

Lie Detection Using *Pupillometric* Response

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Pupils respond to various kinds of stimuli but the three distinct are the constrict response due to bright light, constrict response to fixation and dilate response due to increase in mental effort or arousal. The goal of this project was to evaluate whether telling a lie can trigger the dilation response of pupils and if so can it be detected using sophisticated eye tracking tools. The project due to technical difficulties didn't reach the user testing phase. This paper provides all the organizational, technical insights and challenges faced during the tenure of this project and can be a potential solid basis for future research in this field.

Introduction

Lie Detection is one of the main areas of applied psychology. The need to know whether someone is telling the truth or lying can be pivotal to many court trials, police investigations and so on. There are currently many techniques and tools being used to aid in lie detection some of which are skin conductance response, observing behaviour, speech patterns and analyzing brain signals. The technique on which this project is based on is the pupillometry. In human anatomy

the pupil dilation and constriction is controlled by our autonomic nervous system which is responsible for unconscious control of certain functions of our body for example the regulation of organ activity. The research work from applied psychology (1) (2) paved the way for the fundamental idea of this project. The goal of the project was lie detection by observing the pupil size variation. As per the design of experimental setup, it was also necessary to explore the probability of test user evading the detection which was requisite to satisfy the hypothesis assumed that the experimenter would become better at lie detection with time. After that a series of test runs would be made to establish the baseline for the user after that the user would be exposed to actual test scenarios which in our case are two. The planned end of this study was the result analysis and establishing a solid fact that is if this technique of lie detection is feasible and comparable to other techniques being used.

Literature Review

The field of applied psychology is very active and a lot of research is being done with regard to lie detection using physiological phenomenon. Some of the research (3) (4) relating to this field turned out to be a great source of motivation and helped in understanding some core concepts and techniques necessary to overcome potential challenges.

The first paper gave insight about the user study which was focused on pupil size variation after an auditory stimulation. This auditory stimulation was based on equally divided positive and negative sounds. The subjects rated their experience. There was significant response from the pupils when exposed to emotional sounds such as baby crying meaning that the human autonomic nervous system is sensitive to arousing emotional situations (1).

The next paper also constituted of an experimental setup where the pupillary response of the test users was analyzed after committing a mock crime when exposed to the photographs of crime scene. The experiment resulted in relatively high degree in accuracy for lie detec-

tion hence promoting pupillary response as effective method for criminal interrogation and lie detection (2).

Last paper which was studied for this project also assessed the possibility of using pupil diameter as the index of deception as compared to polygraph question test. The results of this experiment concluded that pupil diameter changes can be a predictor for deception or lie and it has the potential to replace the traditional measuring parameters such as blood pressure variation (5).

Experimental Setup

The experimental study consisted of two experiments the goal of which was to find the answers for our research questions.

Method

The planned experimental procedure was as follow:

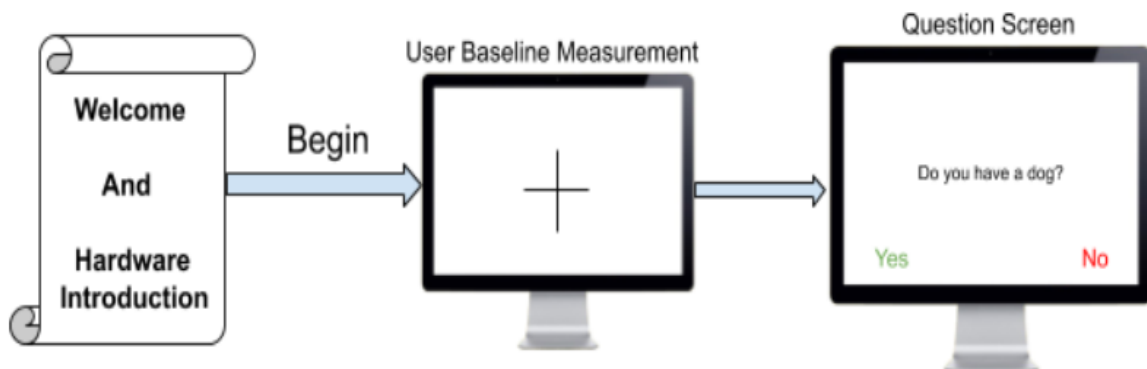


Figure1:ExperimentalProcedure

The experiment begins with introduction of experimenter, the experiment hardware and the setup to make the subject comfortable before the start of experiment. This is done to mitigate the effect of pre-experimental stress which might cause changes in pupil size before the start of

experiment. Before the beginning of each experiment clear instructions of the experiment are presented to the subject on the monitor which the subject acknowledges by pressing a button on the keyboard and the experiment begins. The experiment begins by measuring the baseline value of the subjects pupil. Baseline value is the normal value of pupils in resting position which is calculated when the subject is exposed to a special screen. This is crucial in order to measure the changes in pupil size during the experiment. After which the question screen shows up, which lasts for 10 seconds and the subject has to choose the answer within this time.

Experiments

The experiment was structured in a way that its design should remain same but it should be able to answer different research questions by minor alteration of the setup. The experiment was conducted in two states, which are as follows:

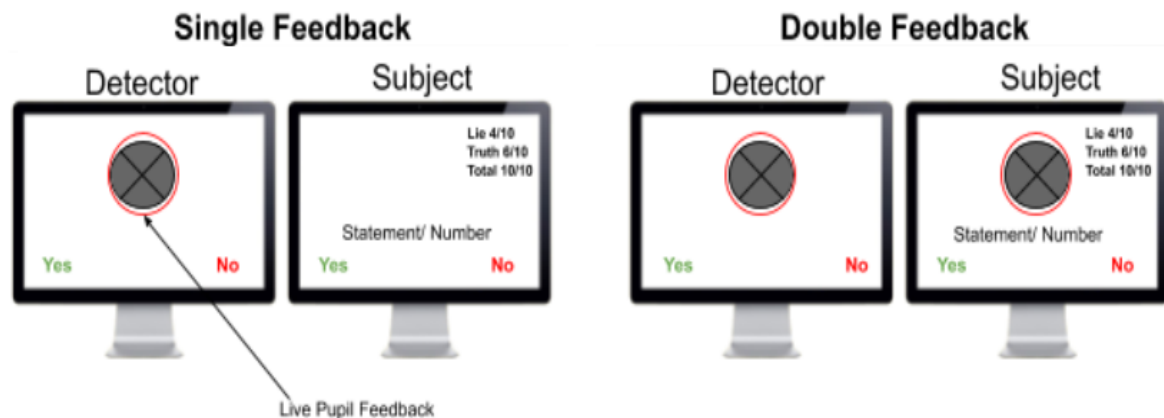


Figure2:SingleFeedbackAndDoubleFeedback

As the main idea of this study was real time lie detection, hence it was necessary for the experimenter to witness the live pupil changes of the test subject as well as the subject to see

his/her own feedback so that any manipulation being made by the subject should be the part of detection procedure to challenge the detector. Hence the concept of single feedback and double feedback state was introduced in this experiment. Each state consisted of two experimental conditions one of which was **lie content** and other one being **lie type**.

Lie Content

The content consisted of either numbers or statements. The reason for exposing the subjects to different content was to get optimal results based on their emotional involvement in this experiment which would in terms produce solid results. It was determined before start of the study that exposing the subjects to numbers would result in less significant changes in pupil size than statements. The inclusion of numbers were still important to answer the hypothetical question that is if the experimenter get better with time in detecting the lie as it would be more challenging. The statements being asked to the subject were crucial for this experiment. The idea was to keep the subject emotionally attached to the study because it would trigger higher response. Hence the statements were designed in such a way that it should be personal or should intrigue the subject more but not to an extent that it would make the subject uncomfortable. For example: **Did you ever cheat someone?** The subjects would be assured about the secrecy of their answers by keeping their identity anonymous. To verify the answers they gave during live feedback session , it was required of them to anonymously give correct answers of each statement in a separate questionnaire which would at the end be useful to correctly match their answers for analysis of result.

Lie Type

The experiments was set up around the idea of free and forced lying for the user. It was instructed to the users to lie freely as they will in one run and in the other run they were forced to lie equally as the tell the truth. The purpose of this strategy was to test the sanctity of lie detec-

tion using pupil diameter changes. The runs of both forced and free lying as well as statements and numbers were complemented with single feedback and double feedback state.

Apparatus

The experiment was setup on the windows desktop machine with an external monitor attached to it for the double feedback and real time lie detection. The tracker used to collect the pupil diameter changes was **SMI RED500/RED250**. The software used for the coding of this experimental study was PsychoPy along with Notepad++ for editing the code.

Coding

Coding was in terms challenging part of this study. Due to the use of older eye tracking device with no technical support the result gathering was indeed challenging sometimes as it produced bugs along the way. The initial implementation was straight forward with just a single feedback. As the study progressed the changes were made to the code adding in complexity and compatibility issues of both software and hardware. It was first necessary to call in the libraries necessary for the functioning of the eye tracker.

```
# Initialize components for Routine "iViewX_Connect"
iViewX_ConnectClock = core.Clock()
from iViewXAPI import *                               #iViewX library
# -----
#---- connect to iViewX
# -----
res = iViewXAPI.iV_Connect(c_char_p('141.54.159.23'),
c_int(4444)
, c_char_p('141.54.159.21'), c_int(5555))
```

```

res = iViewXAPI.iV_GetSystemInfo(byref(systemData))
print "iV_GetSystemInfo: " + str(res)
print "Samplerate: " + str(systemData.samplerate)
print "iViewX Verion: " + str(systemData.iV_MajorVer
sion) + "." +
str(systemData.iV_MinorVersion) + "." + str(system
Data.iV_Buildnum
ber)
print "iViewX API Verion: " + str(systemData.API_Major
Version) +
"." + str(systemData.API_MinorVersion) + "." + str
(systemData.API
_Buildnumber)

```

Then the dual monitor setup had to be initialized

```

# Setup the Window
win = visual.Window(
    size=[1000, 1000], fullscr=True, screen=1,
    allowGUI=True, allowStencil=False,
    monitor='testMonitor', color=[-0.3,-0.3,-0.3], color
    Space='rgb',
    blendMode='avg', useFBO=True,
    units='pix')

win2 = visual.Window(

```

```

size=[1000, 1000], fullscr=True, screen=2,
allowGUI=True, allowStencil=False,
monitor='testMonitor2', color=[-0.3,-0.3,-0.3], color
Space='rgb',
blendMode='avg', useFBO=True,
units='pix')

```

And after that the routines and cycles of the experimental setup were initialized. A routine according to the instruction manual of PsychoPy is: **"Routine might specify the timing of events within a trial or the presentation of instructions or feedback"** (6). The following code is an example for one such routine.

```

# Initialize components for Routine "bl_instructions"
bl_instructionsClock = core.Clock()
baseline_instructions = visual.TextStim(win=win, name='baseline_instructions',
    text='Baseline will be recorded in 10 seconds after which
the experiment will begin. \n\n(to start press <space>)',
    font='Arial',
    units='pix', pos=[0, 0], height=30, wrapWidth=None, ori=0,
    color=[-0.5, -0.5, -0.5], colorSpace='rgb', opacity=1,
    depth=0.0);

```

The routines were setup in a loop, such that after each statement is answered, the tester will have 10 seconds to decide whether the answer given by the subject is lie or truth after which a new statement or number would show according to the run of experiment.

Discussion

The pupil size variation provides promising results in terms of lie detection . The experimental study took into perspective all the loopholes which might effect the results of this study and were addressed accordingly. To verify the results , it was depending on the subject that during the questionnaire phase they will provide correct answers to the statements and for that their identity was kept anonymous. The states of experiment were designed in a way to answer the research questions while keeping the setup almost similar to maintain continuity in the experiments causing less stress and hassle for the subject. The experiment before its testing phase was brought on to an halt due to technical difficulty. The tracker being used for pupil diameter variation was not able to work again due to which the testing was not conducted. Before the actual testing there was a minor bug in the code which was being worked on. The bug was detected in double feedback run. During this run whenever the subject would give the answer to a statement or a number the live pupil feedback to the subject would stop while the feedback to the tester was uninterrupted. This was an issue which needed to be fixed because it was necessary for the subject to also view his/her own pupil size variation so that it can be possible for them to control or try to vary their pupil size to challenge the tester in detecting.

Conclusion

The study unfortunately didn't conclude but it provides all the solid basis finish the study. The testing during the development phases of this study showed promising results that how the use of pupil variation be efficient and reliable for lie detection.

References and Notes

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