E3 offered some caution when gamifying mindfulness as one particular aspect that needs to be considered is the slowness of mindfulness. Mindfulness is a practice that takes time and patience to engage with and to learn as a skill, and a lot of games and

apps in particular revolve around skill. When teaching beginners, the most important thing is to develop the experience of being grounded by focusing on the attention of oneself in a non-judgemental way avoiding self criticism.

"So paying attention in a very harsh, cold or critical way – that's not mindfulness. But paying attention with a sense of interest, warmth, friendliness even (especially to our own experience or that of others) – that's mindfulness."

It also needs to be carefully reviewed by practitioners as any mistakes rolled out can easily be ramped up into practices.

3.3.5.6   Applying Mindfulness to Anxiety

Answering Aim 2: What is the best way to present mindfulness techniques to a younger audiencefor their understanding?

And Aim 4: Are these techniques suitable for addressing anxiety?

The increase in accessibility to mindfulness practices is great as more people are incentivised to learn and participate, especially through popular apps like Headspace, however it cannot replace regular sessions with practitioners. E3 offered some caution on handling anxiety through mindfulness apps, as it must not be seen as a solution for what can develop into detrimental situations for the individual.

"It's really important to have self-soothing possibilities available to people, things that help them cope with day to day life, but I'd sometimes be worried about people who actually need more support and tailored guidance falling through the cracks of something that was designed to be a lighter public-health style intervention rather than something more clinical or personalised"

When using mindfulness to address anxiety in particular, E3 noted that bringing the attention to parts of the body that are "anxiety resistant", such as the feet is a useful way to help cope with anxiety. As mindfulness is about attention, it can be ineffective to put all your focus into the breath or chest as they may feel uncomfortable or tight when you are anxious.

3.3.5.7   Extra Features Suggested

Ideally if the game is created to be customisable, there are two environments that exist within the game - one for the carer to customise the profile and one for the child to play.

An additional feature or minigame suggested by E4 was a bubble popping game, the monotonous and simple game involved tapping the screen to pop bubbles which is effective for relaxing the user when stretched, and provides an immediate award in the same way the activity can be appealing in real life.

3.4 Design Principles

3.4.1 HCI Design Principles

In addition to the technical requirements defined above, it is important to take into account the design principles which can be used to guide the design process of an interactive game. The 10 Nielson's Usability Heuristics (1994) act as a good rule of thumb and are the most general principles in the field of HCI. [26]

3.4.2 ASC Design Principles

A set of design principles specifically aimed to accommodate for individuals with ASC is taken into account for designing the game. The design principles were collected by Laura Bartoli et al. (2014), who presented general guidelines for designing technology for children with autism, and expands on the results from the interviews conducted with experts. [2]

1. The goals should be unique and explicit.

2. The goal should be focus on a singular task.

3. The instructions should be explicit and provided at every step.

4. The game should be repeatable and predictable, there should be no sudden or unseen events

5. The graphics should be minimalistic, but aesthetically nice and visual elements should not distract or overwhelm the child.

6. Rewards should be offered after good performances. A reward system which is preferred by the child, increases motivation.

7. The icons should be large and easy to see. The text should be simple, clear and easy to read. The colours should be soft.

8. Navigation should be straightforward.

3.5 Design Requirements

3.5.1 Game Design

Based on the literature review in Chapter 2, the results of the Design Workshops in Section 3.2, the results of the interviews with experts in Section 3.3 and the design principles outline in section 3.4, we can refine our game design requirements for implementation. The environment of the game will be a snow globe that houses each of the mindfulness activities identified in the design workshops as discussed in Section 3.2.5.2.

1. The target population is children with ASC between the ages of 6 and 11.

2. The target platform is a portable tablet device with a touch screen

3. The language is simple and direct

4. The game is intended to be used by both carers and children

5. The play environment is for the child

6. The admin environment is for the carer, only they can change settings

7. The game can be customised

8. The game will have minimalist design

9. The game environment will be set inside a snow globe

10. The game will have multiple levels, each with a different mindfulness activity

11. The game will have a reward system incentivising play

12. The game will be easy to navigate and allow quitting at any point

13. The game must be consistent and straightforward

14. Each mindfulness activity will have slow gameplay, with a focus on attention

Essential requirements for the game that are not implemented due to time and limited scope of the research will be considered as part of Future Work. The game will focus on the playable elements most relevant to implementing the mindfulness techniques discussed.

3.6 Summary

This chapter presents the design principles and methodology used for gathered requirements that will be used for the design of the game. It discusses the procedure and outcomes of the design workshops with typically developing children and interviews with experts on HCI, ASC and Mindfulness and how this is relevant for helping children with autism cope with anxiety. In the next chapter, the resulting requirements are used to create the implementation of the interactive game for the target population and context.

Chapter 4

Implementation

This chapter presents the game implementation based on the design requirements and methodologies discussed in chapter 3 before introducing the main concepts to developing a game in Unity and the implementation decisions regarding the game platform. The full organisation of the code responsible for creating the game is discussed, as well as changes to the design with appropriate justification and which features are set for future work. This chapter aims to answer the research question **RQ4 How can these strategies be implemented on an interactive smart tool or game suitable for children with ASC?**

4.1   Choice of Platform

From early on in the study, it was a requirement for the game to run on portable touch screen devices. This decision was based on the literature review and was further re-informed in Chapter 3, as the interactivity is a desirable and engaging function of the game. (**requirement 2**) When choosing between the available operating systems, both Android and iOS were considered and a choice had to be made between the two.

- **Android** - Android is developed by Google and applications for this OS is developed using Android Studio using `Java`, `Kotlin` and `XML`. The researcher has previous experience in all the languages and developing in Android Studio.

- **iOS** - iOS is developed by Apple and applications for this OS is developed using the `Swift` programming language, and you must own a Mac computer if you wish to develop using this.

- **Using Unity** - Unity is a Game Engine platform that allows us to develop in 2D and 3D using `C#` that exports to multiple different platforms which allows us to get around any platform specific restrictions related to development.

The researcher decided to use Unity for developing due to previous experience, lack of restriction on platform choice and game development support in both 2D and 3D. As there are no specific features or libraries of either OS that result in a particular benefit or limitation, the choice of OS is based on the resources available to the researcher.

4.2   Developing in Unity

The prototype of the game was developed using Unity 5 (2019) which is available for both Mac and Windows operating systems. Unity uses `C#` for development as its default scripting language and includes pre-existing functions that facilitate the creation of the game. Unity also allows for cross-platform functionality including computers, tablets, video game consoles and virtual reality (VR) which is potentially useful for both testing and future expansion.

In general games in Unity are split into separate Scenes, where each scene represents a particular activity or menu screen. Each `Scene` is composed of different Unity `GameObjects`, which operate using three main functions. `Awake()` which initialises the `GameObject`, `Start()` which is called on the first frame update when a Unity scene is loaded and `Update()` which is called on every frame. Each `GameObject` can define its own fields and helper functions to be used within the `Start()` and `Update()` functions, as per the object-oriented paradigm. Unity's pre-existing library functions also accommodate event listeners handlers for input, and object geometry functions.

The researcher already had experience developing in Unity 2D and 3D and using similar object-oriented programming languages, which reduced the amount of time to familiarise themself with `C#` and Unity technologies. Having the ability to develop in both 3D and 2D in Unity provides many advantages, in particular many expansive options for a game of this nature. Initially the researcher opted to create a 2D game focusing on the interactivity element of the mindfulness techniques, however it would be possible to create a full environment for exploration in Unity 3D with the mindfulness techniques implemented as different activities. This kind of environment is richer and can offer a stronger contextual narrative.

4.3   Game Structure

The game is titled **'Settle the Snow'** based on the main goal of the game to settle the snow within the snow globe environment. **(requirements 9 and 11)** Instead of a stress meter that decreases with play, there is a snow bar present through all mindfulness activities which increases with play which represents the settling of the snow. This change in definition acts as more of a reward as discussed in section 3.3.5.3. The game is structured into four different scenes, each with their own `GameObjects` that hold the functionality for that particular mindfulness activity. **(requirement 10)** The `Main Menu` Scene, which is used as primary navigation through the game. And one scene for each of the mindfulness activities, `Breathing`, listening to the `Bell` and playing with the `Fidget spinner`. The main colour scheme is blue and white, with white used for the text and snow background and blue as the main colour to display a feeling of trust, friendliness and open communication. **(requirement 8)** [41]

4.3.1   Main Menu
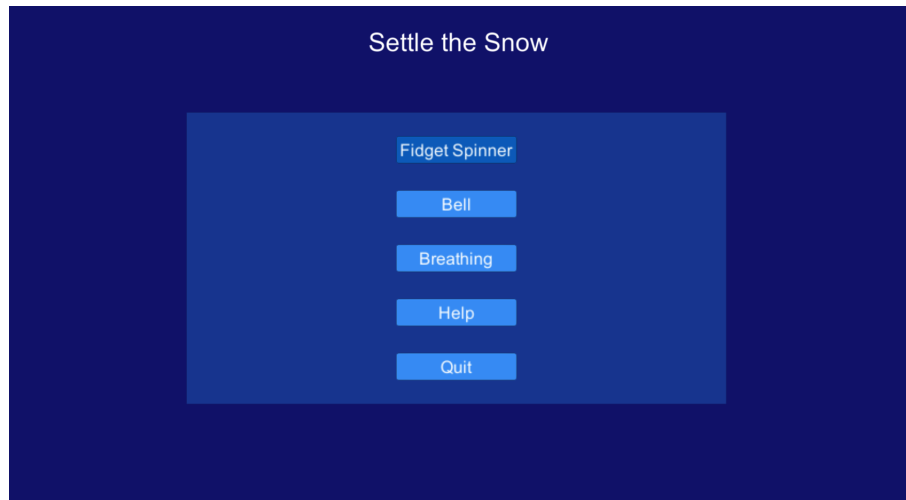
Figure 4.1: Main Menu

The game opens with the `Main Menu` Screen. This screen implements a Unity `Canvas` which presents options to navigate to three different mindfulness activities, which are discussed in the following sections. The `Help` option navigates them to a screen with instructions and information about the game **(requirement 12)**. The `Quit` option quits out of the game. The researcher opted to have all activities available in an easy to navigate menu as noted from the expert interviews. (Section 3.3.5.2)

4.3.2   Fidget Spinner
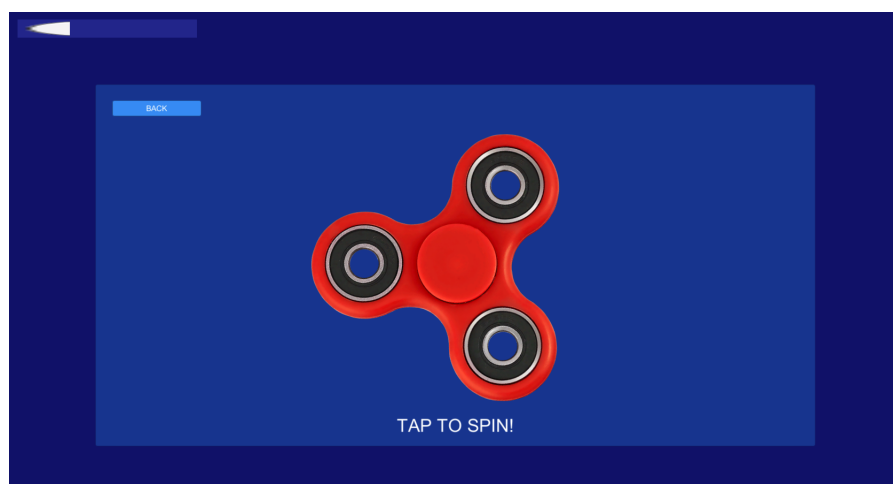
Figure 4.2: Fidget Spinner Activity

This screen implements a Unity `Canvas` which holds a `GameObject` representing the Fidget Spinner. Simple text relays instructions on how to spin the Fidget Spinner and there is also a `Back` option which allows you to exit back to the `Main Menu` Screen. **(requirement 12)**

4.3.2.1 Start

Upon the first frame update after the Fidget Spinner `UI` `GameObject` is initialised, the initial parameters for `spin_speed` are set to the `minimum_speed`. There are also parameters to set the `minimum_speed`, `maximum_speed` and `accelerate` which can be set within the Unity Editor or within the `Settings`, however there are default values initially set.

4.3.2.2 Update

The `GameObject` listens for any event updates. When the screen is tapped repeatedly or held or the mouse button is clicked, (depending on the choice of platform) the Fidget Spinner spins. It spins on a decentralised axis which produces a slight wobble effect similar to what you would see in real life. While the Fidget Spinner is spinning, it accelerates by a factor of the `accelerate` parameter from the its initial speed to the `maximum_speed` and the snow bar in the top left increases. When the screen is no longer being tapped or mouse button is no longer clicked, the Fidget Spinner decelerates by a factor of the `accelerate` parameter until the `spin_speed` is zero. This is to ease the animation so that the spinning does not occur suddenly, as this can be quite jarring to users. (**requirement 14**)

This is based on the success of this activity during the Design workshops as discussed in Section 3.2. The most important component to represent was the spinning of the object, as represented by the children choosing to keep this component but perhaps use a water wheel as an object (Section 3.2.5), so the researcher opted to base this activity as close as possible to the real life object.
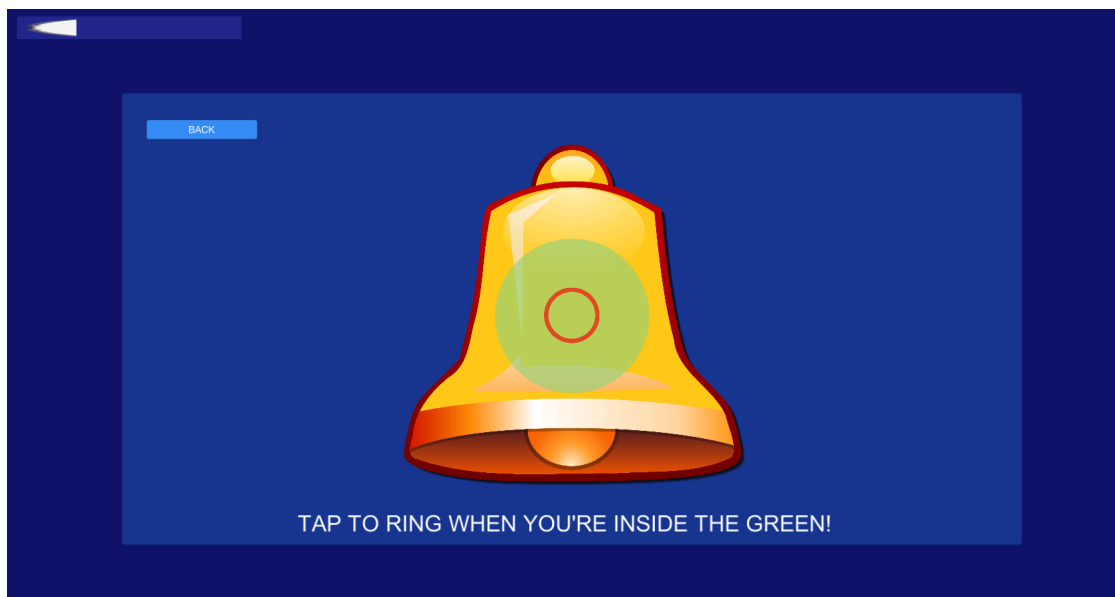
4.3.3 Bell

Figure 4.3: Bell Activity

This screen implements a Unity `Canvas` which holds a `UI GameObject` representing a Bell. Attached to the Bell are two circles, a green goal circle and a red transforming circle, and a meditation bell sound. Simple text relays instructions on how to ring the bell are displayed and there is also a `Back` option which allows you to exit back to the `Main Menu` Screen. (**requirement 12**)

4.3.3.1 Start

Upon the first frame update after the Bell `GameObject` is initialised, the initial parameters for `scale_speed`. There are also parameters to set the `minimum_scale` and `maximum_scale`, whose default values automatically scale to the current screen's resolution (2560 x 1600).

4.3.3.2 Update

The `GameObject` listens for any event updates. Every frame the transform circle is scaled up from its initial size by a factor of the `scale_speed` until it reaches the `maximum_scale`. It is then scaled down by the same factor until it reaches the `minimum_scale`. This creates a slow pulsing effect. The goal circle is in the centre of the bell and does not change size. The screen can be tapped at any point, or the mouse can be clicked but the meditation bell sound will only play and the snow bar in the top left increases if the transform circle is within the bounds of the goal circle. This is calculated using Unity's in-built geometry functions.

The slow pulsing effect is an effort to gamify slowness when presenting the mindfulness techniques, as recommended by E3 in section 3.3.5.5. The meditation bell should only sound after specific time intervals so that there is time to bring your attention and focus to this point, instead of being spammed repeatedly. (**requirement 14**) This also provides a visual for interacting with the bell ringing.
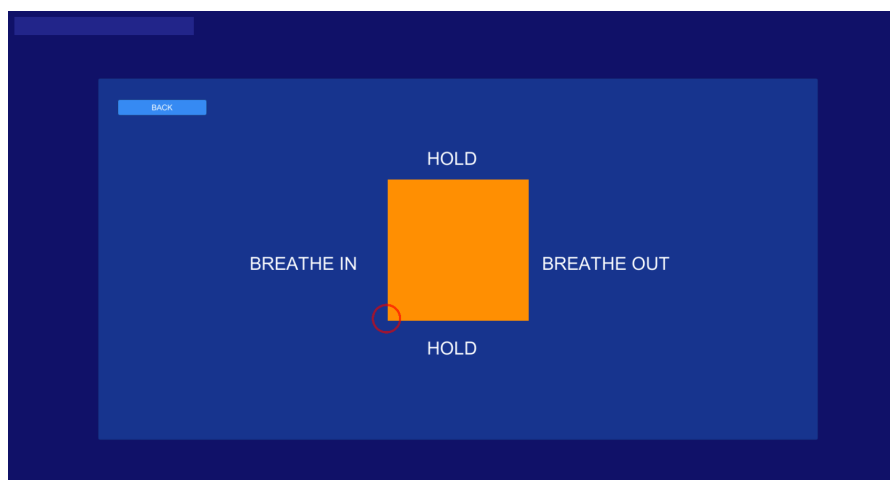
4.3.4 Breathing

Figure 4.4: Breathing Activity

This screen implements a Unity `Canvas` which holds a `UI GameObject` representing an orange breathing square. Attached to the breathing square is a small red transform circle, initially placed on the bottom left corner. Simple text relays instructions on when to breathe are displayed and there is also a `Back` option which allows you to exit back to the `Main Menu` Screen. (**requirement 12**) This activity is based on the mindfulness breathing technique called square breathing, which is suggested to be suitable for kids as an activity.[32] Other mindfulness breathing activities based on physical interaction and following a meditation audio would be possible to implement, but the researcher opted for the visual depiction of square-breathing as it is more interactive and easy to follow, and audio can be implemented in addition to this.

4.3.4.1 Start

Upon the first frame update after the Breathing Square `GameObject` is initialised, the initial parameters for `speed` are set.

4.3.4.2 Update

Every frame, the transform circle moves along the edges of the square. Text displaying when to breathe in, hold your breath, and breathe out are displayed along the edges of the square. The intention of this activity is as you view the circle moving along the edges of the square, you follow the corresponding instruction on the edge of the square. The circle takes the same amount of time to traverse the full length of each edge.

4.4 Future Work

Due to the limited scope of this research as a proof of concept to demonstrate the potential use of applying mindfulness techniques in a game and time constraints, particular features which have been discussed as part of the game requirements have been left as future work. The main focus of this implementation was to focus on the play environment used by the child, so some features are deemed as extra. These are discussed below.

4.4.1 Settings and Customisation

The `Settings` option will enable the practitioner to customise specific settings. **requirement 7**) There would be nothing preventing the children from entering the practitioner-only mode so it would be possible to add an additional password for entry. (**requirements 5 and 6**) Due to this, there will be two separate environments specific to the child and practitioner. (**requirement 4**)

Due to the expansive scope of the customisation options such as colour, animation speeds, verbal or non-verbal options and implementation of different environments and rewards, the full functionality of customising the game using the `Settings` option has been omitted from this implementation version of the game.

4.4.2 Drawing Activity

Due to the scope of creating an entire drawing mini-game that composes the functionality of a full art app, this was deemed to be out of the scope of the research mostly due to time constraints. Mindful Drawing is an engaging activity for children, as suggested by Section 3.2, and including a wider range of mindfulness activities would improve the effectiveness of the game.

4.4.3 Sound Design

As suggested in Section 3.2, relaxing sound design could be incorporated into the game. This can help engaging with each activity and in general help the individual relate to the specific context of the environment. This is also a customisation option, as children with ASC may prefer particular sounds as suggested from the expert interviews. However due to limited time and lack of access to extensive sound design libraries this is left for future work.

4.5 Summary

This chapter discusses the possible choices for software and hardware to implement the game. Based on these decisions, the game was created using Unity 5 (2019) in `C#`. The design requirements based on the literature review, design workshops with typically developing children and interviews with experts that were originally set out in chapter 3 is discussed during the implementation. Any features left for future work are suitably justified. The implementation composes of a menu selection screen with three mindfulness activities. The next chapter presents evaluation workshops held with four typically developing children.

Chapter 5

Evaluation

This chapter presents the results of the evaluation with participants from a second workshop held in early March to address the goals and critically analyse the final implementation of the game given the criteria defined in Chapter 3. The success and limitations of the game are discussed, and a list of suggested improvements and further features is presented. The limitations due to external circumstances of the evaluation are also discussed. This chapter aims to answer the following research questions:

RQ4.1 Are the activities appropriate to help children with ASC cope with anxiety?

RQ4.2 Is the tool perceived as engaging for the target population?

5.1 Evaluation Workshops

The evaluation workshops were held with four typically developing children acting as proxies for children with ASC, as with the design workshops held previously in the study. This follows the methodologies described in section 3.1. The children were asked to play through each mindfulness activity, after which they answered some short questions so the researcher could gather feedback and observe the child's intuitions while playing the game.

5.1.1 Aim

The aim of this workshop was to evaluate the design and functionality of the game from the perspective of children of the target age. This included the following:

1. Determine which mindfulness activities were most engaging

2. Determine if the language was clear and easy to understand

3. Determine if the navigation was easy to use

4. Determine if any usability problems or significant bugs exist

5. Gather feedback for further improvement

5.1.2 Participants

We had four children who participated, two of which participated in the design workshops previously (P1 and P4).

Participant	Participant Age	Participant Gender
P1	10	Female
P2	12	Female
P3	15	Female
P4	12	Male

Table 5.1: Evaluation Workshop Participants

5.1.3 Materials

The following materials were used to conduct these workshops.

- Paper and pencil to substitute the unimplemented drawing activity discussed in section 4.4.2 and for the researcher to take written notes during the workshop.

- Smartphone for recording audio and transcription

- Laptop for presenting the game

Unfortunately, while the game was developed to be played using a tablet with a touchscreen, there were some problems with transferring the game onto the iPad. Due to the time restriction for participating in these workshops, the researcher opted to use the laptop to demonstrate the game. The functionalities are mostly the same, except physically tapping the screen is replaced with mouse or touch pad clicks. The researcher planned to resolve this issue in time for the evaluation with experts.

5.1.4 Procedure

- The study underwent the ethical procedure as defined by the School of Informatics at the University of Edinburgh.

- Parents and children were contacted by email with information sheets on the study and consent forms if they were willing to participate

- If the children and the parent submitted their consent forms they were invited to participate in the study.

- We held 4 workshops in one day

- Each participants worked individually

- Each workshop ran for approximately 15 minutes

- After completion of the workshop, certificates were presented to each participant to show appreciation for their participation and input

5.1.4.1 Introduction

Firstly, the concept of mindfulness was reintroduced, allowing all children to familiarise themselves with the aim of the game and to note if any of them had been introduced to mindfulness previously. All the children that participated in the workshops had been introduced to mindfulness before through school.

5.1.4.2 Game Exploration

The game was loaded and handed over to the child and they were freely allowed to navigate through all of the activities, and participated in each for a few minutes to fully engage with it.

5.1.4.3 Post-Game Questions

1. Two stars and a wish - two features that were liked and one feature they wish they could have in the game

2. Favourite Activity and why

3. Feedback on the Design

4. Would this game be suitable for relaxing

5. How do you think you would feel after playing this game

6. Any final suggestions

5.1.5 Results

5.1.5.1 Favourite Features

Answer Aim 1:Determine which mindfulness activities were most engaging

All participants really enjoyed the Fidget Spinner activity as their favourite and would focus completely on it while it was spinning. After the activity was finished, all of them returned to play with it again. All participants enjoyed the bell activity, in particular the listening to the sound and watching the transform circle slowly pulse.

5.1.5.2 Ease of use

Answers Aim 2: Determine if the language was clear and easy to understand

And Aim 3: Determine if the navigation was easy to use

All children found the game easy to use and engage with. The researcher noticed they were all able to navigate between activities and back to the main menu. Most found the language clear and easy to understand when participating in an activity and were even able to engage in the activity without looking at the instructions. With the exception of P2 who did not understand the instructions for the breathing activity and it needed to be explained by the researcher.

5.1.5.3 Suggestions for Improvements and Additional Features

Answers Aim 4: Determine if any usability problems or significant bugs exist

And Aim 5: Gather feedback for further improvement

The children had many different suggestions for improving the current features and new features to be included. All participants commented they would have liked to see animated snow in the background. Some of these suggestions were previously discussed in Section 3.3, evaluation of the design with experts, and noted already as Future Work.

Fidget Spinner Activity

P1 and P3 commented that it would be nice to have a soft "wind" sound while the fidget spinner was spinning. All participants commented it would be nice to choose the colour of the Fidget Spinner. P4 even suggested combining the Drawing activity by allowing you to draw your own Fidget Spinner design. P3 and P4 suggested having multiple spinners and being able to move the spinners around the screen as they spin.

Bell Activity

P1 and P3 suggested having the choice of different meditation bell chimes that could play. P1 also suggested having the choice of different colours for the goal and transform circles. P3 also suggested changing the colour of the transform circle once it is inside the goal circle to add a visual cue of when to ring the bell. P4 suggested the bell could have an animated wobble once the bell is rung.

Breathing Activity

P4 suggested that the shape of the breathing activity is actually a circle instead of a square so it represents the continuous motion of breathing instead of being divided into sharp edges. The timing would be the same as the circle could be divided into quarters.

Rewards

P4 suggested in addition to settling the snow, relaxation points could be counted as you engage with the activities. This is similar to what other mindfulness apps do, such as Headspace, as they count relaxation minutes and also how many days in a row you have been actively using the app. [29] How these points are rewarded would have to be explored as mindfulness does not rely on the 'dopamine hit' that most games do. (Section 3.3.5.3)

Additional Features

P4 suggested having settings to change the speed, which was also suggested by the experts in Section 3.3.5.1. P3 suggested adding images to help describe the instructions in the Help screen. They also suggested including another activity such as bubble popping, which was also suggested by expert E4 in Section 3.3.5.7.

5.1.5.4 Feeling after Play

All the children commented that the design was simple and clean and found the activities relaxing and agreed it would be suitable for this intent.

5.2 Limitations

5.2.1 Proof of Concept

This implementation of this game is a proof of concept and presents the possibility of implementing mindfulness activities. Whether this game would be able to directly address anxiety within children, especially those with ASC, is outside the scope of this research due to feasibility and restriction of resources. Further evaluation with children with ASC is required for validation on these results.

5.2.2 Expert Interviews

In order to evaluate the game further and present more conclusive results, interviews with experts in the fields of ASC and Mindfulness were supposed to be held. In particular this would address **RQ4.1 Are the activities appropriate to help children with ASC cope with anxiety?** as this requires additional expert review. The integrity of the mindfulness activities in this implementation would also have to be discussed with a Mindfulness practitioner. Additionally, suggested features from the children could be implemented and presented to the experts, to allow for further evaluation on features such as the reward system. However, due to this evaluation being scheduled for late March and due to complications such as Covid-19 amongst others, this will be postponed to Future Work. [40]

5.3 Summary

This chapter presents the results of evaluating the implementation of the game in workshops with four typically developing children. It discussed the procedure and outcomes and presents the successes and limitations of the game based on the previously defined design criteria. Further improvements and possible features are presented as well as limitation on the evaluation itself. In the conclusive chapter of this research, the results are critically discussed against the initial target research questions and plan for future work is presented.

Chapter 6

Conclusion

This research project explored how mindfulness activities can be implemented in technology-based tools to aid children with autism experiencing anxiety. The research began with background reading exploring how technological tools help children with autism, the relationship between autism and anxiety and how mindfulness can be used to help with anxiety. This formed the motivation behind the research and four main research questions were used to structure the approach. This chapter presents the results and discusses if each research question was successfully answered while considering the limitations and possible directions for future work.

6.1 Discussion

RQ1. How can mindfulness techniques be applied in an interactive game setting to aid children with ASC experiencing anxiety?

This is the primary research question that this dissertation aims to answer. In order to answer this question a literature review was conducted to explore the relationship of ASC and anxiety, how mindfulness can be used to help cope with this set of symptoms and the benefits of a technology-based intervention. To answer this question, the following research questions had to be addressed to completely answer the primary purpose of this research.

RQ2. What are the current strategies being employed to help children with ASC experiencing anxiety?

The literature review in Chapter 2 discusses how individuals with ASC experience anxiety as a co-occurring disorder that compounds any anxiety they may already have and how anxiety may arise due to the core traits of autism. [6] Mindfulness was identified as an effective method of addressing anxiety [16] which also works well for individuals with autism. [3] Implementing mindfulness techniques into apps allows it to become more accessible and flexible based on user needs, and there is support to suggest that presentation without a practitioner can still provide similar benefits. [8] The researcher aimed to bring together these components to create a game that would be suitable to helping children with ASC cope with anxiety.

RQ3. How can mindfulness techniques be used to help children experiencing anxiety and are these feasible for children with ASC?

Using the information gathered from the literature review, design methodologies and principles outline in chapter 3, design workshops held with typically developing children acting as proxies for children with ASC and interviews held with experts in the fields of HCI, ASC and Mindfulness helped inform different strategies of implementing the different mindfulness techniques keeping in mind the needs for autistic children. An initial set of requirements for implementing a set of mindfulness techniques suitable for children [28] was created using the design workshops which were then reviewed by the experts to gather additional input and game design considerations, specific to their fields, and create a final set of requirements.

RQ4. How can these strategies be implemented on an interactive smart tool or game suitable for children with ASC?

Chapter 4 presents the implementation of the game based on the final set of game design requirements, based on the design review and methodologies for creating a game suitable for children with ASC. The evaluation of this implementation is discussed in Chapter 5, with evaluation workshops involving typically developing children held to test the game against its initial requirements and provide suggestions for improvements. In order to evaluate the effectiveness of this implementation the following questions need to be answered.

RQ4.1 Are the activities appropriate to help children with ASC cope with anxiety?

Due to the limitations as discussed in section 5.2 and the scope of this project being limited to a proof of concept, it was not possible to evaluate this as we did not have access to children with autism and due to circumstances it was not possible to conduct expert interviews in the fields required to evaluate the possibilities of this game being effective in reducing anxiety, accurately presenting mindfulness techniques and being suitable for children with ASC specifically.

RQ4.2 Is the tool perceived as engaging for the target population?

As discussed in section 5.1, the children overall seemed to enjoy the tool and also actively engage with each of the mindfulness activities. The children also actively returned to specific activities they enjoyed, both during and after the completion of workshops which demonstrates their eagerness and engagement. The children also actively gave suggestions for the game on more features that could be added.

6.1.1   Limitations

Due to the limited time available for this research and limited scope of the project, access to practitioners, carers and children with autism was limited. The research involves typically developing children and experts in the fields of ASC throughout the design and evaluation process to reach informed decisions, however it was not possible to carry out studies directly with autistic children. Due to this research looking specifically at how autistic children cope with anxiety, there are ethical considerations to consider involving the stress of the child. Directly addressing anxiety requires a long

process and due to the limit of time and resources this could not be directly evaluated. In addition to this, the game was not implemented to the full extent it should have been, which leaves plenty of future work considerations. However, initial results highlight the potential in how this game could help children with ASC cope with anxiety using mindfulness techniques.

6.2 Extension to 5th Year

As mentioned previously, certain elements of the study had to be postponed and some elements marked as Future Work (Section 4.4) from the original set of design requirements. Here is a summary of the current plan moving into the second component of this research project.

Further Evaluation with Experts

To fully understand how to continue with the implementation of this game to make it more effective in addressing the primary research question, experts in the fields of ASC, Anxiety and Mindfulness will need to be interviewed. This is postponed due to the initial limitations and circumstances around this research. (Section 5.2.2) The effectiveness of the implementation of each mindfulness technique needs to be discussed and analysed with practitioners in the field, and whether these techniques are suitable for addressing anxiety in particular. This may include completely leaving out currently implemented activities or

Environment for Settings

The aim of this research was to implement the Play Environment specific to the child with ASC as the user. After conducting further evaluation and completing that environment, a suitable extension for continuing this game is the Settings which would compose of the customisation settings specific to the Practitioner Environment as discussed in Sections 4.4.1 and 3.3.5.1. This would involve changing settings specific to the functionality of the game such as speed and reward systems, as well as aesthetic design considerations such as the colours and themes of the game. This would also involve more background research into the needs of practitioners in these apps, and has potential for branching into more functionality.

6.3 Conclusion

This research explored the possibilities of implementing mindfulness into a technology based intervention to help children with autism cope with anxiety. A prototype game, "Settle the Snow", was developed involving three different mindfulness activities using the results from the literature review, design workshops with typically developing children and interviews with experts in the fields of HCI, ASC and Mindfulness. The game was then critically evaluated and the resulting successes and limitations of the game presented, with a set of suggestions for improvement and future work.

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Appendices

Appendix A

Parent Information Sheets

Page **1** of **7**

Designing Educational Games and Tools for Children with Autism

Information sheet for parents and guardians

———————————————————————————————————

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

This study was certified according to the Informatics Research Ethics Process, RT
number XXXX. Please take time to read the following information carefully. You
should keep this page for your records.

The researchers on this project and their contact details are as follows:

- Brogan Miller: s1643299@sms.ed.ac.uk (Lead Researcher)
- Mourad Elsherei: s1792753@sms.ed.ac.uk (Lead Researcher)
- Sophia Singh: s1623165@sms.ed.ac.uk (Lead Researcher)
- Anna Ali: s1545423@sms.ed.ac.uk (Lead Researcher)
- Qinxiang Chen: s1614842@sms.ed.ac.uk(Lead Researcher)
- Aljawharah Alabdullatif: s1500319@sms.ed.ac.uk (Research advisor)
- Dr. Helen Pain: helen@staffmail.ed.ac.uk (Research supervisor)

University of Edinburgh, School of Informatics

Please return the parent consent form to one of the researchers if you give
permission for your child to participate in the project.

———————————————————————————————————

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Figure A.1: Parent Information Sheet Page 1 of 7

Overview of the project

We are four UG4 students from the University Of Edinburgh working on educational games for children with autism as a part of our Honours projects. Each student pursues research in their chosen area and will develop their own game.

What is the goal of the project?

Brogan: Emotion regulation concerns a person's ability to effectively manage and respond to a social experience by monitoring, modifying and evaluating their emotional reactions. For children with autistic spectrum condition (ASC) this can be very hard and impact upon their behaviour, as well as having a negative effect on their social relationships. I aim to develop a game which helps children tackle such difficulties by applying them within a narrative context.

Anna: It is very common for children with ASC to also have Cerebral Visual Impairment also called Cortical Visual Impairment (CVI). CVI is a brain based visual condition that affects path-ways involved in processing incoming visual information via neural networks throughout the brain. Children that have CVI Meltdowns are commonly triggered by noise, visual clutter, busy environments with lots of movement, unfamiliar environments, unfamiliar people, and revisiting somewhere previously experienced as stressful. The commonly known emotional reactions to the Meltdown are tiredness, brain fatigue, emotional stress, and totally overwhelming fear. The behavioural outcomes of it are headaches, screaming, lying on the floor or being unable to stand/walk, physically attacking, and escaping. The aim of the project is to follow the fundamental concept, 'Cause and Effect', to develop a smart object (within a narrative context) that is interactive via the use of switches. The object will have three main functionalities; motion, producing sound and flashing lights. This will allow the children to be in control of the smart object, which will help the children when processing the visual information received from the smart object and potentially tackle some CVI Meltdown triggers.

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Figure A.2: Parent Information Sheet Page 2 of 7

Mourad: We are investigating how to design an effective and engaging interactive tablet game that is capable of teaching children with ASC about mindfulness, and mindfulness techniques as an alternative means of emotional regulation.

Sophia: Anxiety is a common concern for children with ASC. As young people face more complex and unfamiliar social scenarios this can worsen and can be an additional source of stress. I aim to develop an interactive app which will help children handle negative emotions associated with high anxiety by applying calming activities in an interactive context.

What is the purpose of the workshop?

Brogan: The workshop will help children to explore a vast range of emotions by participating in activities which focus on emotion recognition, emotion regulation and coping strategies for highly anxious emotions. The workshop will also be beneficial for the design of the game as I aim to build the game's narrative in relation to the contexts in which the children describe they feel certain emotions.

Anna: The workshop will guide the children towards personifying the smart object by giving it a narrative context. The aim is to build the smart object with inspiration from the suggestions made by the children. Activities include the children acting out their designed character in pairs, with the other child acting as the user.

Mourad and Sophia: The workshop will guide the children towards creating interactive games focused on calming activities like breathing and other mindfulness related activities. The workshop will be beneficial for designing the app and building interactive tools that the children consider calming and engaging.

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Figure A.3: Parent Information Sheet Page 3 of 7

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How can my child help?

The game designing workshops will comprise a variety of activities which will help to inform the design of our prototype games and provide potential ideas to enhance fun and engaging gameplay for an educational game.

Workshop Information

What happens during the workshop?

Workshops will take place in the Brownies' meeting hall/ Informatics Forum (will be edited depending on which workshop). Your child will get to engage in numerous game development activities and provide feedback and ideas for c. 30 minutes. If your child is willing to talk to us about the activities, we will ask them a few questions. They will each participate in X (will edit depending on each workshop structure) workshops, if they are happy to do so.

Video and audio recordings

We would like to either video or audio record the session, to provide a record for later analysis and allow us to freely interact with your child during the session without worrying about taking notes. If you prefer that we do not use videos or pictures of your child for publications, presentations or teaching purposes, you can indicate this on the permission form. In that case, the video would be seen only by us during the analysis. If you are not comfortable with your child being audio (and possibly video) recorded at all, then your child should not participate in this particular study.

We ask parents to read this information sheet so you can make an informed decision about whether participation as a game designer is a good idea for your child.

 If you say "yes" when returning the permission form, we will explain the game designer role to your child, and ask them if they want to help. We will remind your

Figure A.4: Parent Information Sheet Page 4 of 7

child that they can stop being a developer at any time, without having to give any reason, and that we will always listen to them. We will check that the child agrees to be audio (and possibly video) recorded. This explanation will be based on the child information sheet included in this packet. We feel strongly that children should be given a real choice about whether to participate. Even if you say "yes" on the permission form, your child may still say "no" if s/he does not want to be a game developer. We will respect your child's decision.

If you say "no", we will not contact you again about this study and will not ask your child to be a games designer.

Will this project teach my child new skills?

This project is not a type of therapy or intervention. We will not be teaching children new skills or improving existing skills. The information we learn from this project may be used in future games/smart objects that could help children with ASC.

What happens when the project is over?

After the study has finished and we have analysed the information we collected, it will be used to evaluate and further develop the design of the game/smart object and eventually be presented in a final report. This report along with the data and recordings may be shared or presented in scientific journals or conferences. We never share children's names, schools or other personal information.

How will personal information be protected?

Confidentiality is extremely important to us and all data will be processed in accordance with Data Protection Law. Recordings and other information (such as forms with children's names) will be stored safely on password-protected computers or in locked cabinets. Your consent information will be kept separately from your

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Figure A.5: Parent Information Sheet Page 5 of 7

responses in order to minimise risk. Access will be limited to the people involved in the research (listed above). Recordings and other information will be identified only by participant codes or pseudonyms, and will be separated from identifying information (such as name). Your data may be archived for a minimum of 2 years.

Who paid for this research?

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

Who can I contact?

If you have any further questions about the study, please contact any of the lead researchers or the research supervisor Dr. Helen Pain.
If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on https://web.inf.ed.ac.uk/infweb/research/study-updates.

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact any of the lead researchers or the research supervisor.

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Figure A.6: Parent Information Sheet Page 6 of 7

General information

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

For general information about how we use your data, go to: edin.ac/privacy-research

Thank you for taking the time to read this.

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Figure A.7: Parent Information Sheet Page 7 of 7

Appendix B

Parent Consent Sheet

Game Testing Workshop Permission Form (for parents)

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

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

With reference to further anonymous use of video and audio data, please circle yes or no in response to the following (note: even if you say 'No' to this, your child can still participate in the study, but the video and audio data will only be seen by the research team):

> I **AGREE** that short recordings of my child can be used as examples in documents and presentations for research and/or teaching purposes.
>
> YES / NO

If you **give permission** for this study, please fill out the sections below and **return this form to the researchers.**
If you **DO NOT** wish to give permission, **you do not need to do this**. We will not ask your child to participate.

Full name of participating child:

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

Your relationship to the child: _____

Your name (please print clearly): _____

Contact telephone number: _____

E-mail address: _____

Signature:

Date: _____/_____/_____

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March 2020

Figure B.1: Parent Consent Sheet Page 1 of 1

Appendix C

Child Information Sheets

Figure C.1: Child Information Sheet Page 1 of 3

How can I help?

Brogan: Children with autism may find it difficult to understand and describe what they are feeling. I want to help them get more comfortable with their emotions and learn to identify them. I need you to help me to develop a fun game which helps to better understand emotions by sharing stories of when you have felt different emotions and what you like to do when you are feeling a certain way.

Anna: Some children with autism can sometimes find it difficult to process what they see or hear. Especially if the environment is very busy or if too many things are happening. I want to help them process what they see and hear by allowing them to control the following features of an object, movement, sound, and lights, using buttons. They can choose to control one or more features. I need your help to design a character which has these features, and to build a story around the created character, to help them.

Mourad and Sophia: Some children with autism can sometimes find it hard to understand and manage what they are feeling. I want to help them get better at doing that by teaching them how to pay attention in a particular way. When they do this they will start noticing what is happening around them which can help them calm down when they are sad, angry or frustrated. This can also make them feel happy. But I need your help in designing a fun game that can teach them about this.

Qinxiang: My game is to teach children garbage classification. It is a mobile game and you will use your finger to move bin to collect rubbish. I will give you this game to play. After playing game, I have several questions to ask you feedback about this game.

Holly: I am making a game to help children in hospital feel better. My game is a board game (like snakes and ladders!) and I need your help to make it as fun as possible. I will show you some characters and ask you to pick which ones you like the best. We will also play the board game together and you can tell me what I can do to make it better.

What will happen if I help? You will get to take part in game design and testing workshops and participate in other activities.

Figure C.2: Child Information Sheet Page 2 of 3

You can tell Helen or one of the researchers if you want to stop doing any of the activities. You do not have to tell them why. Please tell them if you want to take a break. You can also say you do not want to be a game developer or tester any more, and that is OK.

The researchers will ask if it is OK to make an audio or video recording of you helping design the game and answering questions. This is because it is too hard for them to write down everything that happens. They will listen to and look at the recordings later to help them understand what you thought about the game.

What will happen after I am finished helping? The things you make, do and say in the game testing workshops will help them. They will write about what they have learned and use it to design and evaluate their games.

> **Your mum or dad said it is OK for you to help us.**
>
> **Do you want to be a game developer/tester? You can say "yes" or "no". It is OK to say "no". It will not hurt the researchers' feelings.**

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

Figure C.3: Child Information Sheet Page 3 of 3

Appendix D

Child Consent Form

Child Consent Form

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

I can choose to be a game developer.

I do not have to help if I don't want to.

I can decide to stop taking part or take a break if I want to, I do not have to say why.

It is okay if I change my mind later and say I do not want to be a game developer anymore.

It is okay if some parts of the game are hard for me!

There are no wrong answers to questions.

Anything I can do is very helpful.

Do you want to be a game developer? YES ☐ NO ☐

Helen, Aljawharah, Brogan, Sophia, Anna and Mourad will listen to/watch the recordings later. They may show them to other people who make games for children.

Is it okay to take audio recordings? YES ☐ NO ☐

Is it okay to take video recordings? YES ☐ NO ☐

Write your name: _____

THANK YOU 😊‼

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Figure D.1: Child Consent Form Page 1 of 1

Appendix E

Design Workshop Certificate

Figure E.1: Game Design Certificate for Mindfulness

Appendix F

Evaluation Workshop Certificate

Figure F.1: Evaluation Workshop Certificate for Game Testing

Appendix G

Expert Interview Consent Sheet

Participant Consent Form

Developing an Educational Game to support regulating Anxiety symptoms in children with Autistic Spectrum Condition (ASC)

Researcher: Sophia Singh
(s123165@sms.ed.ac.uk)

Supervisor: Dr Helen Pain
(helen@staffmail.ed.ac.uk)

This interview is to gain feedback and any suggestions for improvements on the game design ideas so far in terms of your knowledge and expertise. All data will be anonymised with pseudonyms (such as E1, E2, etc.) and any recording devices will be disconnected from Wi- Fi. If you consent to being audio recorded, recordings will be stored safely on password- protected computers. You may withdraw from this research study at any time without explanation and you can ask any data you have supplied to that point be withdrawn/destroyed. You can omit or refuse to answer to any question that is asked of you. All data from this study may be archived for a minimum of two years. Please feel free to ask any question related to this study at any time.

I confirm that I have been informed about this project by the researcher and that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.

Please Circle: YES / NO

I understand that my participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.

Please Circle: YES / NO

I consent to my anonymised data being used in academic publications and presentations.

Please Circle: YES / NO

Figure G.1: Interview Consent Sheet Page 1 of 2

I understand that my anonymised data can be stored for a minimum of two years.

Please Circle: YES / NO

I agree to be audio recorded.

Please Circle: YES / NO

I agree to take part in this study.

Please Circle: YES / NO

Participant's Signature: **Date:**

_____   _____

Figure G.2: Interview Consent Sheet Page 2 of 2