

RocketMouse: A Game for Assessing ADHD

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October 29, 2014

1 Abstract

Studies have recently shown that attention deficit disorders may affect upwards of 5% of the population. In recent years, mobile games have also become extremely popular due to the increasing ubiquity of smart phones. By exploiting this trend of mobile game popularity, we hope to create new tools to measure the symptoms of ADHD in the form of a mobile game. In this paper, we explore the results of creating a mobile game application that is capable of testing response time, distractibility, and mobile application preference in users with and without ADHD. We gather basic information about the user, such as whether or not they have ADHD, through a survey the user is asked to filled out at the beginning of the game. We predict that users who have been diagnosed with ADHD type disorders will have higher variability in reaction times, higher distractibility, and will also prefer mobile applications that do not focus on reaction time as a measure of success. Previous studies have indicated that the inhibitory abilities of children with ADHD are normalized when playing video games. Due to this, our mobile game will need to alternate between levels that are more like a mobile game and more like a test. We also predict that children diagnosed with ADHD will have more mobile applications installed on their mobile devices as their short attention spans may cause them to jump from mobile application to mobile application quickly as they may get bored rather quickly compared to a person without ADHD.

2 Introduction

With the recent explosion in the ubiquity of mobile devices and the mobile games that often accompany those mobile devices, a great opportunity is presented to researchers for reaching a large scale, geographically widespread audience through mobile applications, especially for those limited by their local geographic location. Studies show attention deficit disorders affects upwards of 5% of the population and typically most users have to make a trip to the doctor's office to have their symptoms measured and have a diagnosis made.

We propose the development of a mobile application that can help collect data about users to help quantify the response time characteristics that may often accompany a person with ADHD. The mobile application would first survey the user about things such as their age, gender, ADHD diagnosis, if they're medicated for ADHD, and other basic questions. Once the user is done filling out the survey, the user is allowed the play the game. The game will record the response time characteristics of the user as they are playing and upload the response time data to a remote server them once the user is done playing. From there, data mining is performed on the user's response time data to see if any patterns can be established in combination with user's data to see if any strong patterns in the response times stick out between users with ADHD and users without ADHD. The game should be fun and engaging to keep the user interested and playing and hopefully collect as much data on their response time characteristics as possible.

Our game implementation will be a two-dimensional side scrolling game in which the user controls a character that moves from left to right across the screen. As the user moves from left to right across the screen, they must jump over obstacles that appear very quickly, this is where the recording of response times comes into play. The time it takes for the user to tap the screen to make their character jump from the time the object first appears is the time that we will use as a measure for user’s reaction time. Once the user is done, their response time data will be uploaded to a data for further analysis. We predict that users with ADHD type disorders will have higher variability in these reaction times, higher distractibility, and will prefer mobile applications that do not focus on reaction time as a measure of success.

3 Background Studies

There have been many studies done recently that revolve around studying the connections between reaction time and ADHD such as in [3] and [5]. However, we have been unable to find any mobile applications that have been developed for the sole purpose of collecting data to help with ADHD diagnosis. Many studies have indicated that there is in fact a link between the reaction time of people with and without ADHD. Below, we will discuss the results of some of the studies that have been performed on reaction time and ADHD diagnosis and their implications.

In [2] the authors conducted a study on 151 children participants. Out of the 151 children, 104 had previously been diagnosed with ADHD, the other 47 were diagnosed as not having any form of ADHD. The children performed a variety of tasks, but the task that displayed the biggest difference between the two sets of children was the Go/No Go task. The Go/No-Go test is a visual reaction test. The p value was $p < 0.01$ with the null hypotheses being that there was no difference between the two groups of children. So this test was pretty strong evidence that there existed a difference between reaction times for the ADHD diagnosed children and non ADHD diagnosed children.

In [1] the authors showed that there appears to exist a relationship between the variability in reaction times and children diagnosed with ADHD. The study consisted of 144 participants, 60 of which weren’t diagnosed with ADHD, and 84 of which had previously been diagnosed with ADHD. The participants all participated in four reaction time tasks in which they had incentive to do well because they earned prizes if they did well. Overall, the study concluded that ADHD was associated with slower reaction time and also a higher variability in reaction times.

CogCubed is a game that was developed for attempting to diagnose people with ADHD [4]. However, CogCubed required a patient to go into a doctor’s office to use, so the user couldn’t have access to the tool outside of a doctor’s office. This is where our research contribution could be really strong. Having a mobile application that is fun could lead to the contribution of a lot of data that could be analyzed and mined, which could hopefully lead to stronger conclusions or maybe even new conclusions on the relationship between reaction times and ADHD diagnosis.

4 Methods

4.1 Planning of Game and Development Environment

For the development of our mobile game we decided to use the Unity game engine. With Unity we will be able to target mobile platforms (both iOS and Android), desktop platforms, and even the web environment. Unity also allows use to easily creating visually appealing environments and incorporate physics into our mobile game much easier with the use of libraries designed by Unity.

4.2 Survey Development

We designed a survey for gathering basic information about the user that may also help us find correlation amongst certain traits. Our survey asks the following questions:

- What is your age?
- What is your gender?
- Have you ever been diagnosed with ADHD?
- If so, are you medicated for it?
- If not, do you think you may have ADHD?

4.3 Collecting Installed Application Information

We would like to collection information on the mobile applications the user also has installed on their mobile devices. Android provides native support for collecting this information so we had to use native Android code in combination with Unity. By collecting this information, we hope to upload the application information the server and see if there are any relationships between the number of mobile applications and type of mobile applications that user with and without ADHD play on their mobile devices.

4.4 Database Design

We will have one database and that database will be housed on the server. The database will consist of three tables; reaction time table, a survey table, and a user table. It is important to note that we don't store any identifying data about the user such as their name or anything. We assign each user a unique user id for the purpose of organizing the data and associating each user with their reaction time data, survey data, and in the event that they submit more data, we can just add the new data to their data already on the server instead of creating a new entry in the user table. The reaction time table will house the data on the reaction times the user had in the game. The survey table will contain the answers to the survey, and the user table will store data on the user such as their unique user id.

4.5 Privacy and Security of User's Data

Due to the sensitive nature of the data collected, our mobile application must be secure and also must not store any data locally on the mobile device, except for the circumstance where there are multiple users on the same device. In this case, an anonymous identifier will be generated locally to differentiate between the different users.

4.6 Server set up

A server had to be set up to accept data from the user's mobile device, which is uploading the response time data from the user for further processing. We will be utilizing a LAMP set up for the server.

4.7 Development of game

The gather data from user, we thought that the best way to get a large pool of data would be to develop a mobile application that is a game. This way, it would be entertaining for the user to play and the user may be willing to submit more data by playing longer or more often. To develop the game, we first needed to decide on the game type, we decided on a 2d side scroller where the response time characteristics are determined by the amount of time it takes the user the press the screen to jump over an object once the object has appeared on screen.

4.8 Server side scripts for analyzing data

Server side scripts are the scripts that will reside on the server which are responsible for processing and analyzing the response time data that the users send to the server from their mobile devices. These scripts will be written in the Python programming languages and will use the numpy and scipy library for performing the statistical analysis. The scripts will be responsible for accepting data, organizing the data, and storing the data into the SQL database located on the server. The scripts will also be responsible for pulling data from the server and mining the returned data for patterns. We hope to find relationships between reaction times and people who have been diagnosed with ADHD and haven't been diagnosed with ADHD. We also hope to find relationships between the number of applications the user has installed and types of applications the user has installed and whether or not the user has been previously diagnosed with ADHD. The main statistics the scripts will be calculating and analyzing are the correlations between different aspects of the data and also confidence intervals. We hope to establish strong confidence intervals with our results so that we can effectively show how strong our conclusions are.

5 References

- [1] Karalunas SL, Geurts HM, Konrad K, Bender S, Nigg JT. J. Child Psychol. Psychiatry 2014; ePub(ePub): ePub.
- [3] Epstein JN, Langberg JM, Rosen PJ, et al. Evidence for higher reaction time variability for children with ADHD on a range of cognitive tasks including reward and event rate manipulations. *Neuropsychology*. 2011;25(4):427-41.
- [4] Andreou P, Neale BM, Chen W, et al. Reaction time performance in ADHD: improvement under fast-incentive condition and familial effects. *Psychol Med*. 2007;37(12):1703-15.
- [5] Monika D. Heller, Kurt Roots, Sanjana Srivastava, Jennifer Schumann, Jaideep Srivastava, and T. Sigi Hale. *Games for Health Journal*. October 2013, 2(5): 291-298. doi:10.1089/g4h.2013.0058.

References

- [1] P. Andreou, B. M. Neale, W. Chen, H. Christiansen, I. Gabriels, A. Heise, S. Meidad, U. C. Muller, H. Uebel, T. Banaschewski, I. Manor, R. Oades, H. Roeyers, A. Rothenberger, P. Sham, H. C. Steinhausen, P. Asherson, and J. Kuntsi. Reaction time performance in ADHD: improvement under fast-incentive condition and familial effects. *Psychol Med*, 37(12):1703–1715, Dec 2007.
- [2] J. N. Epstein, J. M. Langberg, P. J. Rosen, A. Graham, M. E. Narad, T. N. Antonini, W. B. Brinkman, T. Froehlich, J. O. Simon, and M. Altaye. Evidence for higher reaction time variability for children with ADHD on a range of cognitive tasks including reward and event rate manipulations. *Neuropsychology*, 25(4):427–441, Jul 2011.
- [3] S. L. Karalunas, H. M. Geurts, K. Konrad, S. Bender, and J. T. Nigg. Annual research review: Reaction time variability in ADHD and autism spectrum disorders: measurement and mechanisms of a proposed trans-diagnostic phenotype. *J Child Psychol Psychiatry*, 55(6):685–710, Jun 2014.
- [4] Sanjana Srivastava Jennifer Schumann Jaideep Srivastava Monika D. Heller, Kurt Roots and T. Sigi Hale. A machine learning-based analysis of game data for attention deficit hyperactivity disorder assessment. *Games for Health Journal*, 2(5):291–298, 2013.
- [5] Stewart H. Mostofsky and Daniel J. Simmonds. Response inhibition and response selection: Two sides of the same coin. *J. Cognitive Neuroscience*, 20(5):751–761, May 2008.