Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes

Vivian Varnava

Fourth Year Project Report
BSc Computer Science
School of Informatics
University of Edinburgh
2019
Abstract

Dealing with changes is challenging for children with Autism Spectrum Disorders (ASD) mainly because of their rigidity in thought and behaviour and “insistence on sameness. For example, they can have rigid preferences for food or for clothing, or daily routines which are expected to be strictly followed in tiny details. Sometimes even small changes, such as the change in the furniture position in the room, could cause a lot of distress. For some children with autism, the presence of unfamiliar people, moving to a new house, or going on a trip could be extremely challenging and difficult to deal with.

This project explores how technology can be best designed and developed to support children with autism cope with changes. Previous research revealed that technology has potential in supporting these children overcome their difficulties. On the other hand, children with autism are keen on technology. These are two of the reasons why it was expected that technology may be well placed to be employed to prepare children with autism for changes and/or to support them while dealing with changes.

A User-Centred Design approach was employed, involving typically developing (TD) children, experts/researchers in Human-Computer Interaction (HCI) and ASD, and practitioners. A high-fidelity prototype app (called ‘ChangeItApp’) has been iteratively developed based on the research literature and empirical studies with end users, but also in accordance to the HCI design principles and ASD-specific principles. The summative evaluation revealed that ChangeItApp has potential in helping children with ASD cope with changes.
Acknowledgements

I would like to thank my supervisors, Dr Aurora Constantin and Dr Cristina Alexandru, for their guidance and support throughout this project.

I would also like to thank all the experts and children that participated in my studies. Their feedback was invaluable.
Declaration

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

(Vivian Varnava)
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Chapter 1

Introduction

1.1 Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a lifelong developmental disorder that is characterised by a dyad of impairments: deficiency in social interaction and communication, and repetitive patterns of behaviour and interests, including resistance to change[2]. According to the Centers for Disease Control and Prevention (CDC), ASD occurs approximately in 1 out of 59 children [1], which is three times higher than 20 years ago [4]. Much of this prevalence change was caused due to the increase in awareness of autism, which resulted in the increase of the available resources for testing and treatment [4]. The first symptoms of autism can occur within the first 18 months of life, with boys being four times more likely to be diagnosed than girls [1]. The causes of the spectrum are not well understood. Although there is not a known ‘cure’ for autism, evidence show that early medical and educational intervention can mitigate the autism symptoms [2].

Because of their rigidity in thought and behaviour and “insistence on sameness, dealing with, changes could be challenging for children with Autism Spectrum Disorders (ASD). For example, they can have rigid preferences for food or for clothing, or daily routines which are expected to be strictly followed in tiny details. Sometimes even small changes, such as the change in the furniture position in the room, could cause a lot of distress. For some children with autism, the presence of unfamiliar people, moving to a new house, or going on a trip could be extremely challenging and difficult to deal with.
1.2 Project Goals and Research Questions

The main aim of this research project is to explore how a technology-based tool should be designed and developed to help children with ASD cope with different changes in their daily lives. Based on previous research studies, technology seems to be well placed for supporting children with autism overcome their difficulties. In addition, most of the children with autism have an attraction to technology. Moreover, there is no technology to incorporate the methods used or recommended to children with ASD for dealing with changes, as far as the author is aware. Therefore, in order to achieve this project aim, the following questions have been addressed:

RQ1. What are the methods that are used for helping children with autism cope with changes?

RQ2. How should technology be best designed and developed to support children with autism cope with changes?

RQ3. To what extent does the new technology help children with autism cope with change?

   1. Is the new application usable by children with autism?
   2. Is the tool perceived as fun and engaging for the target population?
   3. Are the activities appropriate to help children with autism cope with changes?

1.3 Dissertation Structure

The research project is divided into eight chapters and the remaining part is structured as follow:

Chapter 2: This chapter presents a review of the literature on Autism Spectrum Disorder which establishes the background of this dissertation. It discusses the characteristics of autism, focusing on the stereotypical behaviour and the resistance to change. It investigates the methods being used by the practitioners and discusses the importance of interventions. It identifies the gap in the literature which it is the aim of this project.

Chapter 3: This chapter presents the methodology of this research project, including the methods used and data collected.
Chapter 4: This chapter describes the pre-design stage in which more requirements in regards to ASD, coping with changes and the design are gathered but from the perspective of practitioners/experts and TD children. Based on the outcome the requirements are set.

Chapter 5: This chapter describes the low-fidelity prototype development which was designed based on the requirements extracted from the literature review and the evaluation studies with experts and children. This chapter also presents the evaluation of the low-fidelity prototype with 3 TD children and 7 HCI/ASD experts.

Chapter 6: This chapter presents the high-level implementation of the tool in Android studio. It discusses the decisions in regards to the software and hardware used.

Chapter 7: This chapter presents the evaluation studies of the final-prototype. The high-fidelity prototype is evaluated by 28 first-time students and academic staff of the School of Informatics, 5 TD children and 6 HCI/ASD experts. Based on the results a conclusion on whether the project was successful in developing a tool that has the potential to help children with autism cope with changes is made.

Chapter 8: This chapter presents the outcomes of the project based on each research question and presents different directions for further research to be carried out.
Chapter 2

Literature Review

2.1 Introduction to Autism

Autism was firstly introduced by Leo Kanner in 1943 after noting that a group of children had an uncommon behaviour [25]. At that time, autism was considered a primary symptom of schizophrenia because of the echolalia, the obsessiveness and stereotypical behaviour the children presented, however he noticed that the symptoms differ from all the other incidents of childhood schizophrenia [25]. However, later this belief was abandoned and today, autism is under the term of Autism Spectrum Disorder (ASD).

Individuals on the spectrum do not differ in terms of outer appearance in respect to the typical developing individuals but instead, they demonstrate peculiarities in interaction, behavior and communication [1]. In the 5th Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V), Aspergers syndrome, Pervasive Developmental Disorder - Not Otherwise Specified (PDD-NOS) and autistic disorder are included in the category Autism Spectrum Disorder [2]. This umbrella term describes a group of lifelong developmental disorders, which have in common the deficiency in social interaction and communication, and stereotypical behaviour and restricted interests [4] [2]. According to DSM-V, an individual must meet the following criteria to be diagnosed for Autism Spectrum Disorder [2]:

A. Deficiency in social interaction and social communication over various contexts.

B. Appearance of restricted, repetitive patterns of behaviour, interests or activities.

C. The symptoms are apparent early in development.

D. Impairment in important areas of functioning.
E. The impairment are not better explained by intellectual disability or global developmental delay.

It is very challenging to notice Autism Spectrum Disorder, because it is a very heterogeneous disorder that affects each individual uniquely [23]. The onset of the autism can occur either in the first months of life, if the child shows developmental abnormalities or in the second year of life, if the child loses skills that were previously acquired skills [24].

A reliable diagnosis can be made between age of 2 and 3, if the child has already showed any concerning symptoms during infancy, such as delay in speech accompanied by lack of social interest and unusual patterns of behaviour [39]. It was common that ASD was not diagnosed until years after the first symptoms, but the broader scientific knowledge, the increase in awareness and improvement of the diagnostic tools have made early diagnosis possible. [39].

An individual can be diagnosed for Autistic Disorder if, by the age of 3, symptoms from the main areas written above, are met [8] [31]. A typical example is a child that neither speaks, nor respond when people addressed him or her. These children seem to isolate theirselves from a group and do not play with other children of their age, but instead, they might repeatedly perform the same action on an item, such as move a car toy back and forth [41]. Diagnosis for Asperger's Syndrome is given when an individual meet the same criteria as Autistic Disorder, but unlike Autistic Disorder, they do not show any communication deficits [8] [31]. Additionally, there is neither any speech delay prior to 3 years of age, neither any cognitive delays and does not meet any criteria for another Pervasive Developmental Disorder [8] [31]. The individuals on Asperger’s syndrome often graduate from high level of education, but they find difficulties in their adulthood due to the absence of social skills [41]. Lastly, a diagnosis for PDD-NOS is given when the individual have impairment in social interaction and impairment in either communication or restricted patterns of behaviour [8] [31]. This category represents a milder form of autism and children on PDD-NOS can develop communication skills but have difficulties to engage in school activities [41].

Frequently, multiple psychiatric disorders co-exist with autism spectrum disorder [38]. Previous study showed, that 70% of autistic individuals had at least one additional disorder with most common the social anxiety disorder and attention-deficit/hyperactivity
disorder [38]. ASD is associated with high levels of depression and anxiety which may lead to suicide attempts [29]. It was found that 66% of individuals on Aspergers syndrome reported having suicidal thought, and 35% reported suicidal attempts or plans for suicide [7].

2.2 Core Impairments and Strengths

2.2.1 Deficiency of Social Interaction and Communication

Children on the spectrum show inability to develop social skills and usually isolate themselves or develop limited or no relationships with others, due to their inability to develop, maintain and understand relationships [2] [39]. The show deficiency to interact and engage in activities with others, and express their emotions and thoughts [2]. It is considered that autistic individuals “lack a theory of mind” because they lack the ability to think and understand about mental states of themselves and others, including emotions and beliefs [37]. Another characteristic of individuals on the spectrum is the absence of eye-contact, facial expressions and body movement when interacting with others [2] [39]. They can, also, show absence or limited imaginative activities, including pretend play, and incapability to imitate other’s behaviour [2] [39] [37].

The Communication Deficiency varies between autistic individuals, ranging from non-verbal communication to some language delay and language impairment [2]. Even verbal individuals, they often have problems in word meaning, speech comprehension and the present inability of developing and sustaining a conversation [2] [39]. Different language forms such as jokes, sarcasm, verbal expressions and other subtleties are not easily understood by autistic individuals [39].

2.2.2 Restricted and Repetitive behaviour

One of the main characteristics of Autism Spectrum Disorder, as described in DSM-5, is restricted and repetitive behaviour that includes [2] [35]:

1. stereotyped body movements, such as hand flapping
2. repetitive speech such as echolalia and restricted vocabulary
3. continuous use with parts of objects, such as spinning wheels on toy cars,
4. rigid and atypical interests, such as intense interest on trains,

5. and strong attachment to routines, sameness and ritualized patterns of behaviours such as insisting that items are arranged on the dinner table in a precise way

Individuals on autism have on obsessive desire to sameness and routine. They struggle to alter their routine either when a change appears, both expected and unexpected, or when they have to make a transition from one activity to another. For individuals on the spectrum, the world seems frightening due to its unpredictability [42]. The stereotypical behaviour is an attempt for autistic people to acquire control and security, by creating rigid rules [42]. Moreover, in an event of change or an unpredictable situation such as meeting new people, individuals on the spectrum increase the level of stereotypical behaviour [42]. Changes in their daily routine, schedule or in patterns of objects can cause challenging behaviours such as aggression, self-injurious behavior, tantrums, or non-compliance [2] [42]. [42].

2.2.3 Other Impairment

Individuals with autism, can also exhibit sensory peculiarities which can be oral, tactile, visual and auditory [2]. Some autistic individuals can be hypersensitive to some sound that are unnoticeable to others or react negatively to loud sounds, such as fireworks [26]. They might show discomfort of bright lights, discomfort of wearing certain clothes due to texture or they might remove some foods from their diet due to flavour [26]. Individuals on the spectrum may also, present an unusual attraction to lights or objects [2]. Another common feature in ASD is that they focus on a small detail instead of capturing the whole meaning of the situation [42].

2.3 Diagnosis

A diagnosis of ASD, is carried at age of 2-4 if the child has shown developmental delays [39]. The diagnosis includes two steps: Developmental Screening & Comprehensive Diagnostic Evaluation in which the children are tested developmental delays by an expert [1]. Early diagnosis is essential for children on the spectrum since after the diagnosis they can immediately begin appropriate interventions, especially designed to meet their needs [39]. Research has shown that verbally and intensive interventions can have positive outcomes on children’s development [39].
2.4 Interventions

Due to the nature of ASD, individuals are faced with many challenges throughout their lives. The proportion of young adult with autism aged 21 to 25 who have ever lived independently is only about 17% [20] and almost 80% of people on the spectrum are either unemployed or underemployed. Although a lot of research has been done on Autism Spectrum Disorder, it does not support any trustworthy “cure” or “recovery” from autism. However, studies prove that early and intensive interventions on autistic children can improve core symptoms, that can help them improve their quality of life later on [8][21] [14]. Children with ASDs who start an intervention program prior to 2 years old have higher improvements than those who enter programs after this age [21]. As mentioned before, the spectrum affects each child in different way and therefore the intervention should be carefully selected to address the child’s weaknesses and take advantage of the child’s strengths [27] [21].

The NHS website states that the interventions aim to improve:

- communication skills (e.g. using pictures to communicate)
- social interaction skills (e.g. gaining the ability to understand the feelings and emotions of other people)
- imaginative play skills (e.g. encouraging pretend play)
- and academic skills such as reading, writing and maths

Appropriate treatment can also help individuals handle their depression, anxiety and anger from early stage and deal with it throughout their lives. [27].

2.5 Technology-Based Interventions

Over the past years the research and awareness on Autism Spectrum have improved and it was inevitable that technology would be involved in the treatment of ASD. Many new technology-based interventions were built with the aim to improve functional capabilities of individuals with disabilities and enhance the work of practitioners and parents. The development of technology in treatment of autism is a new field but it

is growing rapidly and there exist a variety of different technologies such as mobile computers, virtual reality and robotics [19].

The technological devices can play crucial role in the lives of children with ASD and their families since they can enhance their quality of life. They can be used as educational tools that can assist in teaching social skills, communication skills, fine motor skills, functional life skills, organizational skills, and promote independence [28].

Children with autism spend twice as much time playing video games than typically developing children [30]. Due to the characteristics of autism, individuals are attracted to technology because it does not involve social interaction, it offers consistency and predictability, and children can control the pace of activity.

A professor and an individual on ASD, Temple Grandin, in his publication with title “Thinking in pictures” [17], mentioned “I THINK IN PICTURES. Words are like a second language to me”. Autistic individuals might not process the information of the speaking language as efficient as they do while they are looking at pictures. Technology includes graphics and pictures that are easily available and it can catch and control their attention [28]. At the same time, technology can be easily adapted to meet the needs of each individual. For example individuals with auditory or colour sensitivities can adjust the tool to the appropriate level or it can be a mean to communicate for non-verbal individuals [28].

Crutchfield et al. [9] developed an application that could help to reduce the repetitive behavior in adolescents with autism using a self-monitoring program. The results showed a marked decrease in the stereotypical behaviour when the self-monitoring application was introduced.

2.6 Visual Activity Schedules

Visual Activity Schedules are one of the primary and important method to teach a child different skills. Visual schedules use photos or other images that represent the different activities or behaviors that an individual has to complete during an individual task (e.g. brushing teeth) or throughout the day (e.g. at school or in the home). They are used to increase their independence and the predictability, and help in transitioning between activities [10]. The use of visual schedules is very effective since it can be
more comprehensive and at the same time it can be accessed any time. On the other hand describing a schedule to individuals on the spectrum with words, they might forget it or not understand it completely [32]. Previous research papers introduced the visual schedules in the classroom in order to ease transitions between activities for autistic students [5] [10] [36]. Visual schedules have been proved to increase the independence of transition within and between activities on students with autism. In general, activity schedules have proved effective in [5]:

1. Successfully transition between and within activities [5] [36]

2. Improve daily living skills such as independent dressing and meal preparation [5]

3. Reducing tantrum behaviors [5].

4. Predict scheduled events [10].

5. and Anticipate changes made throughout the day [10].

Our world is not predictable, which is what makes it so confusing to the person with ASD. The use of schedules is a mean to ensure certainty to individuals but also the mean to introduce novelty. As described in the book Been There. Done That. Try This!: An Aspie’s Guide to Life on Earth, individuals on Asperger Syndrome describe there experience through change and mention that the key element to deal with change is to be warned in advance and therefore have time to adjust [3]. Banda and Grimmett noted that activity schedules gives the ability to introduce new activities in the daily schedule since the child will have time to understand what is requested, have time to adjust to the change and at the same time get the feeling of certainty [5].

TEACCH(Treatment and Education of Autistic and Communication Handicapped Children) approach is an academic program that focuses on finding appropriate methods for individuals on the spectrum. The TEACCH approach suggests, that autistic individuals are encouraged to follow routines and that should be respected. However, once the child learns the routine, it should be slightly modified, for example through the use of slightly different materials of work, path walked, games played etc [32]. The aim is to introduce small changes and not break the routine. The structure of the routine should remain predictable, but details should vary, so the individual will learn to focus on the overall structure rather than on the details [32]. This technique is called Graded
Change and aims to decrease the repetitive behaviour in individuals with autism [42]. This will help the individual to develop flexibility and adaptive skills and then cope with changes more easily. On the other hand, if the child gets too attached with the routine then the effects will be quite the opposite [32]. This can also happen if the practitioner/parents do not develop routines for the children and hence the children develop for their own which can be very rigid [32].

2.7 Social Stories™

Social Stories™ is another popular and primary intervention for children with autism. They were introduced by Carol Gray in early ’90s and they represent small stories that describe certain situations, events or activities based on 10 criteria. Gray has introduced those 10 criteria (See Appendix A) that would be used as a guidance for creating the appropriate Social Stories™ with respect to the meaning, learning experience and fitting for the target population.

Social Stories™ aim to teach children [18]:

1. develop daily skills such as how to clean teeth or get dressed
2. develop social skills such as sharing and thanking
3. develop academic abilities
4. understand emotions
5. learn how to behave when they get angry
6. and learn how to cope with changes or stressful events such as a new car and moving houses

The Social Stories™ has proved very effective for children with autism since they facilitate in better comprehension due to the images. Thiemann and Goldstein noted that the use of Social Stories™ has been effective in increasing specific communication skills, decreasing inappropriate behaviours and in increasing the social interaction with other peers [40].

Social Stories™ has also be proved effective in introducing novel events. Ivie et al. [22], in an experiment with three boys on ASD, observe that the children participated more in novel situations Social Stories™ are used. This may happened because the children learnt about the novel activities in advance and therefore the novelty
decreased. By reading the story, the children did not spend time to process new information but instead participate in the new activity [22].

2.8 Motivation

Resistance to change is directly associated with the third core symptom, the stereotypical behaviour of children with autism. The restricted interests stand as an obstacle preventing them from extending their interests in different areas and activities. Developing adaptive skills and resilience is essential for this population in order to help them accept changes more easily and become interested in trying new activities. As mentioned in section 2.6, children on the spectrum are encouraged to have a routine and follow a visual schedule throughout their day. Changes can occur as part of the schedule which is encouraged to alter constantly. This can be enhanced with the use of Social Stories™ discussed in section 2.7. Learning flexibility takes time and effort. Creating Visual Activity Schedules and Social Stories requires a lot of effort to write, find images and arrange them correctly, and they can be damaged over time. As said before ASD is a very heterogeneous disorder and its symptoms severity varies between individuals. For practitioners, who probably interact with a lot of children on the spectrum, it is even more challenging to create social stories and schedules that meet the needs of each one separately. This has as a result that the individuals do not receive the appropriate training.

Technology has proven a prevalent factor in childrens lives, positively influencing both their education and personal lifestyle. Digital tools previously developed focus on assisting children with autism transition between activities in a school environment. Although practitioners use a variety of methods to help children deal with changes, there is a lack of technology-based tools supporting them and this gap must be addressed.

The purpose of this research is to investigate the current interventions on ASD and with the use of the technology create a technology-based tool to enhance the work of the practitioners to teach children on ASD cope with changes. The changes addressed in this project are divided into 3 categories: expected changes (e.g. a road trip), unexpected changes (e.g. a sudden event happening) and transition between activities.
2.9 Summary

This chapter presented the research on ASD and identified the methods being used and the existing technologies that help children with autism cope with changes. This enabled to find the gap in the literature and the motivation behind this project. From the literature, Social Stories™ and Visual Schedules are considered the most effective methods in helping children with autism cope with changes. Based on the information of the literature review the application will support both functionalities. In the next chapter, two studies are discussed: a workshop with 2 TD children and 3 interviews with practitioners or experts on ASD.
Chapter 3

Methodology

This chapter presents the methodology that was used for this research project. It begins by presenting the User-Centered Design in Section 3.1 and the stages in the Development of the application in Section 3.2.

3.1 User-Centred Design

The User-Center design (UCD) is a framework in which the users are involved throughout the design process firstly introduced by Norman & Draper (1988) [34]. The idea of this approach is to place the user at the center of the design. The International Standard 13407 is the basis for many UCD methodologies and it suggests four processes as follows [11]:

- Understand and specify the context of use
  Identify the people who will use the product, the tasks they will perform and under what conditions they will use it.

- Specify requirements
  Identify any business requirements or user goals that must be met for the product to be successful.

- Create designs and prototypes
  Using paper or computer-based mock ups, create design solutions. Then present it to sample users who will be responsible to give feedback. Based on the feedback the design choices are refined.
- Evaluate designs
  In an iterative process, evaluate the design to identify flaws. Then refine the design and re-evaluate until the design meets the usability goals.

![Diagram of User-centered Design]

**Figure 3.1: User-centered Design**

In this research project, typically developing (TD) children, experts/researchers in Human-Computer Interaction (HCI) and ASD, and practitioners are involved in every stage of the development. Especially important is the participation of children in this project as these are the end users. It is often forgotten that children are not ‘just short adult’ and that they have their own likes and dislikes. A lot of designers tried to develop technologies for children by involving teachers and parents rather than children directly [13]. Druin (2002) suggests that the children can take the role of the user, tester, informant, and design partner and be involved in the development process [13].

The TD children act as proxies for children with since involving children with autism is avoided due to the stress that such an evaluation might cause them [16]. However, previous research suggests that involving TD children is particularly important when designing technologies for children with disabilities [16].
3.2 Development stages

The methodology that was adapted in this project is inspired by the five-stage design described by the Scaife and Rogers (2001). The stages are as follows:

1. Requirement Gathering
   This stage aims to search and discover information on the Autism Spectrum Disorder and gather all the information that is required about current procedures as well as technologies being used to help children with autism cope with changes. It involves research from the literature review, three semi-structured interviews with experts and a workshop with 2 typical developing children. In this stage, children of age 6-11 years old are recruited to identify how they feel and overcome undesirable changes. The literature review is presented in Chapter 2 where the evaluations with children and experts are described in Chapter 4. This stage aims to answer the first research question ‘What are the methods that are used for helping children with autism cope with changes?’ and partly the second question ‘How should technology be best designed and developed to support children with autism cope with changes?’.

2. Design
   The interview with experts and the workshop with the children also helped to define design requirements. Once the data were analysed using thematic analysis and open coding in combination of the outcomes of the literature review, a set of requirements was established.

3. Low-fidelity prototype
   In this stage, the requirements that were gathered were used to design a low-fidelity prototype first on paper and then using Figma software. The low-fidelity prototype was then evaluated by both HCI and/or ASD experts and 3 TD children in order to extend the design further. Seven HCI/ASD experts were recruited and ‘Cooperative Evaluation’ method was used. The evaluation with children was carried in two sessions and the children either worked in pairs or individually. The results from both evaluations were analyzed using top-down thematic analysis. The evaluation studies are presented in Chapter 5. This stage aims to partially answer the second research question ‘How should technology be best designed and developed to support children with autism cope with changes?’
4. High-Fidelity Implementation

This stage aims to implement a high-fidelity prototype based on the requirements and information gathered after the low-fidelity prototype evaluation. This stage is presented in Chapter 6.

5. High-Fidelity Prototype Evaluation

This stage aims to evaluate the high-fidelity prototype with first time users, TD children and HCI/ASD experts. Firstly, an evaluation with 28 students and academic staff members of the University of Edinburgh was carried out. The data were collected using questionnaires with a combination of 1-5 likert scale questions and open-ended questions. The data then were analysed using Descriptive statistics. Secondly, the prototype was evaluated with 5 TD children who worked in pairs or individually and finally, 6 HCI/ASD experts evaluated the application using a combination of the ‘Co-operative Evaluation’ and semi structured interview. The evaluation studies are presented in Chapter 8. The data from both studies were analysed using a top-down thematic analysis. This stage aims to answer the third research question ‘To what extend does the new technology help children with autism cope with change?’ In this stage, any new information introduced by the participants is discussed in the ‘Future Work’ section.

3.3 Summary

This chapter presented the Methodology of this project. Firstly it introduced the User-Center Design and explained the importance of end-users throughout the development process. Particularly important is the participation of TD children for designing technologies for children with disabilities[16]. Lastly, the chapter presented the 5 stage design by the Scaife and Rogers and explained which chapter each stage is covered. The next chapter explains the pre-design stage in which involves an evaluation with children and an evaluation with experts with the aim to gather more requirements.
Chapter 4

Pre-Design Studies

This chapter reports the studies with practitioners and experts on ASD, and typical developing (TD) children to better understand the challenges that children with autism encounter during changes, to identify what are the practices and procedures used for supporting these children cope with changes and for collecting new requirements for the tool. Due to the limited time of the project it was very difficult to find children on the spectrum so we worked with typical-developing children who acted as proxies for children with autism. Three interviews with experts and one workshop with two typical-developing children were carried out. This chapter aims to completely answer the first research question: **RQ1: What are the methods currently being used for helping children with autism cope with changes?** Additionally, the studies reported here contribute to answer the second research question: **RQ2: How technology should be designed to support children on the spectrum cope with changes?**

4.1 Interview

In order to identify the interventions that are currently being used, three semi-structured interviews were carried out, with two practitioners with experience in working with children with autism and one researcher with expertise in ASD. The interviews intended to give a wide range of information from the perspective of experts.

4.1.1 Aims

Three main aims were set for the interviews with experts:

- Determine the changes that children with autism find most difficult to cope with.
• Determine the current procedures and practices being used to help children on ASD cope with those changes.

• Determine features the tool should include.

4.1.2 Participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Position/Occupation</th>
<th>Areas of expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Social Worker, Trainer in a centre with autistic individuals</td>
<td>Teaching individuals with autism</td>
</tr>
<tr>
<td>E2</td>
<td>HCI expert, Senior Laboratory Manager, School of Informatics</td>
<td>HCI, developing games for children with autism</td>
</tr>
<tr>
<td>E3</td>
<td>Speech language therapist, worked with children with ASD for 30 years</td>
<td>Teaching children with autism and typical-developing children</td>
</tr>
</tbody>
</table>

Table 4.1: Details of the participants in interview

4.1.3 Data Collection Method

The data were collected using audio recording. Two audio recording devices were used to ensure that the data are backed up and everything is captured. The researcher also was taking notes while the experts were talking. The study had the structure of a semi-structured interview.

4.1.4 Settings

The one of the three interviews took place in Informatics Forum at the University of Edinburgh since E2 works there and it was a convenient location. The other two interviews were carried through Skype because it was more convenient than face to face.

4.1.5 Materials

The materials used for the interviews were:

• Information Sheet and Consent Form for Experts (See Appendix C)
• Two voice recording devices
• Laptop for researcher’s notes
• List of questions for the interview

4.1.6 Procedure

The participants were contacted through email and the information sheet, consent forms and questions were attached so they had time to read them in advance and learn what is being requested from them. The experts who did the interview through Skype, sent the information sheet and consent form though email in advance. E2 had printed and signed the consent form prior to the meeting.

At the beginning, some time was spent for introduction and then the project and its goals were explained to the participant. The interview took 30-40 minutes.

The interviews were semi-structured with three main questions referring to the aims (4.1.1) This enabled the researcher to collect enough data to cover the aims that were set, but it also allowed follow up questions where necessary and therefore, more in-depth information. Most of the questions were broad to allow the participants to provide details.

4.1.7 Data Analysis

After the sessions were over, the data from the recordings were transcribed. Both transcription and notes were analysed using Thematic Analysis. To analyse the data, the Braun & Clarke’s [6] 6-step framework was followed. The thematic analysis followed a deductive, top down approach and therefore the analysis began with pre-established themes. The themes were the aims set in Section 4.2.1. Secondly, the data were read several times and codes were generated on interesting features. Then, the data based on their codes were added to the corresponding themes. The following themes were identified:

• Changes

• Current procedures and practices

• Tool feature
4.1.8 Results

Based on the thematic analysis, the following data were identifies:

**Changes**

The interviews identified the different changes children with autism come across and also which changes the tool should handle. Both E1 and E2 focused on changes that can occur in their daily lives whereas E2 also mentioned changes that can occur in their development while they are growing up. Specifically, E3 stated:

“It could be very difficult to cope with changes to a timetable and there are always changes in school ... It could be difficult to cope with plan change and it could be very difficult to cope with unpredictable change and that happens too.”

All the participants mentioned different types of changes such as change in the route to school, absence of teacher, fire drills, different people collecting them from school changes in lunch, going to a new place and also E3 highlighted “So a change anywhere, anywhere can be hard.”.

After analyzing the data the changes mentioned were divided into two categories: expected changes and unexpected changes. In addition, from literature review, changing and transitioning between activities was also considered as another category [5].

**Current procedures and practices**

The interviews also gave the opportunity to investigate the different methods being used from practitioners and compare them with the results found in the Literature Review.

All of the participants highlighted the importance of preparing children with autism in advance. E1 remarked:

“I think, it is really useful to prepare them in advance. The more preparation the better.”

With regards to preparing children with changes, E1 and E3 mentioned the use of schedules/timetables. E1 stated that every day they explain the schedule to the children and every change is described in advance. He mentioned that they describe changes and schedules, verbally, due to the limited resources and equipment they have. Also, E3 mentioned that:
“The most common one, the daily routine schedules that we use, it supports routines, understand foreign routines and then planning for change...If there is a plan change they(teachers) show where the change is and they can explain what is going to happen.”

Then she also remarked that “Changes are unpredictable where timetables are predictable.” and she added:

“Perhaps a social story about how a child manages change...Social stories are really really helpful, I think, for explaining change and how to manage change.”

She explained that each child has a unique way of self regulating and this can be adapted in the form of Social Story™. E2 also mention that Social Stories™ can be used to explain when and why something is happening and how the children should react and therefore they can better understand and prepare for a change.

E3 also suggested the use of diaries which are similar to visual schedules, symbols added to schedules to present where the change will appear, planners, photographs and real objects if the children find difficulty in understanding pictures.

**Features the tool should include**

None of the experts was aware of any technology-based tool to help children with autism cope with changes and they all agreed that such a tool could be beneficial. Specifically, E3 remarked:

“The common goal is to help them learn, to become more independent when things are stressful and I think an app could be absolutely fantastic for helping children to read, practice, prepare, rehearse how to deal with stressful situations”

E2 mentioned that the tool should include Social Stories™, because the use of graphics that technology offers, can make the interactions more realistic and that will make the change more comprehensive to the children. He also stated that the story should answer the following questions “What will happen?”, “When will this happen”, “Why will this happen?”, “What will I have to do?” “How will this be resolved?”. E1 mentioned that schedules are fundamental and the tool should support this functionality. E3 also considered useful to include a section of coping strategies when changes occur, customised for the specific child. In respect to the usability of the tool, E1 considered crucial that the tool should have the ability to be customised and it should follow a
sequential order making it simple to use. He then added that the tool should have the ability to include photographs and text. E3 emphasised that it should be user-friendly and designed to be adequate for the target population in respect to the language used and the graphics chosen. E2 proposed that it would be essential that it has the ability of replaying and reviewing things. He also suggested, that the use of characters or players would be very motivating.

4.2 Workshop with children

In order to identify how children of the target age population experience changes, one workshop with two male typically developing children was conducted. The children acted as proxies for children with ASD[16]. Specifically, it was important to identify the reaction of the children when they face a change, their emotional state and what they do to compensate. At the same time, data in regards to the design of the tool could be identified.

4.2.1 Aims

Two aims were set for the workshop with children:

- Determine how children react to change and ways of compensating.
- Determine further features and ideas that should be included in the tool.

4.2.2 Participants

The participants were two brother TD children (Table 5.2) and they acted as proxies for children on ASD.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>Male</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>Male</td>
</tr>
</tbody>
</table>

Table 4.2: Children participants’ details
4.3 Data Collection Method

The data were collected using audio recording. Two audio recording devices were used to ensure that the data were backed-up and everything was captured. The researcher also was taking notes while the experts were talking. The study had the structure of a semi-structured interview.

4.3.1 Settings

The workshop took place in Informatics Forum at the University of Edinburgh as this was found a convenient location for both participants and researchers.

4.3.2 Materials

The materials used for the workshop were:

- Consent form and Information sheet for parent/guardian (See Appendix C)
- Consent form and Information sheet for children (See Appendix D)
- Coloured pencils
- A3 paper with printed backgrounds (See Appendix F)
- Two voice recording devices
- Camera for pictures
- Red and green sticky notes
- Instruction sheet for the researchers
- Laptop for researcher’s notes

4.3.3 Procedure

The parents/guardians were contacted through email. The information sheet and consent forms for parents, and the information sheet and consent form for children were attached in the email so they had time to read them in advance and learn what is being requested in the workshop. For a child to participate, it was requested that both
the parents and the child sign their consent form and accept the audio recording. The workshop took 30-40 minutes.

The workshop started with a brief introductory ice breaker where the children introduced themselves and described their favourite activity. The children felt comfortable very quickly since they were brothers and the knew each other. Then the project goals and workshop was explained to the children. Once the children felt more comfortable, the information sheet and the consent form were given to them. After the children read the information sheet they signed the consent form and return them to the researcher.

Children were given two different worksheets (See Appendix F). They worked independently on a worksheet and then they swapped. The papers were split into two columns: Activities I like and Activities I do not like. The other materials (coloured pencils and sticky notes) were available on the table and the children were able to use as many as they wanted. The workshop had three different activities as follow:

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Children were asked to use the green sticky notes and draw five activities that they like and the red sticky notes for five activities they don’t like depending on their category(school day, holiday). Then they had to stick the sticky notes on the right column on their paper.</td>
</tr>
<tr>
<td>2</td>
<td>Children were asked to exchange papers and do changes to their brother’s paper. Then they had to replace two of the activities their brother likes with two activities that their brother don’t like and return the paper back to him.</td>
</tr>
<tr>
<td>3</td>
<td>The children discussed their feelings on the changes and they were asked to make any changes that will help them compensate.</td>
</tr>
</tbody>
</table>

During the workshop, some photographs of the children drawing were taken (Figure 4.1). In the end of the workshop, each child received a certificate of participation (See Appendix F).

### 4.3.4 Data Analysis

After the workshop was over, the recording were transcribed in documents. Due to the small number of children participating in the workshop and the small amount of data collected, thematic analysis was not considered appropriate method. Instead, open
coding and axial coding as described in Saldana(2013) were used. Based on this approach the following codes were noted:

- Likes
- Dislikes
- Coping Strategies
- Design Features

### 4.3.5 Results

Table 4.3 and 4.4 presents the the codes and the outcomes for each participant. For E1, the ‘trip to Egypt’ was replaced with ‘no trip to Egypt’ and ‘the technology’ with ‘no technology for the next holidays’. For E2, ‘hockey’ was replaced with ’6 hours of History’ and ‘technology’ with ‘a full day of History’.

When children were asked to describe their feelings after the changes made on their paper, they seemed to be very annoyed with those changes. C2 characterised the changes as “torture”. It was clear that both children did not like those changes particularly because their favourite activities were replaced. However, they were positive when they were asked to make changes that will help them compensate. From the analysis, the procedures that help children compensate through changes are:

- P1 could be able to compensate by doing activities similar to the activities that were changed (Not being able to use technology, he can compensate by reading books instead)

- On the other hand, P2 could be able to compensate, if although there was a change, it would be an interesting change. (he could compensate 6 hours of arithmetic if someone was coming at the lesson saying something interesting)

Each child had to deal with different changes and therefore they had different ways of accepting the change. The small amount of data prevents the identification of any patterns in the methods of accepting changes, however, it is clear that each child reacts differently to a change. As part of the third aim, a feature the tool should include, is the ability to be customised, a feature also discussed in the interview with experts. Also during the workshops the children also mentioned ‘magic’ and ‘famous people’. Children usually show an interest towards fantasy and superpowers and this can be
used in learning. Weisberg et al. proved that stories with anthropomorphic animals and events that cannot occur in reality encouraged greater learning than the realistic stories [43]. Therefore a fictional character is a nice feature to add in the requirements.

Figure 4.1: Children workshop

4.4 Design Principles

4.4.1 HCI Design Principle

In order to identify the requirements for the tool, it is essential to take into account a set of design principles which can be used for guidance in the design process. The 10 Nielsen’s Usability Heuristics (1994) [33] are the most general principles and work as a rule of thumb when designing interaction systems (taken from Heuristics (1994)[33]):

HCI_P1: Visibility of system status
    Appropriate feedback should be given to the users within appropriate time so the users are always informed about their status. The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

HCI_P2: Match between system and the real world
    The interface should use concepts, language and real-world conventions that are familiar to the user.

HCI_P3: User control and freedom
    Allow the user to have control of the interaction. Users should be able to undo
actions, exit from any sequence of actions, and not be forced into a series of actions.

HCI_P4: Consistency and standards
Information that is the same should appear to be the same. Information that is different should be expressed differently. Developers need to know the conventions being used in the software.

HCI_P5: Error prevention
If possible, prevent errors from happening in the first place.

HCI_P6: Recognition rather than recall
Show all the options available to the user rather than expecting them to remember them all. Do not require users to remember information from one screen to the next.

HCI_P7: Flexibility and efficiency of use
Experts should have a way to use the interface faster or more efficiently. Design should have accelerators like keyboard shortcuts to allow skilled users to move faster.

HCI_P8: Aesthetic and minimalist design
Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

HCI_P9: Help users recognize, diagnose, and recover from errors
Error messages should be clear, written in plain English, explain the problem, give constructive advice on how to solve the problem.

HCI_P10: Help and documentation
Unless the system is extremely simple, some people will need help documentation.

4.4.2 ASD-Specific Design principles
A set of design principles specifically for designing technology for individuals on the spectrum, was taken into account. Specifically, the design principles were collected by Bartoli et al. (2014) and by Pavlov Nikolay (2014). Bartoli et al. (2014) have
presented general guidelines for designing technology for children with autism where Nikolay (2014) presented UI recommendations for people with ASD with the aim to improve accessibility and usability. The principles relevant to the project are listed below:

ASD_P1: The goal should be unique and explicit. Each goal should be related to one single task.

ASD_P2: Instructions should provided at every step.

ASD_P3: Rewards should be offered after good performances. A reward system which is liked by the child, increases motivation.

ASD_P4: Repeatability and Predictability.

ASD_P5: The graphics should be minimalistic, but aesthetically nice and visual elements should not distract the child.

ASD_P6: The text should be clear and simple, the colours soft and the icons large.

ASD_P7: The navigation should be straightforward.

4.5 Design Requirements

Based on the literature review discussed in Chapter 2, the outcomes from the interviews with experts discussed in 4.1, the outcomes from the workshop with the children discussed in 4.2 and the design principles presented in 4.4, an initial set of design requirements was established. These requirements were used to design a low-fidelity prototype and then they were updated after evaluating the design with experts and children discussed in Chapter 5. The initial set of requirements of the tool is listed below:

- The target children population is children on ASD between the age 6 and 11 years old.

- The tool is intended to be used by practitioners.

- It can be customized.

- The application should be developed for a touchscreen tablet

- Language is simple and there is not too much text
• It is be very visual with appropriate colours

• It is be consistent

• It is be straightforward

• It provides two different modes: one for practitioners and one for children.

• Only the practitioners are allowed to make changes on the tool.

• It allows the user to create Social Stories™.

• It allows the user to create Visual Schedule.

• It allows the user to create the Schedule for the day.

• It allows the user to create a list of coping strategies.

• It provides the ability to edit, delete and add stories/schedules/day schedules/strategies.

• The stories/schedules/day schedules/strategies are saved and available for review at a later time.

• It provides examples of stories/schedules/day schedules/strategies.

• It provides simple templates for filling information.

• It supports a pet character.

• It allows the user to add photographs and images.

It essential that the tool provides a reward system and even better a game so it can become more attractive to the children. However, because the time is limited the whole functionality of a reward system will not be implemented but will be considered as part of Future Work. As part of the current work, the tool will focus on how the practitioners can customize the application and how the children could use it.

4.6 Summary

This chapter was intended to gather requirements that will be used for the design of the tool. It describes the interviews with experts, which aimed to identify the methods being used by practitioners for helping children with autism cope with changes. At the
same time, experts suggested features the tool should support. Secondly, this chapter presents the workshop with the TD children which helped to identify the reaction of children on changes. It also presents a set of HCI design principles and ASD-specific principles that work as a guidance when designing the tool. Finally, based on the principles and the results of the workshop and the interviews in combination with the literature review, a set of requirements emerge and presented.

The next chapter describes how the findings of this chapter were used to create a low-fidelity prototype and presents the results after evaluation with experts and children.
Chapter 5

Low-fidelity Prototype Design

In this stage of the research, the aims are to design a low fidelity prototype based on the list of requirements extracted in Chapter 3 and then evaluate it with experts on HCI and ASD, and TD children. Firstly, a low-fidelity prototype was developed using Figma [15], as presented in Section 5.1. For the evaluation, a study with seven experts and two workshops with TD children were carried and discussed in Section 5.2 and Section 5.3, respectively. This chapter aims to answer the second research question: How should technology be best designed to support children with autism cope with changes?

5.1 Description of the Design

Based on the set of requirements described in Section 4.4, a low-fidelity prototype app, was developed using Figma [15]. Apart from designing the interfaces, Figma has the capability to provide connections between the interfaces and therefore it can simulate how the users would navigate thought the interfaces. As a result, the prototype that was developed was quite similar to a real working app. This enabled the participants to better understand how the app works. In comparison to the paper prototyping, Figma application provided a more realistic way of interaction and the participants were not required to imagine how the application works. At the same time, the Figma application enabled to reveal usability issues that could be missed with the paper prototyping, such as wrong navigation between interfaces or small buttons that cannot be clicked easily. Although the application seemed realistic, the participants in the evaluation were reminded that it was not a fully developed app and therefore they are encouraged to think about new ideas. The app was named ‘ChangeItApp’. The following sections
present ‘ChangeItApp’ interfaces and their interactions.

5.1.1 Menu Screen

The application opens with the ‘Menu Screen’ as shown in Figure 5.1. This screen presents four options which are discussed in the following sections. The application provides a fictional character, in this case a zebra, which is called ‘children’s pet’. Implementing a reward system or a game are considered part of future work, due to the limited time available. For now, the pet is considered a preliminary version of a reward system. The practitioners are able to edit the application if they press the cloud button, ‘Edit Mode’ shown on the top-left corner. This will enable them to enter into the practitioners-only interface and make modifications. There is nothing from preventing children from entering into the practitioner-only interface, but for this stage, the researcher assumed that the children do not press this button. Under this assumption, the practitioner-only interfaces are called ‘Edit Mode’ and the children’s interfaces are called ‘Play mode’. Once the practitioners edit the application, they returned back to ‘Play Mode’ button and hand the application to the children.

![Figure 5.1: Menu Screen](image)

5.1.2 Visual Schedules Screen

‘Visual Schedule’ Screen (Figure 5.2) presents the interface that the child enters when ‘My Schedule’ button is clicked. The two buttons shown have the following functionalities:
• When clicking on ‘My Today’s Schedule’ button, the child’s schedules for the current day will be displayed (Figure 5.3.a-c). This is split into Morning, Noon and Night.

• When clicking on ‘My General Schedules’ button, a list of all the visual schedules created by the practitioner will be displayed (Figure 5.4.a). These represent smaller task schedules such as school activities or morning routine. When the children finish an activity, they can mark it as done by clicking on it as shown in Figure 5.4.c. A tick sign will appear and then the next activity is presented as shown in Figure 5.4.d. When they complete the schedule the pet congratulates the child as shown in Figure 5.4.e.

![Figure 5.2: Visual Schedules Screen](image)

![Figure 5.3: Today's Schedule](image)

(a) (b) (c)
5.1.3 Social Stories Screen

When the child clicks on the ‘My Stories’ button of the Menu Screen (Figure 5.1), the child will see a number of Social Stories (Figure 5.5.a). They are all the Social Stories™ the practitioner created for the specific child. By clicking on one of them, the child can navigate the story as shown in Figure 5.5.b-c. At the end of the story the pet congratulates the child (Figure 5.5.d).

5.1.4 Coping Strategies Screens

When the child clicks on ‘My Toolkit’ button of the Menu Screen (Figure 5.1), the screen on Figure 5.6 is presented. It shows all the coping strategies the practitioner added for the particular child.
Figure 5.6: Coping Strategies Screen

5.1.5 Pet Screen

When clicking on the ‘My Pet’ button of the Menu Screen (Figure 5.1), the children are taken to screen (Figure 5.7) where they can select their favourite pet. The selected pet is indicated by the blue boarder.

Figure 5.7: Pet Screen
5.1.6 Edit Mode Screens

After entering the ‘Edit mode’ the practitioner can either modify the story or add a new one as shown on Figure 5.8. If the practitioner clicks on the story, they are allowed to modify it. To add a new story, the practitioner has to click on the plus button shown at the top right corner on Figure 5.8.a. The same functionality can appear to Activity Schedules as well.

![My Stories](image)
![Edit Story](image)
![Edit Step](image)

Figure 5.8: Add or modify a Social Story™

5.2 Evaluation with Experts

In order to evaluate the low-fidelity prototype, a formative evaluation with 7 experts on HCI and/or ASD was carried. It was important to conduct the evaluation with experts in order to ensure that the application follows the research goals and identify any gaps that were missed. The evaluation with experts helped to recognise usability problems and collect suggestions. It was also an opportunity to identify if the tool is appropriate for the target population and if the tool is suitable to help children with autism cope with changes.

5.2.1 Aims

This study intended to evaluate the initial design of the application. Four aims were set for the evaluation with the experts:
• Determine the appropriateness of the application for the target population (children with autism aged 6-11 years old).

• Determine the appropriateness of the application for helping children with autism cope with changes.

• Identify any usability issues.

• Collect suggestions for improving the tool.

5.2.2 Participants

The participants were 7 experts (E1 - E7) on HCI and/or on ASD as shown on Table 5.1. Each session was conducted individually so more data could be collected and compared.

<table>
<thead>
<tr>
<th>Experts</th>
<th>Position/Occupation</th>
<th>Areas of expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Researcher in HCI</td>
<td>Experience in HCI and ASD, developing technologies for children with ASD</td>
</tr>
<tr>
<td>E2</td>
<td>Researcher in HCI</td>
<td>Experience in HCI and ASD, developing technologies for children with ASD</td>
</tr>
<tr>
<td>E3</td>
<td>Masters in Design Informatics</td>
<td>Experience in HCI and ASD, developing technologies for children with ASD</td>
</tr>
<tr>
<td>E4</td>
<td>Researcher in HCI</td>
<td>Experience in HCI</td>
</tr>
<tr>
<td>E5</td>
<td>Researcher in HCI and assistive technologies</td>
<td>Experience in HCI, developing technologies for children with ASD</td>
</tr>
<tr>
<td>E6</td>
<td>PhD in Usable Security,</td>
<td>Experience on HCI and ASD</td>
</tr>
<tr>
<td>E7</td>
<td>Researcher in HCI</td>
<td>Experience on HCI and ASD</td>
</tr>
</tbody>
</table>

Table 5.1: Testing workshop experts’ details

5.2.3 Data Collection Method

The data were collected using audio recording. Two audio recording devices were used to ensure that the data are backed up and everything is captured. The researcher was also taking notes while the experts were working on the application. Finally, an online questionnaire in Google Forms was filled by the experts in which they had to rate the application.
5.2.4 Settings

All the workshops took place at the University of Edinburgh at School of Informatics in a quite room.

5.2.5 Materials

The materials used for the workshops with experts were:

- Information Sheet and Consent Form for Experts (See Appendix H)
- Two voice recording devices
- Notebook for researcher’s notes
- Touchscreen laptop with the prototype in Figma
- Instruction Sheet for the researcher

5.2.6 Procedure

All the participants were contacted through email with the information sheet and consent forms attached, so they had time to read them in advance and learn what is being requested from them. Each session was run separately with one participant per session, but the same procedure was carried.

The method used in the sessions was the ‘Cooperative Evaluation’ which is a version of ‘Think-aloud’ protocol [12]. In comparison to the ‘Think-Aloud’, in ‘Cooperative Evaluation’ the users are encouraged to participate as a collaborator and not as a simple participant. The participant can ask questions (e.g. why, what-if) whenever it is necessary to clarify the users behaviour. At the same time the user can ask the participants to clarify various aspects for any problem they encountered [12]. This created a friendly atmosphere and it was a more natural way for the participants to verbalize their thoughts.

At the beginning, the participants were introduced to the project and its goals. They were also informed about the study aims and procedure structure. Then, they were asked to read the information sheet and sign the consent form (See Appendix H) . Once they signed and accepted the audio recording, the prototype was presented to them. A short description of the tool followed, which included the main functionalities of the tool and the methods for helping children with autism that are being used. The participants were allowed to interact freely with the app and at the same time, express
their thoughts. In this way, the conversations were flexible and therefore, more ideas arose. In the end of the session, they were asked to fill in a small questionnaire (See Appendix I). Each session lasted for about 35-50 minutes.

5.2.7 Data Analysis

The data from the recordings were transcribed. Both the transcriptions and the notes were analysed in the same manner as the interview with experts, discussed in Chapter 4. Thus, Braun & Clarke’s [6] 6-step framework for thematic analysis was followed. The thematic analysis followed a deductive, top down approach and therefore the analysis began with pre-established themes. The themes were the aims set in Section 5.2.1. Secondly, the data were read several times and codes were generated on interesting features. Then, the data based on their codes were added to the corresponding themes. The following themes were identified:

- Suitability of the tool for the target population and appropriateness of the methods (Aim 1) Sub-themes:
  - Ease of use
  - Appropriateness of the design
  - Appropriateness of the methods

- Suggestions and Areas for Improvement (Aim 2, Aim 3) Sub-themes:
  - Rewards System and the Pet
  - Changing to practitioner-only interface
  - Visual Schedules
  - Others

- General usability issues (Aim 2) Sub-themes:
  - Observed
  - Commented
5.2.8 Results

All the experts were very positive towards the application and they gave essential feedback and suggestions for improvement. However, most of the suggestions were considered part of Future Work due to their complexity and the limited time. From the thematic analysis, the following results were identified:
Suitability for the target population and effectiveness of the methods

Based on the results of the online questionnaire, the experts appear to be satisfied with the tool since the overall rating of the application was 4/5 (Figure 5.9.c). They, also, found the application easy to use with average rating 4.14/5 (Figure 5.9.b) and all of them considered this application suitable for the target population (Figure 5.9.a). Furthermore, all the experts considered the chosen methods appropriate for helping children with autism cope with changes. E6 mentioned that he could not find something wrong with the application but just areas for improvement.

Suggestions and Areas for Improvement
The evaluation with experts was really helpful to identify the weaknesses of the tool. The areas that were discussed the most are the following:
i. **Rewards System and the Pet**

Although a reward system was considered part of the Future Work, E1, E2, E3 and E6 considered that it should exist (4 out of 6 experts). E3 suggested that the pet could narrate the story, give encouraging comments or get rewards in the end. As example, she suggested that the child can feed the pet. Specifically E3 remarked:

"Why do we need a pet? What does it do?...I would like something with the pet, giving carrots maybe".

E1 and E4 also suggested that practitioners should be able to upload a picture of the pet.

ii. **Changing to practitioner-only interface**

E3, E6 and E7 commented that after clicking on the button ‘Edit Mode’ did not observe any change in the interfaces and therefore it was not apparent that they entered to ‘Edit Mode’ (3 out of 7 experts). E6 also commented that the children can easily enter the practitioner’s interface without realising it and make changes. Preventing this, both E6 and E3 considered that changing the background colour is essential.

iii. **Visual Schedules**

The interfaces regarding the ‘Visual Schedules’ received a lot of feedback and a variety of different suggestions from the experts. As a result, the researcher considered that it essential to modify these interfaces.

E2 considered that the tasks on the day schedule can be linked with the appropriate Social Story™, if exists. She stated:

"Linking social stories with the schedules would be the nicest step forward”.

She also suggested that it should not be limited to one day but instead to the weekly schedule or monthly schedule.

Moreover, E4 and E7 considered that there are two many steps until you reach the ‘Task Schedules’ and ‘Day Schedules’ (2 out of 7 experts). Specifically, E4 considered that there should only be one schedule, the ‘Day Schedule’ which will contain all the tasks of the day. On the other hand, E7 suggested that the
‘Visual Schedules Screen’ (Figure 5.2) should be removed in order to decrease the number of steps.

The researcher has also noticed that E1, E2, E3, E6 and E7 found difficulty to perform the action of clicking a task as ‘Done’ (Figure 5.4c) (5 out of 7 experts). E7 commented that the children prefer to click on checklists and therefore a check box would be more appropriate.

iv. Other suggestions

E6 suggested that it would be good to include an agenda with the changes previously made. Specifically he remarked:

*I feel there is a missed trick with allowing the child to see their previous encounters with changes in schedules. For example this change has happened before and you did so well or look this change hasn’t happened at this time before but you dealt with a change late at night.*

This was considered an important suggestion since it was also appeared in the literature review. Specifically, an individual on Asperger Syndrome commented “Approach each new change with the experience you have gained from past changes”[3].

E3 suggested that it would be very effective if there is a colour palette option so that the practitioners can modify the background colours. She commented that some children are not attracted to bright colours and therefore the option of changing the tool’s colour theme should be considered.

**Usability Issues**

Some of the usability issues that were observed or commented by the experts were:

1. Inconsistency of buttons in Social Stories™: only back button is apparent (4 out of 7 experts mentioned)

2. Elevation of tasks misleads the users to think that the options are clickable (observed in 7 out of 7 experts)

3. Boarder of coping strategies misleads the users to think that the options are clickable (observed on 4 out of 7 experts)
4. Text size is small when reading the Social Story™ (observed in 2 out of 7 experts)

5. Appropriate messages when deleting, adding or modifying were not apparent. (commented by 1 out of 7 experts)

5.3 Evaluation workshop with children

While the evaluation with the experts was valuable to identify usability problems, areas for improvements, suggestions and appropriateness of the tool, it is crucial to evaluate the initial design from the perspective of children. This section presents the formative evaluation study with 3 TD children who acted as proxies for children on ASD.

5.3.1 Aims

The aims of this study were as follows:

- Determine whether the application is easy to use and understand
- Determine whether the children find the application enjoyable
- Determine usability problems
- Receive suggestions for improvement

5.4 Data Collection Method

The data were collected using audio recording. Two audio recording devices were used to ensure that the data are not lost. The researcher also was taking notes while the children were working on the application. Finally, a likert scale was used so the children could rate the application.

5.4.1 Participants

The participants were three neurotypical children between the age of 8 and 11 as shown in Table 5.2 and they acted as proxies for children on ASD. For this evaluation, leaflets were contributed (See Appendix J) inviting children to participate. C3 also participated in the study carried in Pre-Design stage (Chapter 4). The other two children, C1 and
C2 are brothers and they recruited after receiving a leaflet specifically designed for this evaluation study (See Appendix J). The workshops were intended to be in pairs but unfortunately one of the children was absent and therefore C3 participated individually.

<table>
<thead>
<tr>
<th>Session No.</th>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>C1</td>
<td>Male</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>Male</td>
<td>11</td>
</tr>
<tr>
<td>S2</td>
<td>C3</td>
<td>Male</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 5.2: Evaluation children details

5.4.2 Settings

The workshop took place in Informatics Forum at the University of Edinburgh in a quite room.

5.4.3 Materials

The materials used for the study were:

- Consent form and Information sheet for parent/guardian (See Appendix K)
- Consent form and Information sheet for children (See Appendix N)
- Two voice recording devices
- Instruction sheet for the researchers (Table 5.3)
- Touch Screen laptop with the low-fidelity prototype in Figma
- Notebook for researcher
- A paper with a printed emoji likert scale (See Appendix M)
Table 5.3: Instruction Sheet

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>You wake up in the morning and you want to check your schedule for today. Find your schedule for today and describe what activities you have.</td>
</tr>
<tr>
<td>2</td>
<td>You are at school and you would to check what subjects you have at school today.</td>
</tr>
<tr>
<td>3</td>
<td>Not all the children know what to do when there are fire drills at school. Your teacher asks you to read the story about fire drills so you will know what you have to do next time.</td>
</tr>
<tr>
<td>4</td>
<td>Some children can get easily upset and so when they get upset their teacher asks them to check their toolkit for their calming activities. Let’s check the calming activities.</td>
</tr>
<tr>
<td>5</td>
<td>Let’s change the pet.</td>
</tr>
</tbody>
</table>

5.4.4 Procedure

The parents/guardians were contacted through email. The information sheet and consent forms for parents, and the information sheet and consent form for children were attached in the email so both children and parents had time to read them in advance and learn what is being requested in the study. For a child to participate, it was requested that both the parents and the child sign their consent form and accept the audio recording.

The workshop started with a small introductory ice breaker where children were invited to introduce themselves and describe their favourite trip. Then, the project goals and workshop was explained to the children. Once the children felt more comfortable, the information sheet and the consent form were given to them. After the children read the information sheet and signed the consent form the prototype were shown to the children and they were explained how they can use Figma. In comparison to the experts, the children did not perform any tasks in the practitioners-only interface but only in the children’s interfaces. Each session lasted 30-40 minutes.

The researcher instructed the children on the tasks they had to perform (Instruction Sheet). After they perform the activities, they were asked a series of questions as follow:
• What did you like the most about this application?

• Is there something that you did not like?

• Is there something you would like to change?

• Is there something you would like to add to this application?

• Did you find it hard or easy to use this application?

• Would you use this application to check your every day schedule?

• Did you like that you had a pet? What would you like the pet to do more?

When the children answered all the questions, an emoji likert scale (See Appendix M) was given to each of them and they were asked to rate the application overall. At the end of each session, each child received a certificate of participation (Appendix L).

5.4.5 Data Analysis

The data from the recordings were transcribed. Both the transcriptions and the notes were analysed in the same manner as the study with experts, discussed in Section 5.2. Thus, Braun & Clarke’s [6] 6-step framework for thematic analysis was followed. The thematic analysis followed a deductive, top down approach and therefore the analysis began with pre-established themes. The themes were the aims set in Section 5.2.1. Secondly, the data were read several times and codes were generated on interesting features. Then, the data based on their codes were added to the corresponding themes. The following themes were identified:

• General usability issues/unclear areas (Aim 1, Aim 3)

• Favourite Features (Aim 2)

• Suggestions and Areas for Improvement (Aim 3)

5.4.6 Results

The children were excited when they were presented the application and started to interact with it immediately. The average overall rating of the application was 4.7/5 and none of them found a significant difficulty in use. From the thematic Analysis, the following results were identified:
General usability issues/unclear areas

C1 and C2 could easily interact with “ChangeItApp” without any difficulty and they tried all the functionalities quite quickly. On the other hand, C3 had some difficulty to understand how the applications is used and specifically he spent some time to find the ‘Visual Schedules’ interface. This might happened due to the fact he was working individually. However, he got used to it really quickly and he also stated that “Once I knew what it was all about, it was easy”.

By observing the children, all of them found difficulty to mark the tasks as done in ‘Task Schedule’ interface. They also tried to click on features that were not clickable. Both of these issues occurred in the evaluation with experts.

Favourite Features

All the children said that their favourite feature is the pet and also agreed that having the option to choose makes the application even better. Specifically, C2 stated:

“No only they see a happy, friendly pet but they are able to choose them. I think it’s what would make them much happier.”

and then he added that being able to personalise the application for each child is a really nice feature.

Suggestions and Areas for Improvement

C1 and C2 considered that the pet should get accessorises as a reward whenever they complete a schedule or the story. C3, also suggested that the pet could encourage the children whenever they get stack. C2 also suggested that a person talking to them would be a nice feature. All of the children mentioned that they would like a game and P2 suggested that he would like a quiz after reading a story.

5.5 List of Requirements

The suggestions made by the experts and children are listed in Table 5.3. Each suggestion is marked as ‘Done’, ‘Done Partially’, or ‘Future Work’ depending on what is feasible for the time available. The requirements focus on improving the current design of the tool where the new suggestions of experts and children are considered part of ‘Future Work’. This is because the time available does not permit to add more functionality to the tool and at the same time implement the one that was already designed.
The only new functionality that is going to be implemented partially is a basic reward system. This functionality was considered part of ‘Future Work’ at first, but after the evaluation with experts and children, the researcher considered it an important feature for the tool.

<table>
<thead>
<tr>
<th>No</th>
<th>Suggestion</th>
<th>Done/Future Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Add reward system for the pet</td>
<td>Done Partially</td>
</tr>
<tr>
<td>2</td>
<td>Add both next and back button in the story book</td>
<td>Done</td>
</tr>
<tr>
<td>3</td>
<td>Add a checkbox next to each task</td>
<td>Done</td>
</tr>
<tr>
<td>4</td>
<td>Modify the background colour when entering into the practitioners-only interface</td>
<td>Done</td>
</tr>
<tr>
<td>5</td>
<td>Remove the elevation from features that are not clickable</td>
<td>Done</td>
</tr>
<tr>
<td>6</td>
<td>Add messages when adding, deleting or modifying a feature</td>
<td>Done</td>
</tr>
<tr>
<td>7</td>
<td>Decrease the steps for accessing the schedules</td>
<td>Done</td>
</tr>
<tr>
<td>8</td>
<td>Remove the boarder of coping strategies because it misleads the users to think that it is clickable</td>
<td>Done</td>
</tr>
<tr>
<td>9</td>
<td>Increase the text size</td>
<td>Done</td>
</tr>
<tr>
<td>10</td>
<td>Link the social stories with the tasks in ‘Day Schedule’</td>
<td>Future Work</td>
</tr>
<tr>
<td>11</td>
<td>Add weekly or monthly schedules</td>
<td>Future Work</td>
</tr>
<tr>
<td>12</td>
<td>Add functionality for uploading a picture of pet</td>
<td>Future Work</td>
</tr>
<tr>
<td>13</td>
<td>Add the option of changing colour theme</td>
<td>Future Work</td>
</tr>
<tr>
<td>14</td>
<td>Add an agenda of past changes</td>
<td>Future Work</td>
</tr>
<tr>
<td>15</td>
<td>Add interaction for coping strategies</td>
<td>Future Work</td>
</tr>
<tr>
<td>16</td>
<td>Game/Quiz</td>
<td>Future Work</td>
</tr>
<tr>
<td>17</td>
<td>Add text to speech functionality</td>
<td>Future Work</td>
</tr>
</tbody>
</table>

Table 5.4: Suggestions and requirements to consider for the next stage
5.6 Summary

The chapter presented the design of the low-fidelity prototype which was designed based on the requirements presented in Chapter 4. Then, it described the evaluation studies with both HCI/ASD experts and TD children. From the results of the evaluation studies, both experts and children seemed satisfied with ‘ChangeItApp’ and the experts agreed that the application and the methods are suitable for the target population. Apart from that, both children and experts suggested new ideas and areas for improvement which are going to be addressed in the High-Fidelity Prototype Implementation in Chapter 7. Finally, the chapter presented a new list of requirements that are going to guide the high-fidelity implementation on ‘ChangeItApp’. The chapter aimed to answer the second research question: **How should technology be best designed to support children with autism cope with changes?**. After completing this stage, the design is set and the tool is ready to be implemented.
Chapter 6

High-Fidelity Prototype
Implementation

In this stage of the research, the aim is to develop a high-fidelity working prototype based on the results extracted in Chapter 5. This chapter begins with a discussion on the technologies being used during the implementation and the decisions made. It progresses with the high-fidelity prototype description and presents the changes made based on the evaluation outcomes. This chapter aims to answer the second question: How should technology be best designed to support children with autism cope with changes?

6.1 Platform

From early in development, it was decided and set as requirement that the tool will run on touch screen devices. This was a decision made based on the literature review and backed up by the evaluation with experts in Chapter 4: Pre-Design Stage. However, the decisions on the operating system and on which platform is more appropriate and better meet the requirements of the project had to be made.

6.1.1 Operating System

The decision of the operating system was drawn after identifying and analysing the operating systems that support the development of applications on portable devices. Taking into account the popularity, the following operating systems were considered:

A. Android OS
Android OS was developed by Google and it is the most widely used operating system. The system components are written in Java, C, C++, and XML and applications can be developed on any major operating system: Windows, Mac OS and Linux. The development using Android offers a large range of devices that the application can run on.

B. iOS

iOS was developed by Apple and it a very popular and expensive operating system. Applications on iOS are written in Objective-C using the Cocoa Touch library. However, developing such applications requires a computer running Mac OS.

Developing this tool on either Android or iOS could not bring any real advantage and therefore the researcher’s decision was based mainly on experience and resources available. The researcher had significant experience on Android development, however did not have any experience on iOS and no access to any Apple devices. Taking into consideration the researcher’s experience and the resources available, Android was chosen as the application’s operating system.

6.1.2 Development Software

There is a variety of different software available for developing Android applications and the decision was drawn by weighting the pros and cons of two different software:

A. Android Studio

Android Studio is the integrated development environment (IDE) designed specifically for Android development and the code is mainly written in Java, Kotlin and XML.

B. Unity

Unity is a cross-platform real-time engine that enables the development of 2D and 3D applications. Unity used C# and it is one of the most popular game development engines. One of the main advantages of Unity is that a single script can be compiled and used for many platforms.

Taking into account the researcher’s experience and the project’s requirements, Android Studio was considered more appropriate than Unity. The main reason of this decision was the lack of the researcher’s experience on Unity. On the other hand, the
researcher had previous experience in developing android applications using Android Studio and a lot of years of experience on Java. Due to the limited amount of time of this project, learning to develop on Unity could need time and effort that could be used elsewhere. Furthermore, Unity is game engine where the project is mostly concerned for a non-game side of the tool. Although Unity allows both game and non-game development, it does not offer any significant advantage over Android Studio for the specific application.

6.2 Resources

The application was developed on Android Studio 3.3.2 and it could run on any version from 5.0 and above. To test the application, a mobile phone, Nexus 6P running Android Version 8.0 was used.

6.2.1 Java and XML

Java is the native programming language used for developing applications on Android Studio. The application is comprised of several java files: some of which represent interfaces of the application, others are java objects and others help in manipulating data of the local database, SQLite.

The XML used to build the interfaces of the application. It contains every image, button and text box that the application has.

6.2.2 SQLite

SQLite is an open-source relational database and it is emended on Android by default. This functionality was implemented on the application and therefore storing and retrieving data was feasible. Using the database the users can add, modify and delete data. Using the database facilitate to exchange data between interfaces.

6.2.3 Version Control System (VSC)

BitBucket was used as the version control software. A private git repository was created, ensuring that the application was backed up at all times and protected. At the
same time, Git keeps track of every change made and therefore the researcher could compare the code with earlier versions.

6.3 Description of the Design

Based on the updated set of requirements described in Section 5.6, the high-fidelity prototype app, was developed using Android Studio [15]. The prototype followed the same design with the low-fidelity prototype and therefore most of the functionality is the same. The following tasks can be performed:

- The practitioners are able to add or modify Social Stories™, Schedules, Task Schedules and Coping Strategies
- The children can view their daily schedules which are divided into Morning, Noon, Evening
- The children can mark the Task Schedules as ‘Complete’
- The children can choose and read a Social Story™
- The children can find their coping strategies
- The children choose their favourite pet
- The children can choose a reward.

6.3.1 Menu Screen

The application opens with the ‘Menu Screen’ as shown in Figure 6.1. This screen presents four options which are discussed in the following sections. The application provides a fictional character, in this case a cat, which is called ‘children’s pet’. The practitioners are able to edit the application if they press the cloud button, ‘Edit Mode’ shown on the top-left corner. This will enable them to enter into the practitioners-only interface and make modifications. There is nothing from preventing children from entering into the practitioner-only interface, but for this stage, the researcher assumed that the children do not press this button. Once the practitioners edit the application, they returned back to ‘Play Mode’ button and hand the application to the children.
6.3.2 Visual Schedules Screen

When clicking on ‘My Schedule’ button, the child’s schedules for the current day will be displayed (Figure 6.2.a-c). This is split into Morning, Noon and Night.

![Figure 6.2: Today’s Schedule](image)

In this interface, by clicking ‘My Task Schedules’ button, a list of all the visual schedules created by the practitioner will be displayed (Figure 6.3.a). These represent smaller task schedules such as school activities or morning routine. When the children finish an activity, they can mark it as done by clicking on it as shown in Figure
6.3.c. A tick sign will appear and then the next activity is presented as shown in Figure 6.4.d. When they complete the schedule the pet shows a speak bubble with the message ‘Tab Me’.

![Image](image.png)

Figure 6.3: Sample Task Schedule for a day at school

6.3.3 Rewards Screen

By clicking on the ‘Tab Me’ button, the ‘Rewards Interface’ will show (Figure 6.4) and the child can choose a reward. Once, the child tabs on any reward the ‘Menu Screen’ is displayed.
6.3.4 Social Stories Screen

When the child clicks on the ‘My Stories’ button of the Menu Screen (Figure 6.1), the child will see an number of Social Stories (Figure 6.5.a). They are all the Social Stories™ the practitioner created for the specific child. By clicking on one of them, the child can navigate the story as shown in Figure 6.5.b-c. At the end of the story the pet has the same speak bubble with the message ‘Tab me’ (Figure 6.5.d). Once the child press on the ‘Tab me’ button the ‘Rewards Screen’ will appear as before (Figure 6.4).
6.3.5 Coping Strategies Screens

When the child clicks on ‘My Toolkit’ button of the Menu Screen (Figure 6.1), the screen on Figure 6.6 is presented. It shows all the calming activities that the practitioner added for the particular child.

![Figure 6.6: My Toolkit Screen](image)

6.3.6 Pet Screen

When clicking on the ‘My Pet’ button of the Menu Screen (Figure 6.1), the children are taken to screen (Figure 6.7) where they can select their favourite pet. The selected pet is indicated by the blue boarder.
6.3.7 Edit Mode Screens

After entering the ‘Edit mode’ the practitioner can either modify an item (schedule, story calming activity) or add a new one. Figure 6.8 shows how the practitioner can edit a ‘Task Schedule’. If the practitioner clicks on the task of the ‘Day Schedule’, they are allowed to modify it (Figure 6.8.c). To add a new task, the practitioner has to click on the plus button, provide a description and then save it(Figure 6.8.c).
Figure 6.9: Edit Task Schedule

Figure 6.9 shows how the practitioner can edit a ‘Task Schedule’. If the practitioner clicks on a specific task of the ‘Task Schedule’, they are allowed to modify it. To create a new ‘Task Schedule’, the practitioner has to click on the plus button to add a schedule (Figure 6.9.a) and then the practitioner has to add tasks for the specific schedule by clicking the plus button (‘Add Step’) in Figure 6.9.c. The same functionality can appear to ‘Social Stories’ interface as shown on Figure 6.10.

Figure 6.10: something

Figure 6.11 shows how the practitioner can edit a ‘Toolkit: coping strategies’. If the practitioner clicks on a coping strategy, they are allowed to modify it. To add a new task, the practitioner has to click on the plus button (Figure 6.11.a).
6.4 Summary

This chapter presents the software and hardware decisions made for the implementation of the High-fidelity prototype. Based on those decision the application was developed in Android Studio using Java. The application is very similar in design with the low-fidelity prototype. Only minor changes were occurred which aimed to increase the usability of the application. Also, A very basic rewards system is developed in order to motivate the children and make the application more enjoyable. The next section presents the 3 evaluation studies that were carried out: the feedback survey, an evaluation study with HCI/ASD experts and a study with TD children.
Chapter 7

High-fidelity Prototype Evaluation

This chapter presents three evaluation studies: a feedback survey with Informatics students and staff of University of Edinburgh, an evaluation study with TD children and an evaluation study with experts. The aim is to answer the final research question and its sub-questions, presented in Chapter 1: **To what extend does the new technology help children with autism cope with changes?**. The feedback survey is presented in Section 7.1 and aims to answer the first sub-question: **RQ3.1: Is the new technology usable by children with autism?**. Section 7.2 describes the evaluation study with five typical developing children with the aim of answering the second sub-question: **RQ3.2: Is the tool perceived as fun and engaging for the target population**. Lastly, Section 7.3 presents the evaluation study with the experts and aims to answer the third sub-question: **RQ3.3: Are the activities appropriate to help children with autism cope with changes?**

7.1 Feedback Survey

The prototype was firstly evaluated by Informatics students and staff of the University of Edinburgh at the Feedback Day Event. Feedback day event is organised within the School of Informatics for the final year students, who present their dissertation projects to other students and academic staff with the aim to get feedback. Many of the undergraduate students and the staff of the University attended the event. The final year students had their own space and stand for presenting their project and the visitors were able to freely move around and ask questions about the projects and provide their feedback. The purpose of the study was to receive general feedback in regards to the usability of the application. At the same time, users were encouraged to express new
ideas and suggestions.

7.1.1 Aims

Two aims were set up for this study:

- Determine how easily new users can navigate through the application
- Determine whether the design is attractive to users
- Collect suggestions for improving the tool

7.1.2 Participants

The participants were Informatics students and staff of the University of Edinburgh who attended the feedback day event. Table 7.1 presents details of the 29 participants who interacted with the application and completed the online questionnaire.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
<th>Experience with HCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male</td>
<td>45-64</td>
<td>No experience</td>
</tr>
<tr>
<td>2</td>
<td>Male</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
<tr>
<td>3</td>
<td>Male</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
<tr>
<td>5</td>
<td>Male</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
<tr>
<td>6</td>
<td>Female</td>
<td>&lt;24</td>
<td>No experience</td>
</tr>
<tr>
<td>7</td>
<td>Female</td>
<td>&lt;24</td>
<td>No experience</td>
</tr>
<tr>
<td>8</td>
<td>Male</td>
<td>&lt;24</td>
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</tr>
<tr>
<td>9</td>
<td>Female</td>
<td>&lt;24</td>
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<tr>
<td>10</td>
<td>Male</td>
<td>&lt;24</td>
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</tr>
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<td>11</td>
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<td>&lt;24</td>
<td>No experience</td>
</tr>
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<td>Male</td>
<td>&lt;24</td>
<td>No experience</td>
</tr>
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<td>13</td>
<td>Male</td>
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<td>HCI expert</td>
</tr>
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<td>14</td>
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<td>&lt;24</td>
<td>No experience</td>
</tr>
<tr>
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<td>Female</td>
<td>&lt;24</td>
<td>No experience</td>
</tr>
<tr>
<td>16</td>
<td>Male</td>
<td>&lt;24</td>
<td>No experience</td>
</tr>
<tr>
<td>17</td>
<td>Male</td>
<td>&lt;24</td>
<td>No experience</td>
</tr>
<tr>
<td>18</td>
<td>Male</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
<tr>
<td>19</td>
<td>Male</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
<tr>
<td>20</td>
<td>Male</td>
<td>45-64</td>
<td>No experience</td>
</tr>
<tr>
<td>21</td>
<td>Female</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
<tr>
<td>22</td>
<td>Female</td>
<td>45-64</td>
<td>Some experience</td>
</tr>
<tr>
<td>23</td>
<td>Male</td>
<td>&lt;24</td>
<td>No experience</td>
</tr>
<tr>
<td>24</td>
<td>Male</td>
<td>24-44</td>
<td>No experience</td>
</tr>
<tr>
<td>25</td>
<td>Female</td>
<td>24-44</td>
<td>HCI expert</td>
</tr>
<tr>
<td>26</td>
<td>Male</td>
<td>24-44</td>
<td>No experience</td>
</tr>
<tr>
<td>27</td>
<td>Female</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
<tr>
<td>28</td>
<td>Male</td>
<td>&lt;24</td>
<td>Some experience</td>
</tr>
</tbody>
</table>

Table 7.1: Details of the participants in feedback survey
7.1.3 Data Collection Method

The data were collected using an online questionnaire (See Appendix O) in Google Forms which the participants had to fill in. The researcher was also taking notes for any suggestions the participants expressed.

7.1.4 Settings

The survey took place at School of Informatics since it was the place where the Feedback Day Event was organised.

7.1.5 Materials

The materials used were:

- Touchscreen laptop with the working prototype
- Touchscreen laptop for answering the online questionnaire
  The questionnaire had likert scale questions from 1-5 and 2 optional open-ended questions. The questions focus on the usability and the overall experience with the application.
- Notebook for researcher’s notes
- A poster with the project overview (See Appendix U)
- A stand where the researcher presented the project

7.1.6 Procedure

Twenty eight from the visitors who showed an interest in the current project provided me with feedback. A short description of the project was given to each of them and then they were asked to freely interact with the working prototype. In the end they were asked to complete the feedback questionnaire (See Appendix O) evaluating the tool. The questionnaire was created using Google Forms and it was anonymous. The questionnaire asked the participants to rate their overall experience with ‘ChangeItApp’, provide general feedback and identify usability problems. The information sheet and consent form were part of the questionnaire and the users could not proceed to the main survey without consenting. The researcher also took notes of the comments the visitors expressed.
7.1.7 Data Analysis

After the feedback survey, the data collected from the questionnaire were transferred in Excel Spreadsheet using Google Forms. Then, Descriptive statistics were used to summarize the data. Conveniently, Google Forms can create charts and graphs automatically and therefore, the results were converted into charts once the event was over. The open-ended questions were optional and therefore only few people provided feedback. As a result, qualitative analysis was not carried.

7.1.8 Results

The results of Descriptive Statistics are presented in figure 7.1. The majority of the participants (25 out of 28) appreciated the application as ‘Easy’ (4) or ‘Very Easy’ (5) (Figure 7.1.a). Only one participant rated the app ‘Not Easy’ (2) and two rated it as ‘Neither easy not difficult’. However, the participant who rated the application as ‘Not Easy’ mentioned that larger icons and help section would make the app easier to use. By observing the participants, all of them managed to perform the activities with only few errors and nobody stacked in any part. Most of them commented that the application was very easy to use but 2 out of 28 participants expressed in the questionnaire that they found some difficulty with the ‘back button’.

Also, the majority of the participants (23 out of 29), marked the application as ‘Suitable’ (4) or ‘Very Suitable’ (5) for children between 6-11 years old (Figure 7.1.b). Only 5 participants considered the application as ‘Neither suitable nor unsuitable’ or ‘Unsuitable’ (5 out of 28). One of the participants who marked the application as ‘Unsuitable’ considered that the language is not appropriate for the children.

Overall the application got a high rating (Figure 7.1.c) with the majority marking the application as ‘Very Good’ (4) (15 out of 28). 10 of the participants appreciated the application as ‘Excellent’ where only 3 out of 28 rated it as ‘Good’ (5). A participant mentioned that the application is a brilliant idea and she suggested that it should be tested further and released to the market. Many of the participants expressed a lot of positive comments in regards to the application.

Some other suggestions based on the researcher’s notes and the open-ended questions were the request of more interactions for the pet (7 out 28 participants) and the ability to add interactions on each ‘Coping Strategy’ (1 out of 28).
(a) Easiness in use

(b) App Suitability

(c) Overall Rank

Figure 7.1: Results of the Feedback Survey
7.2 Evaluation workshop with children

Once again, in order to evaluate the experience of children with the app and collect more suggestions for improvement, both in terms of usability and suitability, an evaluation with typically developing children between the age of 7 and 11 was carried. Five TD children who acted as proxies for children on ASD participated at this stage of the evaluation. Three sessions were conducted in which the children attended in pairs (N=2) or individually (N=1). The children were asked to evaluate the working prototype, ‘ChangeItApp’ in the same way they did for the low-fidelity prototype, discussed in Section 5.3.

7.2.1 Aims

This study intended to evaluate the final design of the application from the perspective of children. Specifically, this study aimed to answer the second sub-question, presented in Chapter 1, RQ3.3: Is the tool perceived as fun and engaging for the target population. More detailed aims were:

- Determine whether the design is suitable for children between 6-11 years old.
  - What did the children like the most?
  - What did the children like the least?

- Determine whether the tool is easy to use and all the interfaces are clear to understand

- Receive recommendations and ideas for improving the tool

- Determine the overall experience of children with the application

7.2.2 Participants

The children were five TD children between the age of 7 and 11, as shown in Table 7.2 and they acted as proxies for children on ASD. C3, C4, C5 had also participated in the workshop carried in Low-Fidelity Prototype evaluation (Section 5.5). The other two children, C1 and C2 are brothers and they were recruited via email. C3 and C4 are also brothers and they participated in the workshop together as they did in the Low-Fidelity Prototype evaluation (Section 5.5). The workshops were intended to be in pairs but,
unfortunately, one of the children was absent and therefore C5 participated individually. The same child worked individually in the Low-Fidelity Prototype evaluation.

<table>
<thead>
<tr>
<th>Session No.</th>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>C1</td>
<td>Male</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>Male</td>
<td>9</td>
</tr>
<tr>
<td>S2</td>
<td>C3</td>
<td>Male</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>C4</td>
<td>Male</td>
<td>11</td>
</tr>
<tr>
<td>S3</td>
<td>C5</td>
<td>Male</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 7.2: Evaluation study children details

7.3 Data Collection Method

The data were collected using audio recording. Two audio recording devices were used to ensure that the data are backed up and everything is captured. The researcher also was taking notes while the children were working on the application. Finally, a likert scale (See Appendix M) was used so the children could rate the application.

7.3.1 Settings

The workshop took place in Informatics Forum at the University of Edinburgh in a quite room.

7.3.2 Materials

The materials used for the workshop were:

- Consent form and Information sheet for parent/guardian (See Appendix T)
- Consent form and Information sheet for children (See Appendix R)
- Two voice recording devices
- Instruction sheet for the researcher (Table 7.3)
- Touch Screen laptop with the working prototype in Android Studio
• Notebook for researcher
• A paper with a printed emoji likert scale (See Appendix M)
• Camera for photographs

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>You wake up in the morning and you want to check your schedule for today. Find your schedule for today and describe what activities you have.</td>
</tr>
<tr>
<td>2</td>
<td>You are at school and you would to check what subjects you have at school today.</td>
</tr>
<tr>
<td>3</td>
<td>Not all the children know what to do when there are fire drills at school. Your teacher asks you to read the story about fire drills so you will know what you have to do next time.</td>
</tr>
<tr>
<td>4</td>
<td>Some children can get easily upset and so when they get upset their teacher asks them to check their toolkit for their calming activities. Let’s check the calming activities.</td>
</tr>
<tr>
<td>5</td>
<td>Let’s change the pet.</td>
</tr>
</tbody>
</table>

Table 7.3: Instruction Sheet

7.3.3 Procedure

The evaluation followed the same procedure as the one used for the Low-fidelity Prototype evaluation, discussed in Chapter 5. Prior to the workshops, the parents/guardians were contacted through email. The information sheet and consent forms for parents, and the information sheet and consent form for children were attached to the email so both children and parents had time to read them in advance and learn what is being requested in the workshop. For a child to participate, it was requested that both the parents and the child sign their consent form and accept the audio recording.

Once the participants and their guardians/parents arrived at the location, the parent/guardian were given the information sheet and they were asked to sign the consent forms, one for each child. After that, they returned them to the researchers and left the room. The workshop started with a small introductory ice breaker where children were invited to introduce themselves and describe their favourite animal. Once the children felt more comfortable, the information sheet and the consent form were given
to them. After the children read the information sheet and signed the consent form the prototype were presented to the children. In comparison to the experts, the children did not perform any tasks in the practitioners-only interface but only in the children’s interfaces. Each session lasted 30-45 minutes.

The evaluation was a combination of a task-based evaluation and a freely exploration. The researcher instructed the children on the tasks they had to perform (Instruction Sheet) but at the same time did not intervene if the children preferred to try different options or if the children could perform the tasks without the instructions. After they perform the activities, they were asked a series of questions which aimed to answer the aims set in Section 7.4.3. The questions were as follows:

1. Did you find it hard or easy to use this application?
2. Was the schedule easy to understand?
3. Was the story easy to read?
4. What did you like the most about this application?
5. Is there something that you did not like about the application?
6. Is there something you would like to change or to add to the application?
7. Did you like that you had a pet? Did you like that you pet won a reward?

When the children answered all the questions, an emoji likert scale (See Appendix M) was given to each of them and they were asked to overall rate the application. At the end of each session, each child received a certificate of participation (See Appendix S).

7.3.4 Data Analysis

After the sessions were over, the data from the recordings were transcribed. Both transcription and notes were analysed using Thematic Analysis. To analyse the data, the Braun & Clarke’s [6] 6-step framework was followed. The thematic analysis followed a deductive, top down approach and therefore the analysis began with pre-established themes. The themes were the aims set in Section 7.2.1. Secondly, the data were read several times and codes were generated on interesting features. Then, the data based
on their codes were added to the corresponding themes. The following themes were identified:

- Overall satisfaction
- Ease in use
- Favourite Features
- Suggestions and areas for improvement/change
- General usability issues/unclear areas

7.3.5 Results

The children were excited when they were presented the application and started to interact with it immediately. Based on the results of Thematic Analysis the following data were identified:

**Overall Experience with the application**

Overall the children appreciated the application and enjoyed working with it. The majority of the children ranked the application as either ‘Excellent’ or ‘Very Good’ (4 out 5 participants) where only one child consider the application ‘Good’ (Figure 7.2). The child who considered the application ‘Good’ mentioned that he doesn’t need such an application. On the other hand, the other 4 children mentioned that they would use this application to check their daily schedule.

![Figure 7.2: Overall Rank](image)

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Ease in use
All the children agreed that the application was easy to use. They also agreed that the story was easy to read and the schedule easy to understand. Also, the researcher did not notice any difficulties when the children interacted with the application and all of them could easily read the stories, and use the schedules and coping strategies. Of interest is the fact that the children performed the actions without instructions and all of them explored all the interface really quickly.

Favourite Features
C1, C2 and C5 liked their pet the most and C5 commented that he liked that the pet was present in every interface. C3 liked that there is a section where he could see the calming activities, where C4 liked that that the application can be customised for each child. C4 commented:

“I liked that the parents get to easily change something they might don’t like or add anything to it”.

Suggestions and areas for improvement

i. Dislikes
C1, C3, C4 and C5 agreed that there is nothing that they did not like about the application and C4 remarked “Nothing really. There is nothing I would take away from it, just more things to add.” On the other hand, C2 did not like the calming activities and he remarked:

“If you look at a screen when you are upset it doesn’t help you. If I scream out, I just put my hand over my mouth and just do.”

This comment was really important since it answers the third sub-question ‘RQ3.3: Are the activities appropriate to help children with autism cope with changes?’, a question that was later given to the experts. Although, all the experts in the low-fidelity prototype evaluation (Chapter 5) agreed that the methods used are effective, no one considered that the ‘calming activities’ might not. The aim of this functionality is to remind the children what they have to do, whenever they get upset after a change. But no one thought that when the children are upset, they will not use a screen to calm them down.
ii. **Suggestions and areas for improvement**

The children had a lot of ideas and suggestions. All the children commented that they would like a larger variety of options for the pet and each one expressed their preferences. The ideas where horse, red panda, penguin, dog, bird, crocodile, hamster, hippo and then C3 suggested that the parents should be able to edit the options. Specifically, C3 commented:

> “Maybe you can have a dog or penguin or hamster or the parents can choose what they put on”

C5 also suggested that there should be times next to each task in the ‘Visual Schedules’ because his timetable has them. He also suggested that there should be more interaction in the coping strategies and he remarked:

> “Honestly, I think of what I want and that is what calms me down...I want a cat so I might think about a cat or me getting a cat...One of the things could be a picture of a cat down here (as a coping strategy)”

This functionality was also mentioned by the experts in the low-fidelity evaluation (Section 5.2) but it was marked as ‘Future Work’.

All the children agreed that they like the idea of having pet included in the app and three out of the five mentioned that it is their favourite feature. They were even more excited when they reached the ‘Reward Interface’, but they all had a lot of suggestions to express. It was apparent that the children were not satisfied with the reward system as they expected it to be more elaborated. For example, C3 remarked:

> What do these (rewards) do though? Yes, it is a reward but what happens if you get a reward? Maybe, it should be more interactive. I’ve seen on some other websites, you get something for your pet and if it is food they eat it and then they stop moving.

and C4 agreed. C5 also added:

> “Maybe next time you look at your pet, it could be (the reward) next to it”.

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C1 and C2 also suggested that they would like to have a game including the pet and specifically suggested that they would like the pet to fly, die and then come back to life. C3 also suggested that the pet could talk and encourage the child to complete the schedules, reading the story or calm them down when they get upset.

The reward system is considered part of ‘Future Work’ but it is important to note that its functionality is essential and therefore more research should be done in order to develop a high-level reward system.

Another suggestion mentioned by C3 and C4 was to include a pin to distinguish the ‘Edit Mode’ and ‘Play mode’. He suggested that whenever the practitioners would like to edit the tool and press on the ‘Edit Mode’ button they should be requested to enter a 4-digit pin in order to prevent the children from entering into ‘Edit Mode’ and make changes.

7.4 Evaluation workshop with HCI experts

It was essential to have an evaluation with experts on HCI and/or on ASD with the aim to determine whether the tool is effective and meet the project’s goals, and identify usability problems, areas for improvements and determine

7.4.1 Aims

This study intended to evaluate the final design of the application from the perspective of experts. It aims to answer the third sub-question Are the activities appropriate to help children with autism cope with changes? The following are the more detailed aims:

• Determine the appropriateness of the application for the target population (children with autism aged 6-11 years old).

• Determine the appropriateness of the application for helping children with autism cope with changes.

• Identify any usability issues.

• Collect suggestions for improving the tool.
• Determine the overall experience of the experts with the application

### 7.4.2 Participants

The participants were six experts on HCI and/or on ASD as shown on Table 7.3. All the experts, except E7 had also participated in the Low-Fidelity Prototype evaluation (Section 5.2). However, E7 participated in Pre-Design Stage interview (Section 4.1) and therefore all of them had some experience with the project and the tool. Each session was conducted individually so more data could be collected and compared.

<table>
<thead>
<tr>
<th>Experts</th>
<th>Position/Occupation</th>
<th>Areas of expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Researcher</td>
<td>Experience in HCI and ASD, developing technologies for children with ASC</td>
</tr>
<tr>
<td>E2</td>
<td>PhD in Usable Security</td>
<td>Experience in HCI and ASD</td>
</tr>
<tr>
<td>E3</td>
<td>Masters in Design Informatics</td>
<td>Experience in HCI and ASD</td>
</tr>
<tr>
<td>E4</td>
<td>Researcher</td>
<td>Experience in HCI</td>
</tr>
<tr>
<td>E5</td>
<td>Researcher</td>
<td>Experience on HCI and ASD</td>
</tr>
<tr>
<td>E6</td>
<td>Researcher, Senior Laboratory Manager, School of Informatics</td>
<td>Experience on HCI and ASD</td>
</tr>
</tbody>
</table>

Table 7.4: Evaluation study experts’ details

### 7.5 Data Collection Method

The data were collected using audio recording. Two audio recording devices were used to ensure that the data are backed up and everything is captured. The researcher also was taking notes while the experts were working on the application. The researcher used a combination of a semi-structured interview and an online questionnaire in Google Forms (See Appendix Q). The experts were asked questions while they were interacting with the application and at the same time they had to fill an online questionnaire.

#### 7.5.1 Settings

All the workshops took place at the University of Edinburgh in a quite room.
7.5.2 Materials

The materials used for the study with experts were:

- Information Sheet and Consent Form for Experts (See Appendix P)
- Two voice recording devices
- Notebook for researcher’s notes
- Touchscreen laptop with the high-fidelity prototype in Android Studio
- Laptop with an online questionnaire in Google Forms (See Appendix Q).

7.5.3 Procedure

The evaluation followed the same procedure as the one used for the Low-Fidelity Prototype evaluation, discussed in Chapter 5. All the experts were contacted through email with the information sheet and consent forms attached, so they had time to read them in advance and learn what is being requested from them. Each session was carried separately, but the same procedure was followed.

The method used in the sessions was the ‘Cooperative Evaluation’ which is a version of ‘Think-aloud’ protocol [12]. In comparison to the ‘Think-Aloud’, in ‘Cooperative Evaluation’ the users are encouraged to participate as a collaborator and not as a simple participant. The participant can ask questions (e.g. why, what-if) whenever it is necessary to clarify the users behaviour. At the same time the user can ask the participants to clarify various aspects for any problem they encountered [12]. This created a friendly atmosphere and it was a more natural way for the participants to verbalize their thoughts.

At the beginning, the participants were introduced to the project and its goals. They were also informed about the study aims and procedure structure. Then, they were asked to read the information sheet and sign the consent forms. Once they signed and accepted the audio recording, the High-Fidelity prototype was presented to them. A short description of the tool followed, reminding the participants the main functionalities of the tool and what methods for helping children with autism are being used.

The evaluation was a combination of a task-based evaluation and a freely exploration. The participants were invited to perform a series of tasks and answer a post-task questionnaire. The questionnaire contained a list of tasks and a list of post-task questions in regards to the usability of each interface and the appropriateness of the methods for
helping children with autism cope with changes. The questions had the form of a linear scale from 1 to 5 or they were open-ended questions which the experts had to answer verbally. From their answer follow-up questions were asked where necessary. The researcher considered that it would be easier for the participants to answer the questions verbally and at the same it was possible to ask follow-up questions. The questionnaire was split into three sections. In the first one they were asked to evaluate the interfaces for the children (‘Play Mode’), in the second one they were asked to evaluate the interfaces for the practitioners (‘Edit Mode’) and the third one were asked to evaluate the application overall. Although there were specific tasks that the practitioners had to follow, they were encouraged to, freely, explore the application. Each session lasted for about 35-55 minutes.

7.5.4 Data Analysis

After the sessions were over, the data from the recordings were transcribed. Both transcription and notes were analysed using Thematic Analysis. To analyse the data, the Braun & Clarke’s [6] 6-step framework was followed. The thematic analysis followed a deductive, top down approach and therefore the analysis began with pre-established themes. The themes were the aims set in Section 7.2.1. Secondly, the data were read several times and codes were generated on interesting features. Then, the data based on their codes were added to the corresponding themes. The following themes were identified:

- Overall satisfaction
- Ease in use
- Appropriateness of the application
  Sub-themes:
  - Appropriateness of the method for helping children with autism cope with changes
  - Suitability of the application for the target population (children aged 6-11 years old)
- Suggestions and areas for improvement
  Sub-themes:
– Add interaction when click on coping strategies
– Add functionality for uploading a picture of pet
– Rewards System and the Pet
– Changing to practitioner-only interface
– Visual Schedules
– Others

• General usability issues/unclear areas

7.5.5 Results

The experts were positive once they saw the prototype. Based on the thematic analysis the following data were identified:

**Overall satisfaction**
Based on the results from the questionnaire the average overall rating of the application was 4.17/5. All the experts considered the application either ‘Excellent’(5) or ‘Very
Good’(4) (Figure 7.4.d). All of them said positives comments in regards to the application and P3 was impressed that the application was very similar to the low-fidelity prototype.

**Easiness in use** Based on the results of the online questionnaire, the experts found the application very easy to use with average rating was 4,17/5. Again, all the experts considered the application either ‘Very Easy’(5) or ‘Easy’(4) (Figure 7.4.d). Specifically, E1 stated:

“*I think it is really easy to use,...but I think there are some little things that can be added and enhance the usability of the app, overall. But I don’t think it is difficult at all, it’s not. *”

By observing the experts, the researcher did not notice any difficulty in the use of the application and they all completed the tasks really quickly. All the participants navigate through the application with few errors and nobody stacked in any feature.

**Appropriateness of the application**

i. **Appropriateness of the method for helping children with autism cope with changes**

All the experts who had experience with ASD agreed that the methods being used are suitable for helping children with autism cope with changes. Based on the results of the online questionnaire, the majority of the experts considered the methods ‘Very Suitable’ (4 out of 6 experts) and only one expert considered the methods ‘Suitable’ (Figure 7.3.b). E1 commented:

“*I think they are really good for children with autism. Stories are a big thing for children with autism and being able to edit the stories and customize them based on different situations is really good...So having these stories where the parent can edit them to reflect exactly the situation they are going through is really good and very suitable for this population.*”

On the other hand E4, commented that the ‘Toolkit Interface: coping strategies’ cannot be effective. She commented:
This was a concern that was also occurred in the evaluation study with children and a question for the experts. E3 and E5 (2/6 experts), had some concerns in regards to the effectiveness of the ‘Toolkit Interface: coping strategies’ but they both commented that more functionality can help. P5 commented:

“I think it can help, but it needs more than advice.”

E2, disagreed to this and she remarked:

“I think you have to train them to go and grab this toolkit. I think this is a great way for them, to remind them what they could do if they get upset.”

ii. Suitability of the application for the target population (children aged 6-11 years old)

They all seemed to like the design and the functionality of the application and the average ratings of each interface (Figure 7.1.e) was high. Based on the graph on Figure 7.3 all the interfaces have average rating between 4-5 with the ‘Rewards Interface’ the least favourable and the ‘Menu Interface’ the most favourable. The ‘Reward Interface’ was not liked much but this was something the researcher expected since, as mentioned before, the rewards system was not fully implemented and its functionality was basic. All the experts considered the application appropriate for the target population. E3 remarked that:
“I really like the screens and their design...I think it’s what you typically see for this age group. It just needs a bit of more engagement in terms of games and animations.”

**Suggestions and Areas for Improvement**

Although the experts were satisfied with the application, a software can never be perfect, and therefore they all expressed different suggestions or areas for improvement. The researcher also noted some areas that were unclear or confusing for the experts. Mostly, the experts expressed the same ideas mentioned in the Low-fidelity workshop and marked as ‘Future Work’.

i. **Add interaction when click on coping strategies**

   This was a suggestion mentioned in the Low-fidelity Evaluation and marked as ‘Future Work’. However, it was the topic that was discussed by most of the experts. At first all the experts tried to click on the coping strategies and they realised that there is no functionality. E2, E3, E4, E5 and E6 suggested that the children should be able to click on the coping strategies and see some interaction (5 out of 6 experts). E3 remarked:

   “So I might know that the autistic child has a particular video on YouTube that he really likes that I know that calms him down so I can have that in or maybe he likes a particular show or a joke that always gets him to laugh and then I can just add those things myself and allow him to pick which one he feels at that time he needs. So the ability to add pictures or videos that can be recorded simply from the phone itself would be super good feature to have. ”

   E5 had a similar comment:

   “It doesn’t say much. So maybe if you could click and say a bit more...Maybe you need to include some audio, maybe an option is to listen to a song he likes or pictures or videos of their favourite cartoons.”

ii. **Add functionality for uploading a picture of pet**

   This was also a suggestion mentioned in the Low-fidelity Evaluation and marked as ‘Future Work’. However, it was the topic that was discussed by E1, E4, E6 (3 out of 6 experts). E1 considered that the images of the pet are edited by the practitioner but when she
realised this was not the case she considered this functionality important. E1 commented:

“I think if the child has a pet, they can put their own picture or something like that. I think given more customization its always a good thing.”

iii. Rewards System and the Pet

All the experts liked the ‘Reward Screen’, but they were very disappointed when they did not see any interaction or animation. E1, E2, E5, E6 suggested that there should be a screen containing the rewards the pet gets. E2 commented:

“I wonder, the things that I gave to my pet, are they like saved somewhere?...So I think it is a good thing to have that interaction to make sure that my pet got it or find it somewhere, like how many things I collected.”

iv. Visual Schedules

‘Visual Schedules’ interfaces received a lot of feedback and a variety of different suggestions from the experts in the low-fidelity prototype evaluation and it was the interfaces that was changed the most. In the high-fidelity evaluation more ideas were collected. E3 suggested that there should be a link between the day schedules and task schedules. Specifically, he suggested that a Task schedule can be a part of the Day Schedule where the children can click on and see the sub-tasks. E2 suggested that the schedule can be synchronized with time and automatically alter to Morning, Noon, Evening. E6 mentioned that he would like if he could create new periods of the day rather being predefined to Morning, Noon, Evening. For example, he mentioned that he could add the ‘School Time’ in between ‘Morning’ and ‘Noon’ as a separate category.

v. Others

E1, E2 and E4 commented that the change in the background in ‘Edit Mode’ is an important feature (3 out of 6 experts). However, E5 suggested a password can also be added to surely prevent a child from entering in practitioners-only interfaces. E4 also recommended to connect the application with a web-server where the practitioner can edit or modify the application from another device.

Usability Issues

Some of the usability issues that were observed or commented by the experts were:
1. E2 and E6 mentioned that there should be a sorting mechanism or search bar for the stories and the schedules (2 out of 6 experts). When the Stories and Schedules increase it will be difficult to find a specific one. P6 proposed that task schedules can be organised based on the day of the week and he suggested that they can be grouped into folders.

2. By observing the experts, researcher noticed that 4 out of 6 experts could not notice the scrolling functionality of the ‘Day Schedule’.

3. Another issue identified was the confusion of E1 with the ‘Visual Schedules Interface’. At first sight, she thought that the ‘Task Schedule’ button was associated with the time of the day (Morning, Noon, Evening).

4. Currently the pages and steps in a schedule and a story are distinguished by a number. All the practitioners mentioned that Steps and Pages should have a small description or a title to indicate which part of the schedule or the story each one represent.

### 7.6 Summary

In order to evaluate the High-Fidelity prototype three different evaluation methods were carried out. Firstly, the application was given to first time users (student and staff from the School of Informatics) who were able to freely interact with the application. This study, the feedback survey, intended to gather quantitative data and determine whether the application is attractive and easy to use. It aimed to answer the first sub-question **RQ3.1: Is the new application usable by children with ASD?** All the participants did not find any difficulty in use, although they were not given any instructions and help from the researcher. The results of the online questionnaire also prove that the application was easy to use since the ratings were high. Secondly, an evaluation with 5 TD children was carried out with the aim to answer the second sub-question **RQ3.2: Is the tool perceived as fun and engaging for the target population.** The children found the application very easy to use. However, they were not satisfied with the ‘Rewards System’ the application had and this was something that was mentioned in every study. Lastly, an evaluation with experts on HCI and/or ASD was carried with the aim to answer the third sub-question **Are the activities appropriate to help children with**
autism cope with changes?. Once more, the experts liked the application and considered the methods suitable for the target population. The also considered the application easy to use and effective in helping children with autism cope with changes.

All the participants were very satisfied with the application and they expressed very positive comments. This is also evident from the results of the online questionnaires, since the average ratings from all the studies were high.

By completing all the studies the three sub-questions were answered and therefore, the third research question To what extend does the new technology help children with autism cope with changes? can also be, successfully answered. The results of the evaluation studies show that the application may be effective in helping children with autism cope with changes. However, more evaluation would be necessary for validating the results, since the evaluation sample size was relatively small and children with ASD were not included.
Chapter 8

Discussion, Conclusion & Future Work

This research project explored how technology can be designed and developed with the aim of helping children with autism cope with changes. The project began with a review of the literature in which it was apparent that there is a demand of new technological tools for children with autism and specifically for helping them cope with changes. This formed the motivation behind this project. Three main research questions were set up and drove the structure of this research project. This chapter provides answers to each research question, discusses the limitation of the project and presents the future work directions. Finally it concludes by highlighting the main contributions of this project.

8.1 Research Questions

\textit{RQ1: What are the methods that are used for helping children with autism cope with changes?}

This question has been answered based on the research literature (see Chapter 2) and pre-design studies (see Chapter 4).

First, the literature review showed the methods that are currently being used and the tools that have been developed. Two different methods were identified: the use of visual schedules \cite{5} and the use of Social Stories\textsuperscript{TM}\cite{22}. Previous research showed that the use of Visual Schedules could help children with autism cope with transitions \cite{5}. The literature review also revealed that the Visual Schedules are used to keep track
of changes in the daily routine[32]. On the other hand, Social Stories interventions are mostly used for introducing novel events to children with ASD [22].

A workshop with two TD children was conducted, as discussed in Chapter 3, with the aim of identifying how children react to change and cope with it. At this stage, three experts interviews were conducted with the aim to determine current strategies to help children with ASD cope with changes. The outcome of the interviews showed that the use of Visual Schedules and Social Stories are indeed the methods being used the most. In addition, another method was identified: the use of coping strategies once the change occurs.

Therefore, three methods were identified for helping children with autism cope with changes: Visual Schedules, Social Stories™ and coping strategies.

**RQ2: How should technology be designed to support children with autism cope with changes?**

The answer for this question has been built based on the findings at the following stages: pre-design stage (Chapter 4), low-fidelity evaluation Chapter 6) and high-fidelity prototype evaluation (Chapter 8).

The interviews with the experts and the workshop with children, discussed in Chapter 4, led to a set of requirements and design solutions for an app to support children with autism cope with changes. Based on the outcomes from the literature review, the interviews with experts, the workshop with children and in accordance to the HCI design principles and ASD-specific principles, an initial set of requirements was created.

A low-fidelity prototype was developed which incorporating both users’ experience and relevant research from which the requirements were derived (as described in Chapter 5). An evaluation with three TD children and seven HCI and ASD experts was carried out. The evaluation studies showed that the tool meets the target users’ needs and the goals of the project and improvement suggestions were collected. Based on the outcomes, the set of requirements was updated.

Following the new set of requirements, a high fidelity prototype was developed (Chapter 6) and then evaluated by experts in HCI and ASD, as well as with TD children (Chapter 7). The tool was also evaluated by 29 staff members and students from the
University of Edinburgh, School of Informatics, who gave general feedback and suggestions for improvement in regards to the usability (Chapter 7).

To conclude, all these studies helped design and improve a high-fidelity prototype app (“ChangeItApp”) which was then used in the summative evaluation. This evaluation revealed that the “ChangeItApp” has potential in supporting children with ASD to cope with changes (see next the answer for RQ3)

RQ3: To what extend does the new technology help children with autism cope with change?

To answer this questions, 3 sub-questions were carried as follow:

Is the new application usable by children with autism? The finding of the feedback survey discussed in Chapter 7 and the evaluation studies with children and experts discussed in both Chapter 7 and Chapter 8, intended to evaluate the usability of this application. The majority of the participants considered the application usable. In the feedback survey the participants agreed that the application was easy to use and all of them could navigate through the application without instructions. Those participants were first-time users and they were asked to explore the application freely. The results showed that the participants were able to navigate through the application without help and instructions. The same happened with the evaluation with experts and children. All the participants could navigate easily through the application without the need for the researcher to intervene or to tell them what to do. All of them completed all the tasks really quickly without any major errors or confusion.

Is the tool perceived as fun and engaging for the target population? This questions was answered in the evaluation studies with children in both Chapter 5: Low-Fidelity Prototype Evaluation and Chapter 7: High Fidelity Prototypes Evaluation. Overall, the children seemed to enjoy the tool. Once they were presented the application, they showed signs of the excitement and they immediately started to navigate through the application. This impatience to immediately start interacting with the application shows that the application attracted their curiosity. Also, the children were excited when they saw the reward system and they tried it several times in order to choose a different one each time. This shows that the children were having fun and were engaged to the application.
**Are the activities appropriate to help children with autism cope with changes?**

This questions was answered after the evaluation studies with children and experts in Chapter 7: High Fidelity Prototypes Evaluation. All the experts agreed that the methods being used fulfil the project goals and they are appropriate in helping children with autism cope with changes. The experts also agreed that the application was very easy to use and suitable for the target population. Only a concern was drawn, from both children and experts on the effectiveness of coping strategies. Some experts considered that might not serve its purpose, however none of them considered the method inappropriate. Instead, they suggested ideas on how this method can be improved.

It is important to mention that this project did not involve children on ASD which is the target population. Any conclusions drawn by the evaluation with TD children should be taken with caution when talking about children with ASD. Nonetheless, an evaluation with children on ASD would bring more clarification in answering the RQ3 question. However, the outcomes of all the studies revealed that the ‘ChangeItApp’ might have potential in aiding children with autism cope with changes, is easy to use and fun and engaging.

### 8.2 Limitations

Due to the limited time available for this research project, the access to practitioners and children with autism was limited. Although, the research involves TD children and experts in every stage, it was not possible to carry evaluation studies with autistic children. Also, only few practitioners and children participated in the evaluation studies because it is very difficult to find many participants in this limited time frame. Moreover, the tool was not evaluated on whether it helps children with autism cope with changes as this kind of evaluation requires a long process with with many autistic children. Due to the time and resources limitation this could not be directly evaluated.

In addition to this, the tool was not implemented to the extend it should have been. The time did not permit the implementation of a fully working app and to incorporate all the requirements. Therefore, a number of requirements based on the suggestions from experts in the low-fidelity evaluation marked as future work.

However, based on the resources available and the time available, it was proved that
the tool is appropriate in helping children with autism cope with changes.

8.3 Future Work

As mentioned before, due to the time limitation, many of the suggestions were marked as ‘Future Work’. These suggestions were considered important for further development and therefore they are presented in this section. Based on the results of the evaluation studies, the tool provides the base of a fully functioning application that can be fun, enjoyable, easy to use and able to help children with autism cope with changes. In order to accomplished this, new features can be added. Based on the results from the evaluation studies, the followings can be added:

- A fully functioning reward system.
  This suggestion requires more research in regards to the preferences of children on games. The reward system can contain several games or even be edited by the practitioner.

- More interaction with the coping strategies.
  As mentioned in Chapter 7, the application should allow the practitioners to add videos, music, pictures for the children.

- Add the option to edit the ‘Pet’.

- Add more animation and video for the pet

- Animate the Social Story™ in order to be more realistic.

- Add a large library with graphics for the user to choose.

- Add a pin to distinguish ‘Edit Mode’ with ‘Play Mode’.

- Make the application possible to be modified by another device.
  Another suggestion is to make the application connected to a server instead of a local database and therefore, the practitioner can edit the application from another device. This can also help the practitioners in the school environment. If they want to edit the application for multiple children, then they should be able to do it from one device rather than the specific one for each child.

- Add text-to-speech functionality.
• Link the Task Schedules with the Day Schedule.

• Add the monthly schedule instead of the day schedule.

• Add colour theme palette

An advantage of this application is the ability to be fully customised based on the child. As a result, the Social Stories™ are not only created to help children cope with changes since it provides the flexibility to the users to add their own context. As part of Future Work, involving the specific application in more areas, in regard to children with autism, should be considered.

Another important part of future work, is the evaluation of the tool with children with autism as this was not possible for this project. Further evaluation on the effectiveness and suitability of the application should carried with children on ASD.

8.4 Conclusion

This project explored how a technology-based tool can be designed and developed to help children with autism cope with changes. A prototype app ("ChangedItApp") has been developed and evaluated in an iterative way, using a UCD approach which involved TD children, experts in HCI and ASD, and practitioners. The results from three evaluations studies revealed that "ChangeItApp” can be used by children with ASD to prepare for changes and manage the difficulties during changes. Moreover the results from evaluation brought out a series of improvement suggestions which can be used in further development of the app into a fully functioning and effective tool for supporting children with autism cope with changes. To conclude, this project brought a number of contributions as follows:

• identification of the methods for supporting children with ASD cope with changes (based both on research and practice)

• a design solution for a new app, ”ChangedItApp”, to aid children with ASD cope with changes

• the implementation and evaluation of ”ChangeItApp” to be used by children with ASD prepare for changes and manage during the changes
• empirical evidence from the evaluation of the ”ChangeItApp” with TD children, experts in HCI and ASD, and practitioners that indicate that this may help children with ASD cope with changes.
Bibliography


[9] Stephen A Crutchfield, Rose A Mason, Angela Chambers, Howard P Wills, and Benjamin A Mason. Use of a self-monitoring application to reduce stereotypic


Appendix A

Criteria for Social Stories

Taken from Gray (2010)

**Criterion 1: The Social Story Goal**
Authors follow a defined process to share accurate information using a content, format, and voice that is descriptive, meaningful, and physically, socially, and emotionally safe for the Audience.

**Criterion 2: Two-Step Discovery**
Keeping the Goal in mind, authors gather relevant information to 1) improve their understanding of the Audience in relation to a situation, skill, or concept and/or 2) identify the specific topic(s) and the most critical information (focus) of each Story.

**Criterion 3: Three-Parts & a Title**
A Social Story/Article has a title and introduction that clearly identifies the topic, a body that adds detail, and a conclusion that reinforces and summarizes the information.

**Criterion 4: Format Makes it Mine!**
The Social Story™ format is tailored to the individual abilities, attention span, learning style and talents and/or interests of its Audience.

**Criterion 5: Five Factors Define Voice & Vocabulary**
A Social Story has a patient and supportive ‘voice’ and vocabulary that is defined by five factors:

1. First or Third person perspective statements
2. Past, present, or future tense;
3. Positive and patient tone;
4. Literally accurate; and
5. Accurate meaning.

**Criterion 6: Six Questions Guide Story Development**
A Social Story answers relevant WH questions that describe context, including place (WHERE), time-related information (WHEN), relevant people (WHO), important cues (WHAT), basic activities, behaviors, or statements (HOW), and the reasons or rationale behind them (WHY).

**Criterion 7: Seven is About Sentences**
A Social Story is comprised of Descriptive Sentences and may also have one or more Coaching Sentence(s). Descriptive Sentences accurately describe relevant aspects of context, including external and/or internal factors while adhering to all applicable Social Story Criteria. They are free of assumption or bias, judgment, devaluation, or unidentified opinion Coaching Sentences gently guide behavior via descriptions of effective Team or Audience responses, or structured Audience Self-Coaching, adhering to all other applicable Social Story Criteria.

**Gr-Eight! Formula** The Social Stor™ Formula ensures that every Social Story describes more than directs.

**Criterion 9: Nine to Refine**
The first draft of a story is rarely the final draft. A story draft is always reviewed by relevant caregivers and revised if necessary to ensure that it meets all defining Social Story criteria.

**Criterion 10: Ten Guides to Editing and Implementation**
The Ten Guides to Implementation ensure that the philosophy and Criteria that guide Story/Article development are consistent with how it is introduced and reviewed with the Audience. They are:

1. Plan for Comprehension
2. Plan Story Support
3. Plan Story Review
4. Plan a Positive Introduction
5. Monitor
6. Organize the Stories
7. Mix & Match to Build Concepts
8. Story Re-runs and Sequels to Tie Past, Present, and Future

9. Recycle Instruction into Applause

10. Stay Current on Social Story Research and Updates
Appendix B

Ethics Forms

Part C

Ethical Review Procedures: Level 1

Project Details & Self-assessment

This document is closely modelled on documents used in School of Philosophy, Psychology and Language Sciences provided by Ellen Bard and Cedric MacMartin.

This form is to be filled in and submitted at the same time as the project proposal or the funding application it applies to. The form should be submitted by the Principal Investigator, except in the following cases:

- Post-doctoral fellowships – the proposed postdoc mentor.
- UG, MSc, and PhD research projects – the supervisor.
- Visiting researcher – the staff hosting the visitor.

Please submit the completed form by email to: infkm+ethics@inf.ed.ac.uk

This address, with appropriate RT number once issued, should be used for all correspondence (including forms and attached documents). This is essential to ensure proper record keeping. No signature is required if the form is sent from a valid University email address.

Project Details

➢ Type Of Project:
  - ☐ Research grant proposal
  - ☒ UG final year project
  - ☐ MSc project
  - ☐ Post-doctoral fellowship
  - ☐ PhD project
  - ☒ Research performed by visiting researcher
  - ☑ Personal research
  - ☐ Other: ______________

➢ Is there a sponsor/ funding body? YES / NO

➢ Does the sponsor/funder require formal prior ethical review? YES / NO

If yes, by what date is a response required?

➢ Is any other institution and/or ethics committee involved? YES / NO

If YES, give details and indicate the status of the application at each other institution or ethics committee (i.e., submitted, approved, deferred, rejected):

➢ Title of Project:
  - Designing and developing a technology-based tool to help children cope with changes

➢ Researchers' names, affiliations, emails
  - Supervisor: Aurora Constantin, School of Informatics, aurora.constantin@ed.ac.uk
  - Supervisor, Dr. Cristina Alexandru, School of Informatics, Cristina.Alexandru@ed.ac.uk
  - Undergraduate Student: Vivian Varnava, School of Informatics, s1546508@ed.ac.uk
State which professional organisation guidelines you are using:

- School of Informatics research ethics code: http://www.inf.ed.ac.uk/research/ethics/
- Other ethics code as required by funding body or professional organization:
  Title: ___________________________
  URL: ___________________________
Self-assessment
Refer to Level 2 form for details on any of the following points.

1. Protection of research participants’ confidentiality
   Are there any issues of CONFIDENTIALITY which are NOT ADEQUATELY HANDLED by normal tenets of academic confidentiality? YES / NO
   These include well-established sets of procedures that may be agreed more or less explicitly with collaborating individuals/organisations, for example, regarding:
   (a) Non-attribution of individual responses;
   (b) Individuals and organisations anonymised in publications and presentation;
   (c) Specific agreement with respondents regarding feedback to collaborators and publication.

2. Data protection and consent
   Are there any issues of DATA HANDLING AND CONSENT which are NOT ADEQUATELY DEALT WITH, and compliant with established procedures? YES / NO
   These include well-established sets of procedures, for example regarding:
   (a) Compliance with the University of Edinburgh’s Data Protection procedures (see http://www.recordsmanagement.ed.ac.uk);
   (b) Respondents giving consent regarding the collection of personal data (via consent form).

3. Significant potential for physical or psychological harm, discomfort or stress
   Are there any risks of:
   (a) psychological harm or stress for the participants? YES / NO
   (b) physical harm or discomfort for the participants? YES / NO
   (c) any kind to the researcher? YES / NO

4. Vulnerable participants
   Are any of the participants in the research vulnerable, e.g., children, patients, disabled participants? YES / NO

5. Moral issues and researcher/institutional conflicts of interest
   Are there any SPECIAL MORAL ISSUES/CONFLICTS OF INTEREST? These include:
   (a) Conflict of interest: potential benefit to the researcher, friends or family of a particular research outcome which might compromise the researcher’s objectivity or independence;
   (b) The need to keep the purposes of research concealed;
   (c) Use of participants who are unable to provide informed consent (e.g., children);
   (d) Situations where research findings would impinge negatively/differentially upon the interests of participants. YES / NO

6. Bringing the University into disrepute
   Is there any aspect of the proposed research which might bring the University into disrepute? For example, could any aspect of the research be considered controversial or prejudiced? YES / NO

7. Use of animals
   Does the research involve animals? YES / NO

8. Developing countries
   Does the research involve developing countries? YES / NO

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9. **Dual use**
   Is the research classified or does it have specific adversarial military applications?  YES / NO

10. **Terrorist or extremist groups**
    Does your research concern groups which may be construed as terrorist or extremist?  YES / NO

**Can you stop now?**

You may want to assure yourself that your ‘NO’ answers are correct by checking the detailed form in the next section.

If all the YES / NO answers are NO, the self assessment has been conducted and confirms the ABSENCE OF REASONABLY FORESEEABLE ETHICAL RISKS. This form should be signed by the researchers and submitted. The researchers may retain a copy for their own records.

If any answer is YES, please complete the relevant section in the Level 2 form below.
Ethical Review Procedures: Level 2

Detailed Assessment

This material should help you answer the questions in the self-assessment form.

If any difficulties arise, you should fill in the relevant parts of this form in consultation with a near colleague who is not directly involved with the research. You can also seek advice from members of the School Ethics Panel, or from relevant Ethics Committees of other schools.

You should file a new form if you receive advice on changes from the School or College Ethics Committees. For accountability, the School will view the most recent submission as accurate.

1. Protection of research participants' confidentiality

Refer to the University Data Protection Policy to ensure that the relevant conditions relating to the processing of personal data under Schedule 2 and Schedule 3 are satisfied. Details are available at: http://www.recordmanagement.ed.ac.uk.

1. If the research requires the collection of personal information from e.g., universities, schools, employers, or other agencies about individuals without their direct consent, what information will be sought and why will written consent for access to this information not be obtained from the participants themselves?

➢ N/A

2. If any part of the research involving participants will be recorded using any electronic medium, what medium is to be used and how will the recordings be used?

➢ The participants will be video/audio recorded using a camera or an audio recorder, such as telephone and laptop. The participants will be:

  • children who are going to be video recorded in workshops (evaluating the prototype and the working tool).
  • Researchers/Parents/Practitioners who will use a prototype and express their suggestions (workshop, interviews, surveys)
  • Researchers/Parents/Practitioners who are going to be recorded in interviews.

The recordings will be stored on a password-protected computer accessible only by the researchers. The data will be used only for analysis or used in publication in the honours project, with participants’ consent. Consent forms and other files will be kept in locked filing cabinets.

3. Who will have access to the raw data?

➢ The student conducting the research, Vivian Varnava and the supervisor of the project, Aurora Constantin.

4. If participants will be identified in your records, how will their consent to quotations/identifications be sought?
2. Data protection and consent

Participants have the following rights over observations and records of their own behaviour:

- If they are engaging in any activity outside their normal daily routine (for example answering a questionnaire, listening for a particular syllable), they must be given some account of what they will be asked to do before they start, and must formally consent to participation;
- In any event, if they will be observed or recorded, they must be informed of and consent to the kinds of record taken;
- They must be assured of anonymity in any publication or dissemination;
- They must consent to how the data will be used;
- They must be free to withdraw from participation at any time.

1. Explain how and when written consent will be obtained from participants or from those responsible for participants unable to consent meaningfully on their own behalf. (If further discussion of this form is needed, please attach a copy of any information sheets and consent forms.)
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➢ For Interview: The participants will be contacted by email with the information sheet and consent form attached. The information sheet will have a clear description of the project and information about the interview stating that participants will be audio and/or video recorder.

Workshop: Because workshop will involve children, the guardian/parent must give a formal consent form. The parent will be provided with 2 consent forms and 2 information sheets (one for the parent and one for the children). The parent will be contacted by email in advance inviting their child to participate. The documents will be attached in the email, so the parent will have enough time to read the information sheet and decide whether they want their child to participate. The information sheet will have a clear description of the project and what is requested from their child in the workshop. It will also state that the children will be video or audio recorded but the anonymity will be preserved. An information sheet and a consent form will be given to the child and asked if he/she is willing to participate. The consent form and information sheet will be written in simple language and have a brief description of what they are required to do in the workshop. In order for a child to participate consent forms from both parent/guardian and child must be taken. Even if a parent allows their child to participate but the child is not willing to participate, then his/her choice will be respected.

2. If participants cannot meaningfully provide formal consent in this way, normally someone who is legally able to act on their behalf, for example a parent or legal guardian, must do so. If any of the following cases apply, explain how you will obtain the necessary consent and if you will not, how you can proceed ethically without doing so.

● administrative consent in lieu of participants’ consent

   (Administrative consent may be deemed sufficient:
   i. where the data collection involves aggregated statistical information and where the collection of data presents no invasion of privacy and no potential social or emotional risks:
   ii. where studies focus on the development and evaluation of curriculum materials, resources, guidelines, test items, or programme evaluations rather than the study, observation, and evaluation of individuals.)

● the consent of parents on behalf of minors,

➢ Parents will be given an information sheet containing all the information needed for the project and contact details for further questions. Additionally, they will be provided with a consent form that they have to complete if they allow their child’s participation. In the consent form, they can also indicate whether they allow their child’s pictures to be published.

● the consent or assent (at least verbal) of minors,

➢ Minors will be provided with a different information sheet and consent form
that is written in a way suitable for their age.

- the consent of participants who do not share a language with the researcher,
- the consent of participants with special educational needs.

3. Significant potential for physical or psychological harm, discomfort or stress

- If the research could induce any psychological stress or discomfort, state the nature of the risk and what measures will be taken to deal with such problems.

- If the research requires any physically invasive or potentially physically harmful procedures, give details and outline procedures to be put in place to deal with potential problems.

- If the research involves the investigation of any illegal behaviour, give details.

- If there is a real risk of disclosure of activities which should be reported to the authorities, a warning to this effect must be included in the Informed Consent documents. Please provide the wording of this warning.

If there is any purpose to which the research findings could be put that could adversely affect participants, describe the potential risk for participants of this use of the data. Outline any steps that will be taken to protect participants.

If the research could adversely affect participants in any other way, give details and outline procedures to be put in place to deal with such problems.

If the research could adversely affect particular groups of people, describe these possible adverse effects and the protection to be put in place against them.

If the true purpose of the research will be concealed from the participants, explain what information will be concealed and why.

If participants will NOT be debriefed at the conclusion of the study, explain why not.

➢ N/A to all the above

4. Vulnerable participants

What criteria will be used in deciding on the inclusion and exclusion of participants in the study?

Parents/Guardians will be contacted in advance by email and asked if their child would like to participate. In the email the 2 information sheets and 2 consent forms will be attached so the guardian will have time to read and take a decision for their child’s participation. All the children are welcomed to participate if both parent/guardian and child sign the consent forms and accept that the child is going to be video recorded. Any children can be included in this study.

If any of the participants are likely to be in any of the following vulnerable categories, indicate the category and describe the measures that will be used to recruit, protect and/or inform participants:
If participants will receive any financial or other material benefits because of participation, what benefits will be offered to participants and why?

➢ N/A

5. Moral issues and researcher/institutional conflicts of interest
The University has a draft ‘Policy on the Conflict of Interest’. Regarding research the draft states that a conflict of interest would arise in cases where an employee of the University might be

“... compromising research objectivity or independence in return for financial or non-financial benefit for him/herself or for a relative or friend...”

The draft policy also states that the responsibility for avoiding a conflict of interest, in the first instance, lies with the individual, but that potential conflicts of interest should always be disclosed, normally to the line manager or Head of Department. Failure to disclose a conflict of interest or to cease involvement until the conflict has been resolved may result in disciplinary action and in serious cases could result in dismissal.

If your research involves a conflict of interest or any situation which could be construed as a conflict of interest, please give details.

➢ N/A

6. Bringing the University into disrepute
If on the level 1 form you have answered that some aspect of the proposed research “might bring the University into disrepute”, please elaborate alongside how this might arise, and what steps will be taken by the researcher to mitigate and manage this, to minimise adverse consequences to the University.

➢ N/A

7. Use of animals [based on EU FP7 guidelines]
If the proposed research will use animals, please provide the following information:
1. Describe how you have applied the 3Rs: Reduction, Replacement, Refinement.
2. Describe and justify:
   • species and numbers of animals used;
   • humane end points
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and pain and suffering;
3. Describe how you have explored alternatives to using animals.
4. Answer the following questions:
   • transgenic small laboratory animals?
   • transgenic farm animals?
   • cloning farm animals?
   • non-human primates?

➢ N/A

8. Developing countries [based on EU FP7 guidelines]
Questions to consider include:
1. Does the research project provide benefit to the local community (in terms of access to healthcare, education, allocation of property rights, capacity to assess and use modern technologies while respecting the population’s own choices and needs, etc.)?
2. Does the research project use local resources (genetic resources, animals, and plants)?

How to deal with research involving developing countries
The categories of issues requiring special attention include:
   • A disproportionately heavy burden of diseases (particularly infectious diseases); the breadth and depth of poverty; and high levels of illiteracy
   • Wide disparities in health systems and in access to health care; and imbalance between the often-ample resources available for research and the meagre resources available for even basic health care
   • Inadequate scientific and ethics infrastructures for the required reviewing process
   • The extent of disempowerment of the poor in their personal and communal lives
   • Knowledge of the ways in which people of other cultures traditionally view themselves as individuals embedded in communities with respect to the changing boundaries between perceptions of the self that differ from the classical western notion
   • The need to understand what it means to be ill in contexts very different from those known to researchers and what can be expected from those one consults for help under those circumstances

➢ N/A

9. Dual use [based on EU FP7 guidelines]
1) What is considered as potential dual use
Generally speaking, dual use is a term often used in politics and diplomacy to refer to technology which can be used for both peaceful aims and adversarial military aims. Ethical issues of dual use might arise in cases where:
   (d) Classified information, materials or techniques are used in research;
   (e) Dangerous or restricted materials e.g. explosives are used in research;
   (f) The specific results of the research could present a danger to participants, or to society as a whole, if they were improperly disseminated.
2) How to deal with potential dual use
Regarding implications for the use of and misuse of the research and products, the following measures and strategies can be applied:

(c) The researcher should show awareness of potential risks to participants and society as a whole from inappropriate dissemination of their results;
(d) Appropriate measures to deal with dangerous or restricted materials should be detailed, where applicable;
(e) An appropriate strategy to deal with issues of informed consent and risk management for participants and for society where classified information, materials or techniques are concerned should be demonstrated;
(f) An advisory board should be included in the project, which should identify risks to participants from particular research activities and devise a strategy for minimising and dealing with these risks;
(g) The dissemination and communication strategy of the study results to a wider audience should be controlled by the advisory board, which should report to the relevant funding body on a regular basis.


➢ N/A

10. Terrorist or extremist groups
If your research concerns groups which may be construed as terrorist or extremist, please fill in the following form and submit it with your ethics form.

➢ N/A

Prevent Duty supplementary form
The Terrorism Act (2006) outlaws the dissemination of records, statements and other documents that can be interpreted as promoting or endorsing terrorist acts.

1. Does your research involve the storage on a computer of any such records, statements or other documents? Yes / No
2. Might your research involve the electronic transmission (e.g. as an email attachment) of such records or statements? Yes / No
3. If you answered ‘Yes’ to questions 1 or 2, you are advised to store the relevant records or statements electronically on a secure university file store. The same applies to paper documents with the same sort of content. These should be scanned and uploaded. Access to this file store will be protected by a password unique to you and your School Research Ethics Officer. Please indicate below that you agree to store all documents relevant to questions 1 and 2 on that file store:

   Yes
3a. Please indicate below that you agree not to transmit electronically to any third party documents in the document store:

   Yes
4. Will your research involve visits to websites that might be associated with extreme, or terrorist, organisations? Yes / No
5. If you answer ‘Yes’ to question 4, you are advised that such sites may be subject to surveillance by the police. Accessing these sites from university IP addresses might lead to police enquiries. Please acknowledge that you understand this risk by putting an ‘X’ in the ‘Yes’ box.

24/3/19
6. By submitting to the ethics process, you accept that your School Research Ethics Officer and the convenor of the University’s Compliance Group will have access to a list of titles of documents (but not the contents of documents) in your document store. Please acknowledge that you accept this by putting an ‘X’ in the ‘Yes’ box.

Countersigned by supervisor/manager

➢ N/A to all the above
Appendix C

Interview Information Sheet and Consent Form

Information Sheet for Researchers

"Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes"

This information sheet contains information about the research project of the University of Edinburgh in which you are invited to participate. After reading the information you are asked to fill the consent form accepting your participation in the interview. If you have further questions do not hesitate to contact us and discuss them with us.

RESEARCHES AND CONTACT INFORMATION

Miss Vivian Varnava, lead researcher  
s1546508@sms.ed.ac.uk  +44 (0) 7821102794

Dr. Aurora Constantin, supervisor  
aurora.constantin@ed.ac.uk  +44 (0) 131515643

Dr. Cristina Alexandru, supervisor  
Cristina.Alexandru@ed.ac.uk  +44 (0) 7944116937

University of Edinburgh,  
School of Informatics,  
Informatics Forum,  
10 Crichton Street,  
Edinburgh,  
EH8 9AB

If you accept to participate, please return the consent form to one of the researchers

PROJECT OVERVIEW

I, Vivian Varnava, am currently a fourth-year student at the University of Edinburgh, studying towards my bachelor’s degree in Computer Science. As part of my honours project I am working on the design and implementation of a technology-based tool which will help children with autism cope with changes.

The study is part of an undergraduate project. Conducting the research will not bring any financial benefit to the researchers or to the university.

What are the goals of the project?

Rigidity in behaviour and thought is one of interests the three core symptoms of autism. That could be reflected in tendency to perform monotone activities for a long period of time, as well as in limited and stereotyped patterns of behaviour and
interests. The world seems unbearably chaotic and confusing for individuals with autism because of its unpredictability. Therefore, they often prefer to follow routines to bring order in their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

Since children with autism are attracted to technology, the goal of the project is to explore how a technology-based tool should be designed, for supporting them to cope with different changes in their daily lives.

**INTERVIEW INFORMATION**

In this interview, we would be grateful for your help to gather requirements for a technology-based tool that will help children on autism spectrum cope with changes. You are going to be asked a series of questions about this topic including challenges that children encounter when facing changes, and procedures used to help them cope with such changes. In addition, we will ask for your suggestions about how a technology-based tool could help children deal with changes.

We would like to audio record the session, with your permission, to provide a record for later analysis. If you do not agree with being audio recorded, we will take notes instead.

**AFTER THE INTERVIEW**

After the interview has finished and we have analysed the information we collected, it will be used to design the technology-based tool, and eventually implement it. The results will be summarised in an undergraduate dissertation. The data and findings may be shared or presented in scientific journals or conferences.

**PERSONAL DATA AND PRIVACY**

Confidentiality is extremely important to us. Recordings and other information will be stored safely on password-protected computers or in locked cabinets. Access will be limited to the people involved in the research (listed above).

**WOULD YOU LIKE TO PARTICIPATE?**

This study is completely voluntary, and you are under no obligation to take part. We ask you to read the information sheet, so you can make an informed decision about whether you would like to take part.

Thank you for taking the time to read this.

If you would like to know more about this research and/or if you have questions, please contact one of the main researchers listed above.
Interview Consent Form for Researchers

Have you read the information sheet? YES / NO

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

Do you understand that participation is completely voluntary, and that you can stop the interview 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 recording.

I AGREE to be audio-recorded during the interview and I understand that the tapes will be stored and used by the researchers involved in the study YES/ NO

If you give permission for this study, please return this form to me. By signing YOU AGREE with the above information and understand what is being requested by participating in the interview.

Full name (to appear of certificate): _______________________________________

Contact telephone number: ________________________________________________

E-mail address: __________________________________________________________

Signature: Date: ______/_____/______

__________________
Appendix D

Child Information Sheet and Consent Form

Child Information Sheet

*Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes*

---

This page is for children

A group of researchers from the University of Edinburgh are organising a workshop at University of Edinburgh. This document says who they are, and what they will do during the workshop. The researchers invite you to participate in the workshop to help them design an app to support children on ASD to deal with changes. After you read this document you can decide whether you would like to participate or not. You can also change your mind at any time without giving us any explanation.

---

WHO IS ORGANISING THE EVENT?

We are Vivian, Aurora and Cristina. Our job is to develop technology-based tool for children. We invited you in the workshop because we need your help to develop a technology-based tool to help children cope with changes. Your ideas will be much appreciated.

---

HOW CAN I HELP?

Some things can be harder for certain kids to do than other kids, like making friends, talking, or dealing with changes in plans. We would like to design a technology-based tool to help those children cope with changes. We think that children are capable to become software designers and they must be involved when designing technology for them. So, we ask you to help us understand what children like and don’t like about changes in their everyday life and how technology could help them deal with changes.
WHAT WILL HAPPEN IF I HELP?

When you arrive, you will be given a list of activities, like a timetable so that you know what happens and when. First, we will get to know each other, through a short warm up game. After that, you will participate in certain activities, such as drawing and playing with cards. These are meant to help us build a technology-based tool for children who have difficulties with changes. Remember, we would greatly appreciate if you tell us how children would prefer this technology-based tool to look like.

You can tell us to stop any of the activities at any time. Also, please tell us if you need the toilet, or if you want to take a break. In case you don’t want to help us anymore or feel tired you can say that in any moment. You don’t need to give us an explanation. We will always listen to you.

We will ask if it is OK to make an audio recording of you helping design the technology-based tool, doing activities and answering questions. This is because it is too hard for us to write down everything that happens. We will listen to the recording later to help us understand what you said, or your ideas for the technology-based tool.

WHAT WILL HAPPEN AFTER I FINISHED HELPING?

We will learn a lot from you about what children like and dislike about changes, and how technology could help, after hearing your opinion and looking at your drawings. We will write about what we have learnt, and we will use your ideas to design the technology-based tool.

DO YOU WANT TO ASK A QUESTION?

It is ok to ask us as many questions as you want. We are here to listen to you and answer any questions you have. You can also call your mum or dad anytime. You can ask us help if you find anything difficult while you are working on the activities.

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

Do you want to be a software designer? You can say “yes” or “no”. It is OK to say “no”. We will listen to you without asking for explanations.
Child Consent Form

I can choose to participate in the workshop.

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 help anymore.

It is okay if some activities are hard for me!

There are no wrong answers to questions.

Anything I do is helpful.

Do you want to design a technology-based tool to help children deal with changes? YES ☐ NO ☐

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

We will listen to the recordings later to help us design the technology-based tool.

Is it ok to use images of you as examples in documents and presentations for research and/or teaching purposes? YES ☐ NO ☐

Write your name: ________________________________ and age: _________

VIVIAN, AURORA AND CRISTINA WILL BE VERY HAPPY IF YOU PARTICIPATE
Appendix E

Certificate of Participation Pre-Design stage
## Appendix F

### A3 Paper for children - Pre-Design stage

#### Holiday

<table>
<thead>
<tr>
<th>Activities I Like</th>
<th>Activities I DON'T Like</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### School Day

<table>
<thead>
<tr>
<th>Activities I Like</th>
<th>Activities I DON'T Like</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a)  
(b)
Appendix G

Parent Information Sheet and Consent Form - Pre-Design Stage

Parent/Guardian Information Sheet

Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes

This information sheet contains information about the research project of the University of Edinburgh in which your child is invited to participate. After reading the information sheet you are asked to fill the consent form accepting your child’s participation in the workshop. If you have further questions do not hesitate to contact us and discuss them with us.

RESEARCHES AND CONTACT INFORMATION

Miss Vivian Varnava, lead researcher
s1546508@sms.ed.ac.uk
+44 (0) 7821102794

Dr. Aurora Constantin, supervisor
aurora.constantin@ed.ac.uk
+44 (0) 131515643

Dr. Cristina Alexandru, supervisor
Cristina.Alexandru@ed.ac.uk
+44 (0) 7944116937

University of Edinburgh,
School of Informatics,
Informatics Forum,
10 Crichton Street,
Edinburgh,
EH8 9AB

If you accept to participate, please return the consent form to one of the researchers

PROJECT OVERVIEW

I, Vivian Varnava, am currently a fourth-year student at the University of Edinburgh, studying towards my bachelor’s degree in Computer Science. As part of my honours project I am working on the design and implementation of a technology-based tool which will help children with autism cope with changes.

The study is part of an undergraduate project. This research will not bring any financial benefit to the researchers or to the university.

What are the goals of the project?

Rigidity in behaviour and thought is one of the three core symptoms of autism. That could be reflected in tendency to perform monotone activities for a long period of
time, as well as in limited and stereotyped patterns of behaviour and interests. The world seems unbearably chaotic and confusing for individuals with autism because of its unpredictability. Therefore, they often prefer to follow routines to bring order in their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in daily routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

Since children with autism are attracted to technology, the goal of the project is to explore how a technology-based tool should be designed to support them to cope with different changes in their daily lives.

**What is the purpose of this study?**

This study will be organised as a workshop, during which your child will attend different activities and help us gather requirements for the technology-based tool mentioned above. We are interested in what they like and do not like about changes, and how a technology-based tool could help them overcome the difficulties caused by changes.

**WORKSHOP INFORMATION**

**What happens during the workshop?**

We will spend time before the workshop session to talk to the children to know them better and to allow them to know us. We will use some treats to help them feel comfortable and create an enjoyable environment. Then, they will participate in certain activities in our workshop, such as drawing and playing with cards. Finally, they are going to describe their feelings regarding changes and explain their design choices. The workshop will last for about 30-40 minutes.

**Audio Recordings**

During the workshop, we would like to audio record your child to provide us a record for later analysis. That will also allow us to freely interact with your child during the session without worrying about taking notes. *If you are not comfortable with your child being audio recorded at all, then your child should not participate in this study.*

We would also like to take some pictures while your child is working. We may use them, as well as the data collected from this workshop for publications, presentations or teaching purposes. If you feel uncomfortable for us to use the pictures of your child for publications, presentations or teaching purposes please indicate that on the consent form.

**Will this project teach your child new skills?**

We will not be teaching children new skills or improving existing skills. We are rather interested in your child’s feelings about changes, and opinions as to how technology could help cope with changes.
AFTER COMPLETION OF THE WORKSHOP

What will happen when the project is over?

After the workshop has finished and we have analysed the information we collected, it will be used to design the technology-based tool, and eventually implement it. The results will be summarised in an undergraduate dissertation. The data and findings may be shared or presented in scientific journals or conferences. We never share children’s names, schools or other personal information.

Personal data and Privacy

Confidentiality is extremely important to us. Recordings and other information (such as forms with children’s names) will be stored safely on password-protected computers or in locked cabinets. Access will be limited to the people involved in the research (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 or birth date).

This project has undergone ethical screening in accordance with the University of Edinburgh School of Informatics ethics process.

WOULD YOU LIKE TO PARTICIPATE?

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 he/she does not want to be a software designer any more. We will check that the child agrees to participate to this workshop, be audio recorded and/or be photographed. Even if you say “yes” on the consent form, your child may still say “no” if he/she does not want to participate in this workshop. We will respect your child’s decision.

Thank you for taking the time to read this.

If you have questions or concerns prior, during or after your child’s participation about this research please contact one of the main researchers listed above.
Parent/Guardian Consent Form

Have you read the information sheet? 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. By signing, you agree that the researchers may explain the study to your child and invite him or her to take part in this workshop.

I AGREE that my child will be audio-recorded during the workshop and I understand that the tapes will be stored and used by the researchers involved in the study YES/ NO

With reference to further anonymous use of photographic data, please circle yes or no in response to the following:

I AGREE that short pictures 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 return this form to the researchers. If you DO NOT wish to participate, you do not need to return this page. By signing YOU AGREE with the above information and understand what is being requested by letting your child to participate. You will be provided with a copy of this form.

Full name of child (to appear on certificate): ____________________________
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: _____/_____/

____________________________
Appendix H

Expert Information Sheet and Consent Form - Low-Fidelity Prototype

Information Sheet for Researchers
Evaluation of a low-fidelity Prototype
Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes

This information sheet contains information about the research project of the University of Edinburgh in which you are invited to participate. After reading the information you are asked to fill the consent form accepting your participation in the evaluation workshop. If you have further questions do not hesitate to contact us and discuss them with us.

RESEARCHES AND CONTACT INFORMATION

Miss Vivian Varnava, lead researcher  Dr Aurora Constantin, supervisor  Dr Cristina Alexandru, supervisor
s1546508@sms.ed.ac.uk  aurora.constantin@ed.ac.uk  Cristina.Alexandru@ed.ac.uk
+44 (0) 7821102794  +44 (0) 131515643  +44 (0) 7944116937

University of Edinburgh, School of Informatics, Informatics Forum, 10 Crichton Street, Edinburgh, EH8 9AB

If you accept to participate, please return the consent form to one of the researchers

PROJECT OVERVIEW

I, Vivian Varnava, am currently a fourth-year student at the University of Edinburgh, studying towards my bachelor's degree in Computer Science. As part of my honours project I am working on the design and implementation of a technology-based tool which will help children with autism cope with changes.

The study is part of an undergraduate project. Conducting the research will not bring any financial benefit to the researchers or to the university.

What are the goals of the project?

Rigidity in behaviour and thought is one of the three core symptoms of autism. That could be reflected in a tendency to perform monotone activities for a long period of time, as well as in limited and stereotyped patterns of behaviour and interests. The world seems unbearably chaotic and confusing for individuals with autism because
of its unpredictability. Therefore, they often prefer to follow routines to bring order in their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

Since children with autism are attracted to technology, the goal of the project is to explore how a technology-based tool should be designed for supporting them to cope with different changes in their daily lives.

**WORKSHOP INFORMATION**

At this workshop we would be grateful to receive your help on evaluating a low-fidelity prototype of a technology-based tool, designed using the Figma software, that will aim to help children on the autism spectrum cope with changes. Once you interact with it, we will ask your opinion on the design and any suggestions for improvements you may have for this tool.

We would like to audio record the session, with your permission, to provide a record for later analysis. If you do not agree with being audio recorded, we will take notes instead.

**AFTER THE WORKSHOP**

After the workshop has finished and we have analysed the information we collected, it will be used to implement the technology-based tool. The results will be summarised in an undergraduate dissertation. The data and findings may be shared or presented in scientific journals or conferences.

**PERSONAL DATA AND PRIVACY**

Confidentiality is extremely important to us. Recordings and other information will be stored safely on password-protected computers or in locked cabinets. Access will be limited to the people involved in the research (listed above).

**WOULD YOU LIKE TO PARTICIPATE?**

This study is completely voluntary, and you are under no obligation to take part. We ask you to read the information sheet, so you can make an informed decision about whether you would like to take part.

  **Thank you for taking the time to read this.**

If you would like to know more about this research and/or if you have questions, please contact one of the main researchers listed above.
Workshop Consent Form for Researchers

Have you read the information sheet? YES / NO

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

Do you understand that participation is completely voluntary, and that you can stop the workshop 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 recording.

I AGREE to be audio-recorded during the workshop and I understand that the tapes will be stored and used by the researchers involved in the study YES/ NO

If you give permission for this study, please return this form to me. By signing YOU AGREE with the above information and understand what is being requested by participating in the workshop.

Full name (to appear of certificate): _______________________________________

Contact telephone number: ________________________________

E-mail address: __________________________________________

Signature: _______________ Date: ________________

__________________
Appendix I

Online Questionnaire for experts - Low-fidelity Prototype

Evaluation of a low-fidelity Prototype with Experts

* Required

Please, let me know about your experience with Human-Computer Interaction.

Your answer

What is your overall satisfaction level with this app? *

1 2 3 4 5
Unsatisfied ○ ○ ○ ○ ○ Very Satisfied

How easy was to use this application *

1 2 3 4 5
Very Hard ○ ○ ○ ○ ○ Very Easy

Is application suitable for the target population? *

○ Yes
○ No

Do you have any other comments?

Your answer

https://docs.google.com/forms/d/e/1FAIpQLSdRDTKkVpwyrMZRbx-QwaW9bEza7GY2/n_t=3ugT696e32e/viewform
Appendix J

Leaflet

(a) front page

(b) back page

Who we are!
My name is Vivian Varvatsis and I am currently in my final year of my undergraduate studies at the University of Edinburgh. As part of my Honours project, under the supervision of Dr Aurora Constantin and Dr Cristina Alexandrou, I have designed and developed an evaluation tool to help children with autism cope with change.

How can your child help us?
In the survey, your child will be asked to evaluate a design of a technology-based tool that will help children on the autism spectrum cope with change. The design will be on paper and/or on a computer and your child will be asked to rate it. Then we will provide your child with a series of instructions that he/she have to follow using the design.

Personal Data and Privacy
Confidentiality is very important to us. Information will be collected only by participant codes or pseudonyms and will be separated from identifying information such as name or birth date.

The project has received ethical approval in accordance with the University of Edinburgh School of Informatics.

Information
Vivian Varvatsis
+44 (0) 7821102794
s154550@ed.ac.uk

Dr Aurora Constantin
+44 (0) 1315156423
aurora.constantin@ed.ac.uk

Dr Cristina Alexandrou
+44 (0) 7946174573
cristina.alexandrou@ed.ac.uk

EVALUATION WORKSHOP
Do you have a child between 6-11 years old?

Are they happy to participate in an evaluation of a technology that helps children with autism cope with change?

Then, please contact us at

Vivian Varvatsis
School of Informatics
University of Edinburgh
+44 (0) 7821102794
s154550@ed.ac.uk

If your child wants to participate or you need more information, please contact us.

When & Where
10 Cathedral St. Edinburgh EH8 9AB

Saturday, 9 February 2019
9 am to 12 noon
30-45 minutes

The children will receive a certificate of participation at the end of the workshop.
Appendix K

Child Information Sheet and Consent Form - Low-Fidelity Prototype

Child Information Sheet
Evaluation of a low-fidelity Prototype
Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes

This page is for children
A group of researchers from the University of Edinburgh are organising a workshop at University of Edinburgh. This document says who they are, and what they will do during the workshop. The researchers invite you to participate in the workshop to help them evaluate a design of an app to support children on ASD to deal with changes. After you read this document you can decide whether you would like to participate or not. You can also change your mind at any time without giving us any explanation.

WHO IS ORGANISING THE EVENT?
We are Vivian, Aurora and Cristina. Our job is to develop technology-based tool for children. We invited you in the workshop because we need your help to develop a technology-based tool to help children cope with changes. Your ideas will be much appreciated.

HOW CAN I HELP?
Some things can be harder for certain kids to do than other kids, like making friends, talking, or dealing with changes in plans. We would like to design a technology-based tool to help those children cope with changes. We think that children are capable to become software designers and they must be involved when designing technology for them. So, we ask you to help us by telling us your opinion on the application we have designed. You are going to tell us what you like, what you don’t like and any other suggestions you may have.
WHAT WILL HAPPEN IF I HELP?
First, we will get to know each other, through a short warm up game. After that, you will be given a design of an app on the computer and then you will be asked to explore it. At the same time, we will ask you your opinion on the application. These are meant to help us understand what we should change or what we should add when we build the technology-based tool for children who have difficulties with changes. We may ask you some questions related to your answers. Remember, we would greatly appreciate if you tell us how children would prefer this technology-based tool to look like.

You can tell us to stop any of the activities at any time. Also, please tell us if you need the toilet, or if you want to take a break. In case you don’t want to help us anymore or feel tired you can say that in any moment. You don’t need to give us an explanation. We will always listen to you.

We will ask if it is OK to make an audio recording of you helping evaluate the application, doing activities and answering questions. This is because it is too hard for us to write down everything that happens. We will listen to the recording later to help us understand what you said, or your ideas for the technology-based tool.

WHAT WILL HAPPEN AFTER I FINISHED HELPING?
We will learn a lot from you about what children like and dislike about the application, and how we can improve it, after hearing your opinion and looking at your drawings. We will write about what we have learnt, and we will use your ideas to build the technology-based tool.

DO YOU WANT TO ASK A QUESTION?
It is ok to ask us as many questions as you want. We are here to listen to you and answer any questions you have. You can also call your mum or dad anytime. You can ask us help if you find anything difficult while you are working on the activities.

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

Do you want to be a software designer? You can say “yes” or “no”. It is OK to say “no”. We will listen to you without asking for explanations.
Child Consent Form

I can choose to participate in the workshop.

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 help anymore.

It is okay if some activities are hard for me!

There are no wrong answers to questions.

Anything I do is helpful.

Do you want to evaluate a design of a technology-based tool to help children deal with changes?

YES ☐ NO ☐

Is it okay to take audio recordings?

YES ☐ NO ☐

Do you agree to give us any drawings you may make?

YES ☐ NO ☐

We will listen to the recordings later to help us build the technology-based tool.

Is it ok to use images of you as examples in documents and presentations for research and/or teaching purposes?

YES ☐ NO ☐

Write your name: ________________________________ and age: _________

VIVIAN, AURORA AND CRISTINA WILL BE VERY HAPPY IF YOU PARTICIPATE
Appendix L

Certificate of Participation -
Low-Fidelity Prototype
Appendix M

Scale for children workshop
Appendix N

Parent Information Sheet and Consent Form - Low-Fidelity Prototype

Parent/Guardian Information Sheet

Evaluation of a low-fidelity Prototype

Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes

This information sheet contains information about the research project of the University of Edinburgh in which your child is invited to participate. After reading the information sheet you are asked to fill the consent form accepting your child’s participation in the workshop. If you have further questions do not hesitate to contact us and discuss them with us.

RESEARCHES AND CONTACT INFORMATION

<table>
<thead>
<tr>
<th>Miss Vivian Varnava, lead researcher</th>
<th>Dr. Aurora Constantin, supervisor</th>
<th>Dr. Cristina Alexandru, supervisor</th>
</tr>
</thead>
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<tr>
<td><a href="mailto:s1546508@sms.ed.ac.uk">s1546508@sms.ed.ac.uk</a></td>
<td><a href="mailto:aurora.constantin@ed.ac.uk">aurora.constantin@ed.ac.uk</a></td>
<td><a href="mailto:Cristina.Alexandru@ed.ac.uk">Cristina.Alexandru@ed.ac.uk</a></td>
</tr>
<tr>
<td>+44 (0) 7821102794</td>
<td>+44 (0) 131515643</td>
<td>+44 (0) 7944116937</td>
</tr>
</tbody>
</table>

University of Edinburgh,
School of Informatics,
Informatics Forum,
10 Crichton Street,
Edinburgh,
EH8 9AB

If you accept to participate, please return the consent form to one of the researchers

PROJECT OVERVIEW

I, Vivian Varnava, am currently a fourth-year student at the University of Edinburgh, studying towards my bachelor's degree in Computer Science. As part of my honours project I am working on the design and implementation of a technology-based tool which will help children with autism cope with changes.

The study is part of an undergraduate project. This research will not bring any financial benefit to the researchers or to the university.

What are the goals of the project?

Rigidity in behaviour and thought is one of the three core symptoms of autism. That could be reflected in tendency to perform monotone activities for a long period of time, as well as in limited and stereotyped patterns of behaviour and interests. The
world seems unbearably chaotic and confusing for individuals with autism because of its unpredictability. Therefore, they often prefer to follow routines to bring order in their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in daily routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

Since children with autism are attracted to technology, the goal of the project is to explore how a technology-based tool should be designed to support them to cope with different changes in their daily lives.

What is the purpose of this study?
This study will be organised as a workshop, during which your child will attend different activities and help us evaluate a low-fidelity prototype for the technology-based tool mentioned above. The design will be on a computer and your child will be asked a series of questions about the design. Also, they will be given a series of instructions that he/she have to follow using the prototype. We are interested in what they like and do not like about our prototype, and how it can be improved to become more attractive to children.

WORKSHOP INFORMATION

What happens during the workshop?
We will spend time before the workshop session to talk to the children to know them better and to allow them to know us. We will use some treats to help them feel comfortable and create an enjoyable environment. Then, they will participate in certain activities in our workshop, such as drawing and interacting with the prototype. Finally, they are going to describe their opinion regarding the prototype and suggest any ideas they may have. The workshop will last for about 30-40 minutes.

Audio Recordings
During the workshop, we would like to audio record your child to provide us a record for later analysis. That will also allow us to freely interact with your child during the session without worrying about taking notes. If you are not comfortable with your child being audio recorded at all, then your child should not participate in this study.

We would also like to take some pictures while your child is working. We may use them, as well as the data collected from this workshop for publications, presentations or teaching purposes. If you feel uncomfortable for us to use the pictures of your child for publications, presentations or teaching purposes please indicate that on the consent form.
Will this project teach your child new skills?

We will not be teaching children new skills or improving existing skills. We are rather interested in your child’s opinions and suggestions on the low-fidelity prototype we have designed.

**AFTER COMPLETION OF THE WORKSHOP**

What will happen when the project is over?

After the workshop has finished and we have analysed the information we collected, it will be used to build the technology-based tool. The results will be summarised in an undergraduate dissertation. The data and findings may be shared or presented in scientific journals or conferences. We never share children’s names, schools or other personal information.

**Personal data and Privacy**

Confidentiality is extremely important to us. Recordings and other information (such as forms with children’s names) will be stored safely on password-protected computers or in locked cabinets. Access will be limited to the people involved in the research (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 or birth date).

This project has undergone ethical screening in accordance with the University of Edinburgh School of Informatics ethics process.

**WOULD YOU LIKE TO PARTICIPATE?**

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 he/she does not want to be a software designer any more. We will check that the child agrees to participate to this workshop, be audio recorded and/or be photographed. Even if you say “yes” on the consent form, your child may still say “no” if he/she does not want to participate in this workshop. We will respect your child’s decision.

Thank you for taking the time to read this.

If you have questions or concerns prior, during or after your child’s participation about this research please contact one of the main researchers listed above.
Parent/Guardian Consent Form

Have you read the information sheet?                  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. By signing, you agree that the researchers may explain the study to your child and invite him or her to take part in this workshop.

I AGREE that my child will be audio-recorded during the workshop and I understand that the tapes will be stored and used by the researchers involved in the study. YES/ NO

With reference to further anonymous use of photographic data, please circle yes or no in response to the following:

I AGREE that short pictures 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 return this form to the researchers. If you DO NOT wish to participate, you do not need to return this page. By signing YOU AGREE with the above information and understand what is being requested by letting your child to participate. You will be provided with a copy of this form.

Full name of child (to appear on certificate): ____________________________

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: ______/______/_____

_________________________________
Appendix O

Online Questionnaire - Feedback survey

A technology-based tool to support children with autism cope with changes

This information sheet contains information about the research project of the University of Edinburgh in which you are invited to participate. The questionnaire contains 8 questions and will take no longer than 10-15 minutes to complete. All responses will be kept anonymous and no one will be identifiable in the research. If you have further questions do not hesitate to contact me and discuss them for more information.

* Required

Researchers and Contact Information

Vivian Varnava                        Dr Aurora Constantin                        Dr. Cristina Alexandru
lead researcher                       supervisor                                           supervisor
s1546508@ed.ac.uk                     aurora.constantin@ed.ac.uk                      Cristina.Alexandru@ed.ac.uk
University of Edinburgh,
School of Informatics,
Informatics Forum,
15 Crichton Street,
Edinburgh,
EH8 9AB

Project Overview

My name is Vivian Varnava and I am currently in my final year of my undergraduate studies at the University of Edinburgh, Scotland, UK. As part of my honours project I have designed and implemented a technology-based tool which will help children with autism cope with changes.

Goals of the Project

Rigidity in behaviour and thought is one of interests the three core symptoms of autism. That could be reflected in tendency to perform monotone activities for a long period of time, as well as in limited and stereotyped patterns of behaviour and interests. The world seems unbearabley chaotic and confusing for individuals with autism because of its unpredictability. Therefore, they often prefer to follow routines to bring order in their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in daily routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

Since children with autism are attracted to technology, the goal of the project is to explore how a technology-based tool should be designed to support them to cope with different changes in their daily lives.

Survey Information

In the survey, you are going to help me gather any usability issues of the technology-based tool that will help children on autism spectrum cope with changes. After exploring the tool, you are going to be asked to rate it and comment on the design and functionality. We are interested on both problems and any suggestions for improvement.

https://docs.google.com/forms/d/1SeoJb0sbGyzyfqm2utKAeZ6kcdE8a1TA3dXWPQUdYO4/edit
Personal Data and Privacy

Confidentiality is very important to us. All the data you provide will be stored safely on Google forms and access will be limited only to the people involved in the research, listed above. All the surveys will be anonymous and be identified by participant codes or pseudonyms.

This project has undergone ethical screening in accordance with the University of Edinburgh School of Informatics ethics process.

1. I AGREE to take part in the survey *
   Mark only one oval.
   ○ Yes    Skip to question 2.
   ○ No     Stop filling out this form.

Questionnaire

2. Gender *
   Mark only one oval.
   ○ Male
   ○ Female

3. Age? *
   Mark only one oval.
   ○ <24 years old
   ○ 24-44 years old
   ○ 45-64 years old
   ○ >65 years old

4. Experience with Human-Computer Interaction *
   Mark only one oval.
   ○ No experience
   ○ Some experience on HCI
   ○ HCI expert

5. How easy was the application to use? *
   Mark only one oval.
   1  2  3  4  5
   Very Difficult    Very Easy

6. If you found any difficulties using the app, please specify. (optional)

____________________________________________________
____________________________________________________
____________________________________________________
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____________________________________________________

https://docs.google.com/forms/d/1SeoJb0sbGzyfpm3uKsB2ZtIeE8a1TA3oxWPQJdYO4/edit
7. How suitable is the application for the target population (children between 6-11 years old)?
   Mark only one oval.

   1  2  3  4  5
   Very Unsuitable  3  2  3  4  5 Very Suitable

8. Overall, how would you rate ChangeItApp? *
   Mark only one oval.

   1  2  3  4  5
   Poor          3  2  3  4  5 Outstanding

9. Do you have any other comments? (Optional)

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

Powered by Google Forms
Appendix P

Expert Information Sheet and Consent Form - High-Fidelity Prototype

their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

Since children with autism are attracted to technology, the goal of the project is to explore how a technology-based tool should be designed for supporting them to cope with different changes in their daily lives.

WORKSHOP INFORMATION
At this workshop we would be grateful to receive your help on evaluating a working prototype of a technology-based tool, that will aim to help children on the autism spectrum cope with changes. Once you interact with it, we will ask your opinion on the prototype and any suggestions for improvements you may have for this tool.

We would like to audio record the session, with your permission, to provide a record for later analysis. If you do not agree with being audio recorded, we will take notes instead.

AFTER THE WORKSHOP
After the workshop has finished and we have analysed the information we collected, the results will be summarised in an undergraduate dissertation. The data and findings may be shared or presented in scientific journals or conferences.

PERSONAL DATA AND PRIVACY
Confidentiality is extremely important to us. Recordings and other information will be stored safely on password-protected computers or in locked cabinets. Access will be limited to the people involved in the research (listed above).

WOULD YOU LIKE TO PARTICIPATE?
This study is completely voluntary, and you are under no obligation to take part. We ask you to read the information sheet, so you can make an informed decision about whether you would like to take part.

Thank you for taking the time to read this.

If you would like to know more about this research and/or if you have questions, please contact one of the main researchers listed above.
their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

Since children with autism are attracted to technology, the goal of the project is to explore how a technology-based tool should be designed for supporting them to cope with different changes in their daily lives.

**WORKSHOP INFORMATION**

At this workshop we would be grateful to receive your help on evaluating a working prototype of a technology-based tool, that will aim to help children on the autism spectrum cope with changes. Once you interact with it, we will ask your opinion on the prototype and any suggestions for improvements you may have for this tool.

We would like to audio record the session, with your permission, to provide a record for later analysis. If you do not agree with being audio recorded, we will take notes instead.

**AFTER THE WORKSHOP**

After the workshop has finished and we have analysed the information we collected, the results will be summarised in an undergraduate dissertation. The data and findings may be shared or presented in scientific journals or conferences.

**PERSONAL DATA AND PRIVACY**

Confidentiality is extremely important to us. Recordings and other information will be stored safely on password-protected computers or in locked cabinets. Access will be limited to the people involved in the research (listed above).

**WOULD YOU LIKE TO PARTICIPATE?**

This study is completely voluntary, and you are under no obligation to take part. We ask you to read the information sheet, so you can make an informed decision about whether you would like to take part.

**Thank you for taking the time to read this.**

If you would like to know more about this research and/or if you have questions, please contact one of the main researchers listed above.
Workshop Consent Form for Researchers

Have you read the information sheet? YES / NO

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

Do you understand that participation is completely voluntary, and that you can stop the workshop 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 recording.

I AGREE to be audio-recorded during the workshop and I understand that the tapes will be stored and used by the researchers involved in the study YES/ NO

If you give permission for this study, please return this form to me. By signing YOU AGREE with the above information and understand what is being requested by participating in the workshop.

Full name (to appear of certificate): _______________________________________

E-mail address: _______________________________________

Signature: ___________________ Date: _____/_____/_____

__________________
Appendix Q

Online Questionnaire for experts - High-fidelity Prototype

03/04/2019 Evaluation of a working prototype with experts

Evaluation of a working prototype with experts
* Required

1. Please evaluate the "Menu" Screen.
Mark only one oval.

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Task 1: Find what is on a child's schedule today.

Describe aloud if the schedules were easy to read and any suggestions for improvement you may have.

2. Please evaluate this Screen. *
Mark only one oval.

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Task 2: Find the school schedule of the specific child. Then, mark all the activities as done.

Describe aloud if the schedules were easy to read and any suggestions for improvement you may have.

3. Please evaluate this Screen. *
Mark only one oval.

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Task 3: Find the story that describes Fire Drills.

Describe aloud if the story was easy to read and any suggestions for improvement you may have.

4. Please evaluate this Screen. *
Mark only one oval.

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5. Please Evaluate the "Rewards" Screen  
Mark only one oval.

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**Task 4: Try the option Toolkit.**

Describe aloud your thoughts about this screen.

6. Please Evaluate this screen. *  
Mark only one oval.

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**Task 5: Try the option Pet and change the pet to any of the options provided**

Describe aloud your thoughts about this screen.

**Task 6: Change the mode so you can edit the application. Then delete one task.**

Describe aloud your thoughts about this screen.

**Task 7: Then, move to "Task Schedules" Screen and click on one of the schedules.**

Describe aloud your thoughts about this screen.

**Task 8: Add a new Task Schedule. Try to save it without adding any tasks.**

**Task 9: Add a new Task. Try to save it without a description. Then add a description and either save it or delete it.**

**Task 10: Then save or delete the schedule.**

**Task 11: Move to "My Stories" Screen and press on one of the stories.**

Describe aloud your thoughts about this screen.
Task 12: Delete a page from the story and then save it.

Task 13: Move to "Toolkit Screen", add a new option and then delete it.

Describe aloud your thoughts about this screen.

7. How easy was the application to use? *
   Mark only one oval.
   
   1 2 3 4 5
   Very Difficult  Very Easy

8. How suitable are the methods used for helping children with autism cope with changes? *
   Mark only one oval.
   
   0 1 2 3 4 5
   NA  Very Suitable

9. How suitable is the application for the target population (children between 6-11 years old)? *
   Mark only one oval.
   
   1 2 3 4 5
   Very Unsuitable  Very Suitable

10. Overall, how would you rate ChangeItApp? *
    Mark only one oval.
    
    1 2 3 4 5
    Poor  Outstanding

11. Do you have any other comments? (Optional)


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https://docs.google.com/forms/d/1eBMYm2Z3auqUYYXkz0uLmMYChxJzKnL6FKL8owHFB/edt
Appendix R

Child Information Sheet and Consent Form - High-Fidelity Prototype

Child Information Sheet
Evaluation of a high-fidelity Prototype

Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes

This page is for children

A group of researchers from the University of Edinburgh are organising a testing workshop at University of Edinburgh. This document says who they are, and what they will do during the workshop. The researchers invite you to participate in the workshop to help them evaluate a new technology-based tool to support children on ASD to deal with changes. After you read this document you can decide whether you would like to participate or not. You can also change your mind at any time without giving us any explanation.

WHO IS ORGANISING THE EVENT?

We are Vivian, Aurora and Cristina. Our job is to develop technology-based tool for children. We invited you in the workshop because we need your help to test a technology-based tool that will help children cope with changes. Your ideas will be much appreciated.

Vivian        Aurora        Cristina

HOW CAN I HELP?

Some things can be harder for certain kids to do than other kids, like making friends, talking, or dealing with changes in plans. We have developed a technology-based tool to help those children cope with changes. We think that children are capable to become software testers and they must be involved when designing and developing technology for them. So, we ask you to help us by telling us your opinion on the tool we have developed. You are going to tell us what you like, what you don't like and any other suggestions you may have.
WHAT WILL HAPPEN IF I HELP?
First, we will get to know each other, through a short warm up game. After that, you will be given an android application and then you will be asked to explore it. At the same time, we will ask you your opinion on the application. These are meant to help us understand what we should change or what we should add in order to improve the technology-based tool for children who have difficulties with changes. We may ask you some questions related to your answers. Remember, we would greatly appreciate if you tell us how children would prefer this technology-based tool to look like.

You can tell us to stop any of the activities at any time. Also, please tell us if you need the toilet, or if you want to take a break. In case you don’t want to help us anymore or feel tired you can say that in any moment. You don’t need to give us an explanation. We will always listen to you.

We will ask if it is OK to make an audio recording of you helping test the application, doing activities and answering questions. This is because it is too hard for us to write down everything that happens. We will listen to the recording later to help us understand what you said, or your ideas for the technology-based tool.

WHAT WILL HAPPEN AFTER I FINISHED HELPING?
We will learn a lot from you about what children like and dislike about the application, and how we can improve it, after hearing your opinion and looking at your drawings. We will write about what we have learnt, and we will use your ideas to improve the technology-based tool.

DO YOU WANT TO ASK A QUESTION?
It is ok to ask us as many questions as you want. We are here to listen to you and answer any questions you have. You can also call your mum or dad anytime. You can ask us help if you find anything difficult while you are working on the activities.

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

Do you want to be a software tester? You can say “yes” or “no”. It is OK to say “no”. We will listen to you without asking for explanations.
Child Consent Form

I can choose to participate in the testing workshop.

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 help anymore.

It is okay if some activities are hard for me!

There are no wrong answers to questions.

Anything I do is helpful.

Do you want to evaluate a technology-based tool to help children deal with changes?  
YES □  NO □

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

Do you agree to give us any drawings you may make?  
YES □  NO □

We will listen to the recordings later to help us build the technology-based tool.

Is it ok to use images of you as examples in documents and presentations for research and/or teaching purposes?  
YES □  NO □

Write your name: ________________________________ and age: _________

VIVIAN, AURORA AND CRISTINA WILL BE VERY HAPPY IF YOU PARTICIPATE
Appendix S

Certificate of Participation - High-Fidelity Prototype
Appendix T

Parent Information Sheet and Consent Form - High-Fidelity Prototype

Parent/Guardian Information Sheet

Evaluation of a high-fidelity Prototype
Designing and Developing a Technology-Based Tool to Help Children with Autism Cope with Changes

This information sheet contains information about the research project of the University of Edinburgh in which your child is invited to participate. After reading the information sheet you are asked to fill the consent form accepting your child’s participation in the workshop. If you have further questions do not hesitate to contact us and discuss them with us.

RESEARCHES AND CONTACT INFORMATION

Miss Vivian Varnava, lead researcher
ev1546508@sms.ed.ac.uk
+44 (0) 7821102794

Dr. Aurora Constantin, supervisor
aurora.constantin@ed.ac.uk
+44 (0) 131515643

Dr. Cristina Alexandru, supervisor
Cristina.Alexandru@ed.ac.uk
+44 (0) 7944116937

University of Edinburgh,
School of Informatics,
Informatics Forum,
10 Crichton Street,
Edinburgh,
EH8 9AB

If you accept to participate, please return the consent form to one of the researchers

PROJECT OVERVIEW

I, Vivian Varnava, am currently a fourth-year student at the University of Edinburgh, studying towards my bachelor’s degree in Computer Science. As part of my honours project I am working on the design and implementation of a technology-based tool which will help children with autism cope with changes.

The study is part of an undergraduate project. This research will not bring any financial benefit to the researchers or to the university.

What are the goals of the project?

Rigidity in behaviour and thought is one of the three core symptoms of autism. That could be reflected in tendency to perform monotone activities for a long period of time, as well as in limited and stereotyped patterns of behaviour and interests. The
world seems unbearably chaotic and confusing for individuals with autism because of its unpredictability. Therefore, they often prefer to follow routines to bring order in their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in daily routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

Since children with autism are attracted to technology, the goal of the project is to explore how a technology-based tool should be designed to support them to cope with different changes in their daily lives.

What is the purpose of this study?
This study will be organised as a workshop, during which your child will attend different activities and help us test the technology-based tool mentioned above. The tool will be on a computer and your child will be given a series of instructions that he/she has to follow using the prototype. We are interested in what they like and do not like about our prototype, and how it can be improved to become more attractive to children.

WORKSHOP INFORMATION

What happens during the workshop?
We will spend time before the workshop session to talk to the children to know them better and to allow them to know us. We will use some treats to help them feel comfortable and create an enjoyable environment. Then, they will participate in certain activities in our workshop, such as interacting with the prototype. Finally, they are going to describe their opinion regarding the prototype and suggest any ideas they may have. The workshop will last for about 30-40 minutes.

Audio Recordings
During the workshop, we would like to audio record your child to provide us a record for later analysis. That will also allow us to freely interact with your child during the session without worrying about taking notes. If you are not comfortable with your child being audio recorded at all, then your child should not participate in this study.

We would also like to take some pictures while your child is working. We may use them, as well as the data collected from this workshop for publications, presentations or teaching purposes. If you feel uncomfortable for us to use the pictures of your child for publications, presentations or teaching purposes please indicate that on the consent form.
Will this project teach your child new skills?

We will not be teaching children new skills or improving existing skills. We are rather interested in your child’s opinions and suggestions on the prototype we have developed.

**AFTER COMPLETION OF THE WORKSHOP**

What will happen when the project is over?

After the workshop has finished and we have analysed the information we collected, the results will be summarised in an undergraduate dissertation. The data and findings may be shared or presented in scientific journals or conferences. We never share children’s names, schools or other personal information.

**Personal data and Privacy**

Confidentiality is extremely important to us. Recordings and other information (such as forms with children’s names) will be stored safely on password-protected computers or in locked cabinets. Access will be limited to the people involved in the research (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 or birth date).

This project has undergone ethical screening in accordance with the University of Edinburgh School of Informatics ethics process.

**WOULD YOU LIKE TO PARTICIPATE?**

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 he/she does not want to be a software tester any more. We will check that the child agrees to participate to this workshop, be audio recorded and/or be photographed. Even if you say “yes” on the consent form, your child may still say “no” if he/she does not want to participate in this workshop. We will respect your child’s decision.

Thank you for taking the time to read this.

If you have questions or concerns prior, during or after your child’s participation about this research please contact one of the main researchers listed above.
Parent/Guardian Consent Form

Have you read the information sheet? 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. By signing, you agree that the researchers may explain the study to your child and invite him or her to take part in this workshop.

I AGREE that my child will be audio-recorded during the workshop and I understand that the tapes will be stored and used by the researchers involved in the study YES/ NO

With reference to further anonymous use of photographic data, please circle yes or no in response to the following:

I AGREE that short pictures 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 return this form to the researchers. If you DO NOT wish to participate, you do not need to return this page. By signing YOU AGREE with the above information and understand what is being requested by letting your child to participate. You will be provided with a copy of this form.

Full name of child (to appear on certificate): __________________________
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: ______/______/____
Appendix U

Poster

ChangeItApp
An application that helps children with autism cope with changes

PROJECT OVERVIEW
Rigidity in behaviour and thought is one of interests the three core symptoms of autism. That could be reflected in tendency to perform monotone activities for a long period of time, as well as in limited and stereotyped patterns of behaviour and interests. The world seems unbearably chaotic and confusing for individuals with autism because of its unpredictability. Therefore, they often prefer to follow routines to bring order in their lives and to reduce their anxiety caused by what they may perceive as a terrifying chaos. Unexpected changes can raise serious problems to individuals with autism and they often encounter difficulties to deal with them. Sometimes minor changes such as moving from one activity to another or a slight change in daily routine can cause distress. Other changes, such as going on holiday, moving to a new house or changing school may be extremely challenging.

MOTIVATION
A growing concern for all individuals with autism is employment and having skills to live independently. Developing independence and coping skills from an early age can be a valuable and essential attribute for the future. Technology has proven a prevalent factor in children’s lives, positively influencing both their education and personal lifestyle. Children with autism find technology even more appealing because of the graphics that capture and retain their attention. At the same time, it can be adapted to each child’s needs. Digital tools previously developed focus on assisting children with autism transition between activities in a school environment. Although practitioners use a variety of methods to help children deal with changes, there is a lack of technology-based tools supporting them.

Since children with autism are attracted to technology, the goal of this project is to explore how a technology-based tool should be designed to support them to cope with different changes in their daily lives.

Easy to customise
You will love it
Simple UI

Creator:
Vivian Varnava

Supervisors:
Aurora Constantin
Cristina Alexandru