Lie Detection in Virtual Reality

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1 INTRODUCTION

1.1 Goals
This experiment aims to use pupillary dilation as a means to indicate truth status. Since pupils are known to dilate under cognitive load this can be used as a metric to guess if a person is lying.[1] This paper intends to study pupil dilation in a virtual reality setting and gather data to support that you can use pupil diameter as a metric for lie detection specifically inside of VR.

1.2 Motivations
Methods for determining whether or not a person is telling the truth or a lie have been proposed for centuries, as the ability to differentiate lie from deceit has tremendous legal implications. Techniques, such as the use of a polygraph machine, have been used extensively throughout modern history, however, some recent studies such as Saxe, et al.[2] have found the polygraph to be significantly less reliable than previously believed. While modern alternatives, such as fMRI-based lie detection show promising results, they are prohibitively expensive to use in most legal settings[3], and too complex in nature to explain to juries. Eye tracking could serve as a novel replacement for the polygraph in lie detection, and a more affordable option than fMRI. Furthermore, since pupil dilation is, by nature, heavily influenced by ambient lighting conditions, eye tracking in VR has the potential to eliminate this shortcoming by placing the subject in an environment with strictly controlled lighting. This paper aims to measure the effectiveness of such methods in detecting lies.

1.3 Hypothesis
Research has shown a correlation between a person’s pupil dilation and their relative cognitive load. This has the potential to predict whether a subjects answer to a given question will be truthful or deceitful. Modern eye-tracking apparatuses can accurately and quickly measure the dilation of a person’s pupil, however they are subject to the changing lighting conditions of whatever room they are used in. VR-based eye tracking has the potential to outperform standalone eye tracking apparatuses since lighting, background noise, and surroundings can be strictly controlled within the VR headset.

2 BACKGROUND

Lie detection technologies have been on a steady incline for over a century since the first device named the Lombroso’s Glove was invented in 1881.[4] Eye tracking capabilities net promising results in helping the validity of lie detection applications. The study of eye movements and pupil dilation can be monitored to help determine a user’s truthfulness. Previous experiments have continued to validate the use of eye tracking in lie detection. A lie detecting robot was created for a simulation of a human-robot interaction that studied the pupil diameter in a fixed environment to determine if the human was being truthful.[5] The ability to assess cognitive load to determine a lie stimulates unique opportunities for future implementations. Another meta-analysis of lie detection used social cues to study the response of various questions answered by the participants to emphasize certain cues that had a bigger impact on the ability to successfully detect a lie. [6] The saccade (rapid eye movements), and the pupil dilation showed accurate detection of lies. A pilot experiment resulted significant differences when observing saccade amplitudes. During the truth telling and lie telling situations, it’s observed that lying increases cognitive load. Therefore, cognitive load contributes to minimal eye movements and saccade amplitudes. [7]
3 METHODOLOGY

3.1 Apparatus

This experiment used the Vive Pro Eye to capture eye tracking data. Figure 1 shows a researcher wearing the HMD. The Vive Pro Eye has dual OLED 3.5" diagonal displays that operate at a 1440 x 1600 pixels per eye. It has a 90 Hz refresh rate and a 110° Field of View. It comes with high resolution audio as well. The Vive’s eye trackers are binocular and have a 120 Hz refresh rate, an accuracy of 0.5-1.1°, and a 100° trackable field of view. The environment was created with the Unity game engine which has a 90 Hz refresh rate. This experiment captured data through the Unity update system and opted for a 90 Hz refresh rate for collecting eye tracking data.

3.2 Stimuli

This experiment places the participant in a virtual environment. This environment, presented in Figure 2, is a benign white room with a TV, nightstand and potted plant. The participant will be prompted to focus on the TV. The TV will then guide them through the experiment.

The participant will have audio played through the headphones of the Vive HMD. This audio will contain questions that the participant must answer and a guide telling them how the experiment will be run. There will be twenty questions and each question will be asked in less than five seconds. The TV in the room will play a variety of videos. It will play an introduction to the experiment where a researcher talks about what the experiment is and how it is run. It will also guide the participant through the study by prompting different actions in response to the twenty questions mentioned earlier. These actions are enumerated below.

1. Figure 3 displays a prompt to tell the truth.

2. Figure 4 displays a prompt to tell a lie.
Figure 4: Prompt Participant to Tell a Lie

(3) Figure 5 displays a prompt indicating to the participant that a baseline reading is being collected.

Figure 5: Indicate to Participant Baseline Procedure

3.3 Subjects
The subjects of our experiment will include 10-20 students at Clemson University and will ideally consist of an even distribution of men and women with a similar area of study, but is not necessary for intended outcome. Our target demographic would have a median age of 22-23 including Clemson students of all ages. The quality of subject’s eyesight in reference to glasses or contacts should not have impact on results of the study. Excluding a subject’s student status, our experiment will not have any remaining biases.

3.4 Experimental Design
This experiment will use a within-subjects design. Selected participants will listen to the same set of pre-recorded audio questions, and also be positioned in front of a virtual TV screen set in the virtual environment. Participants will be asked the same set of 20 questions (Table 1). Entering the questioning phase, the computer program will randomly assign the instructions for each question to instruct the participant to either lie or tell the truth. Each question is designed to be answered with a simple true or false statement. Participants will audibly respond with either a lie or truth during the response phase. This methodology compares the pupil dilation and the manner of prevarication because the audio stimuli were of the same set for all subjects should yield fair result. The independent variables of the experiment include the instructions given from the TV to lie or be truthful, and questions asked. The same set of questions are asked to each participant, and all participants are in the same controlled virtual environment. The dependent variable would be the dilation difference during and after giving audible response to the questions. The dependent variable could then be used to predict truthfulness.

<table>
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<th>Table 1: Questions asked to participants.</th>
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3.5 Procedures
Researchers will first introduce themselves to the participants, then give the participants a written description of instructions and the general aims of the experiment. Participants were given a short period to review the documentation and also fill out a survey provided to them by the researchers. Participants were then allowed to ask researchers any other questions they may have. The researchers then guided the participant through eye calibration on the Vive and started the study. When the study begins participants are prompted via the TV in the room to inspect the virtual environment. After a short period their attention is drawn back to the TV and a guide to the experiment is played on the TV. The guide walks through the study and informs the participant that the TV will prompt the user to lie or tell the truth. It then tells the participant that a short practice round will be played and then asks the participant if they are ready to start the real experiment. If so the real experiment begins, if not the same practice round is repeated. Once the real study has begun the experiment will go through an array of questions. Questions will be chosen at random for the participant to lie about. Each question will consist of three phases. Phase one will be a baseline period. No audio will be played and the TV will state that it is gathering baseline data. This period will last five seconds. Then phase two will begin. Phase two is the question asking phase. During this phase the participant will be prompted via the TV to lie or tell the truth while audio is played through the headphones asking a stimulus question. Phase three occurs after phase two. In phase three participants will audibly answer yes or no to the provided question and either lie or tell the truth. This process will occur for each question and the study will end. At this point the
researchers removed the participant from the headset and asked if they had any further questions.

4 RESULTS

TBD.

REFERENCES


