

**DECEPTION DETECTION TESTS ALONG WITH BRAIN-
COMPUTER INTERFACE**

A Thesis
Presented to
The Academic Faculty

by

Aatmay S. Talati

In Partial Fulfillment
of the Requirements for the Degree
Computer Science in the
School of College of Computing at Georgia Tech

Georgia Institute of Technology
August 2018

**DECEPTION DETECTION TESTS ALONG WITH BRAIN-
COMPUTER INTERFACE**

Approved by:

 5-3-18

Dr. Melody Moore Jackson, Advisor
School of College of Interactive Computing
Georgia Institute of Technology



Dr. Thad Starner, Advisor
School of College of Interactive Computing
Georgia Institute of Technology

Date Approved: May 3rd 2018

TABLE OF CONTENTS

	Page
LIST OF SYMBOLS AND ABBREVIATIONS	vii
SUMMARY	viii
<u>CHAPTER</u>	
1 Introduction	1
Problem Statement	1
Proposed Solution	2
2 Research Design	3
Materials	3
Procedure	4
Assessment/Data Collection	4
Storing or Sharing Information	5
3 Participants	6
Inclusion Criteria	6
Exclusion Criteria	6
Risks or Discomfort	6
Confidentiality	7
6 Future Work	8
REFERENCES	9

LIST OF SYMBOLS AND ABBREVIATIONS

BCI	Brain-Computer Interface
DDT	Deception Detection Tests
ERP	Event-Related Potentials
GSR	Galvanic Skin Response
ERN	Error Related Negativity

SUMMARY

Primarily polygraphs (AKA lie detectors) are being used for Deception Detection Tests (DDTs) in terms of knowing hidden and crucial information associated with crime or an incidence. Often, other factors, i.e., nervousness, fear, anger, etc. affect polygraph data negatively. In some cases, the subject could be highly trained to intentionally falsify the DDT results by practicing yoga, meditation, etc. Using few Event-Related Potentials (ERPs), along with continually measuring few polygraph test parameters on the subject would be helpful as an ERP component elicited in the process of decision making. The failure rate of a polygraph is 60%, as recorded by the U.S. Customs and Border Protection (CBP) pre-employment polygraph screening program [1]. This work will help investigators to augment polygraph sensing to determine deception.

CHAPTER 1

INTRODUCTION

DDTs are helpful to know the hidden or crucial information associated with the crime or an incidence [2]. Many times, investigators come to know about direct or indirect associated convicts and factors. The DDTs take place when the subject isn't ready to release the known information. Also, it has been clinically proven that DDTs are much safer than 'third-degree methods'¹ used by some investigators. DDTs cannot take place without supreme court imperative.

Problem Statement

Polygraph predominantly records autonomic reactions. Those changes in the body caused by the conscious mind are not easily controlled by the subject, which may include, but not limited to bodily responses such as skin conductivity, heart rates, respiration rates, blood pressure, capillary dilation, and muscular movements [3]. There's an uncertainty in concepts as changes in arousal states are not necessarily prompted by lying or deception. Polygraph data can also be influenced by subject's nervousness, fear, anger, surprise and many other factors [4]. Surprisingly, a trained person can beat the polygraph test results. A person who's able to control or restrain his/her arousal symptoms thru relaxation exercises, i.e., Yoga, Meditation, etc. [4] Hence during the empirical studies, the reliability of the polygraph has been questioned repetitively. DDT results are declared

¹ Third degree (interrogation) The third degree is a euphemism for torture ("inflicting of pain, physical or mental, to extract confessions or statements").

inconclusive at a governmental level when none of the fluctuations are recorded during the test.

Proposed Solution

Similar to a polygraph, I propose the DDT with augment DDT with biometrics such as blood oxygenation, pulse rates, and skin conductivity along with P300 (P3) and other ERPs. P300 (P3) is an event-related potential (ERP) component elicited in the process of decision making. It is an endogenous potential, as its occurrence links not to the physical attributes of a stimulus, but to a person's reaction to it [5].

Like the polygraph tests, the subject will show/express the sign of fear while answering the questions related to the incidence. The autonomic responses are supposed to indicate short-term stress response, which can be from lying or significance to the subject. The guilty subject is more likely to be concerned with lying about the relevant facts about the crime, which in turn produces a hyper-arousal state which is picked up by a person trained in reading polygraph results [6].

CHAPTER 2

RESEARCH DESIGN

Materials

Pulse Oximeter

When the subject lies, his/her heart rate spikes as they provide the falsifying answer to the examiner/researcher. The pulse oximeter measures changes in pulse rates and blood oxygenation.

Electrodermal/GSR

Electrodermal/Galvanic Skin Response measures the skin conductivity with BITalino sensors attached to the subject's fingers, which is supporting evidence for the deception. That allows us to observe changes in skin conductivity, which indicates stress.

P300 (P3) and other ERPs

ERPs like P300 (P3) are components elicited in the process of decision making. We will use BITalino 8-Scalp Electrodes to measure the EEG data.

Procedure

If a participant decides to be in this study, then his/her part will involve a single, one-hour visit. The tests will be conducted in three steps: pre-test, the test, and the conclusion.

Step 1: Pre-Test

In terms of the pre-test, after the participant signs the consent form, there will be a short conversation with the subject concerning about the amount of sleep the subject has

gotten, medication/drug usage and mental illness. Once the examiner/researcher will proceed to the step 2, once he/she receives the positive answers from the subject.

Step 2: The Test

We will start putting on the EEG cap which will measure electric potentials in their brain during the study. Once the cap is on, we will perform a reference test where we attempt to measure P300 using a standard computer monitor as a display. This display consists of showing the participants series of visual stimuli consisting photographs and pictures of their own family vs. stranger or famous places of the campus vs. famous places of the other university campuses, and we will make sure if the participant can recognize the shown visual stimuli. We will record the pulses and continuously measure the blood pressure to see the correlation between deception and pulse/blood pressure and galvanic skin response increment/decrement.

Step 3: Conclusion

As a final step, we will remove the cap along with turn off the computer screen from the participant and ask if they have any final questions followed by exit questioners. Depending on the results of blood pressure/pulse monitor, conductivity and P300 and other ERPs, researcher/examiner will categorize the test into three categories: positive test, negative test or inconclusive.

Assessment/Data Collection

We will be using openBCI software to collect EEG data, and we will

use BITalino for the bio-monitoring signals. We will employ machine learning techniques to build a classifier for the GSR and all bio-monitoring signals that will correlate with the images to help us find patterns that will indicate recognition.

Storing and Sharing Information

Participant's participation in this study is gratefully acknowledged. It is possible that their information/data will be enormously valuable for other research purposes. By signing the consent form, the participant's consent for his/her de-identified information/data to be stored by the researcher and to be shared with other researchers in future studies. If the participant agrees to allow such future sharing and use, his/her identity will be completely separated from your information/data. Future researchers will not have a way to identify you. Any future research must be approved by an ethics committee before being undertaken.

CHAPTER 3

PARTICIPANTS

The goal of this study is to have 24 participants who are at least 18 years old and have normal or corrected to normal vision, and no serious mental health issues to complete the study with usable P300. Since about 20% of the population do not have measurable P300 responses, we want to have few extra participants (total of 30) since we may experience noise in the data or some other technical difficulties.

Inclusion Criteria

The inclusion criteria for this study are all members of the population with no known mental disorders, between the ages 18 and 69. We are including participants of both genders and all ethnicities.

Exclusion Criteria

The primary exclusion criteria are people under the age of 18 (minors) because children's brains are still developing and respond differently to stimulus. Additionally, any person who knows or suspects they may have photosensitive epilepsy because of the risks associated with participating in the study.

Risks or Discomforts

The risks involved are no greater than those involved in daily activities such as viewing a computer screen in an office setting. If you experience any discomfort with the monitoring devices, computer screen, or the cap, please let one of the researchers know and we can either make adjustments to the devices or the fit of the cap or stop the study early.

Confidentiality

The following procedures will be followed to keep participant's personal information confidential in this study: Your privacy will be protected to the extent required by law. To protect your privacy, there will be no records kept that link you to the data collected. Your records will be kept in locked files, and unless you give specific consent otherwise, only study staff will be allowed to look at them. Participant's name and any other fact that might point to you will not appear when results of this study are presented or published. The Georgia Institute of Technology IRB, the Office of Human Research Protections, and/or the Food and Drug Administration may look over study records during required reviews.

CHAPTER 4

FUTURE WORK

Step 1: IRB Protocol

As a first step to the research, we will need an approval from IRB protocol, and the IRB protocol is being submitted for the review currently.

Step 2: Machine Learning Classifier for other ERPs

We will employ a machine learning classifier and few other ERPs like ERN to classify detection.

Step 3: The Experiment

Once we get an approval from IRB, and we have machine learning classifier; We will conduct the experiment in the Brain Lab located in Technology Square Research Building, and then we will collect the data.

Step 4: Publish

After running the series of the experiments on participants, we will collect the data and analyze the data precisely and publish the paper about this cutting-edge research project.

REFERENCES

- [1] “Customs and Border Protection Polygraph Failure Rate Pegged at 60%.”
AntiPolygraphorg News, antipolygraph.org/blog/2010/03/12/customs-and-border-protection-polygraph-failure-rate-pegged-at-60/.
- [2] Nose, I., Murai, J., & Taira, M. (2009). Disclosing concealed information on the basis of cortical activations. *NeuroImage*, 44(4), 1380-1386.
10.1016/j.neuroimage.2008.11.002
- [3] Rosenfeld, J. (1995). Alternative views of Bashore and Rapp's (1993) alternatives to traditional polygraphy: A Critique. *Psychological Bulletin*, 117(1), 159.
- [4] The Truth About Lie Detectors (aka Polygraph Tests). (n.d.). Retrieved February 12, 2018, from <http://www.apa.org/research/action/polygraph.aspx>
- [5] P300 (Neuroscience). (n.d.). Retrieved February 12, 2018, from [https://en.wikipedia.org/wiki/P300_\(neuroscience\)](https://en.wikipedia.org/wiki/P300_(neuroscience))
- [6] Math, S. B. (2011). Supreme Court judgment on polygraph, narco-analysis & brain-mapping: A boon or a bane. *The Indian Journal of Medical Research*, 134(1), 4–7.