Designing an Educational Tabletop Software for Children with Autism

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Abstract

Discrete Trail Training (DTT) is an intervention method used by behaviour analysts for teaching skills to children with Autism Spectrum Disorder (ASD) around a table using physical materials and artefacts. Traditional DTT suffers from these main challenges: inconsistency due to human limitations; need for repeatedly focusing child's attention on the trail at hand as children with ASD suffer from short attention spans; and disruptions on account of in-session data recording and analysis by the analysts while delivering the training. Developed in collaboration with HCI and behaviour analysis experts, our proposed solution is an interactive, tabletop software application that provides the consistency and integrity that DTT aims to achieve, while engaging the child's attention on the interactive interface, and seamlessly collecting and analysing in-session data in the background. Upcoming usability evaluations of the prototype promise to provide insight into the potential effectiveness of our prototype.

Keywords: *Autism Spectrum Disorder (ASD), Discrete Trail Training (DTT), Child-Computer Interaction (CCI) Education, Children, Learning*

1 Introduction

Autism Spectrum Disorder is a neuro-developmental condition and Autism is one of three recognised disorders on this spectrum, and affects the cognitive development of the child, resulting in low motivation and inclination to learn from their environment as typically developing children do.

In the last 40 years, the rate of incidence of Autism Spectrum Disorders has risen from 4 in 10,000 to approximately 62 in 10,000, as of 2007 (Rutter 2005). Part of this increase can be attributed to better diagnoses and more awareness of ASD, but this still means that there are much greater numbers of people who require or will benefit from specialized teaching.

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Effective, affordable methods of treating and teaching children with autism have become more important in assisting them to be able to interact with the world. As a result, therapists are challenged to find new ways to increase learning opportunities for these children and in turn, enhance their motivation to learn.

Discrete Trial Training (DTT) (Smith 2001) is an intervention, based on the science of Applied Behaviour Analysis. It is a highly structured, research-based method of teaching skills to children with neuro-developmental disorders, such as Autism. DTT has four distinct parts: the trainer's presentation, the child's response (which may be prompted), the consequence, and a short interval between the consequence and the next instruction (Smith 2001). Performing trials in a consistent way is a large contributor to the effectiveness of DTT sessions. Traditionally, DTT sessions are conducted using physical materials while the analyst and child-learner sit around a table.

However, the benefits of DTT can only be reaped if the intervention is carried out, according to the scientific guidelines in a highly consistent format. While this may sound feasible in theory, the reality is that DTT conducted in traditional settings is error-prone as the analysts conducting it are liable to be inconsistent and make mistakes on account of human limitations. Additionally, in-session data recording (e.g. correct/incorrect responses) and analysis by analysts is often inaccurate and disruptive to the primary aim of DTT (Smith 2001).

2 Assistive Technology

Technology can provide the consistency and integrity that DTT aims to achieve, while engaging the child's attention and thus immersing them in therapy for longer periods of time than they would otherwise sustain.

It has been suggested that the reason children with autism gravitate towards technology is because of its consistency, predictability, logic and freedom from social demands (Chen 2012). The concern that the use of computers may inhibit spontaneous language and social interaction in children with autism has not been conclusively evidenced by research. In fact, the children were found to have increased their motivation, use of spontaneous comments, eye gazes towards the parent, and

positive affects while on the computer and decreased their inappropriate language and behaviour compared to baseline play sessions (Whalen et. al 2006). Touch-based applications are particularly suited for this purpose because of their popularity, especially among the younger demographic who have emerged as digital natives (Palfrey and Urs 2008).

A significant number of existing software applications, related to the DTT intervention were found, with their efficacy and usage, documented in research studies. However, many of these applications were designed by domain experts in the field of behavioural analysis alone and therefore did not harness technical expertise or the benefits of good HCI design. Despite their portability benefits, DDT applications on mobile touch devices such as on iPhone, iPad and Android have the disadvantage of limited screen real estate and non-collaborative allowance (Artoni et. al 2012). They also lack the support of multiple simultaneous touch gestures, which is crucial for instances when both the child and therapist could be interacting with the application at the same time. Given DTT sessions are typically conducted with the analyst and child-learner sitting around a table, a tabletop seems well-suited for our interactive software.

3 Project Overview

The hypothesis of our study is that multi-touch table-top software has the potential to engage children in autism therapy while allowing therapists/behaviour analysts to conduct and monitor DTT far more easily and accurately.

The aim of this project is to develop an interactive, multi-touch based software application that mimics the research-based intervention of DTT. In particular, this software focuses on teaching basic colour and shapes recognition. The software application aims act as a novel learning/teaching tool to allow therapists/behaviour analysts to conduct and track sessions with children diagnosed with Autism, in a far more effective and fluid manner, whilst still having the flexibility to customise sessions for each child. Additionally, the software application should also engage the child in the learning process without any sensory overload.

This cross-disciplinary project harnesses the expertise of software engineering and HCI researchers and software developers, certified behaviour analysts and psychology researchers. Our team is working collaboratively to create a solution that leverages the technological affordances offered by touch-based platforms in order to enhance the effectiveness of DTT while preserving its pedagogical requirements and original structure.

As part of the design process, both pen-and-paper and electronic user interface prototypes were created to give a basic vision of the structure of the application. The paper prototype was rapidly created as a very basic view of the application, and discussed at meetings with the subject-matter experts (certified behaviour analysts.)

Using the Scrum software development method allowed us to develop this iteratively and incrementally weaving in feedback from collaborating behaviour analysts. The tabletop used is the Samsung SUR40 with Microsoft PixelSense which supports 50 simultaneous touch points and object recognition.

4 Design Features

The application is aimed at providing a holistic approach to DTT and consists of the following main features:

- Setting up trails customized to individuals
- Conducting trails (train for colours and shapes)
- Tracking and reviewing trials

To use the app, a facilitator will log in, choose a child profile from those they are teaching, and either “train” the user (conduct a trial) or “track” them (review progress data). A trail setup can be customized to select: colours or shapes, number of trails in a session, and type of prompts. Analysts can also select to focus on certain colours by setting them as the correct response and mixing them with a number of other colours of their choice. As children with neuro-developmental disorders can be easily overstimulated or overwhelmed, the portion of the UI that will be presented and viewed by the child has been made as simple and minimal as possible to reduce any distracting factors and allow the child to focus on the task at hand. Data recorded includes correct and incorrect responses for each of the trails in order that trends over the latest DTT session and over time can be reviewed by the analysts.

5 Future Work

Human Ethics approval for conducting usability evaluations is in place. Relevant institutions are currently being invited to participate in our evaluations for usability and usefulness. We expect to discover any remaining usability issues which will then be rectified; and identify the application’s effectiveness in assisting with DTT in the aforementioned areas (providing integrity and consistency, increased child engagement, and seamless data recording and analysis.)

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