TECHNOLOGY OVERVIEW

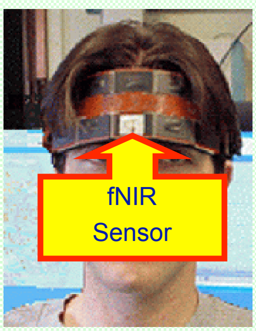
Functional Optical Brain Sensor to Detect Deception

Conventional methods of detecting deception rely on autonomic measures of emotional response such as heart rate or skin conductance to detect deception; these peripheral measures have not proven to be sufficiently reliable. The functional near-infrared (fNIR) sensor detects deception by directly monitoring brain activity. Importantly, this technology also allows the design of safe, portable and field-deployable brain monitoring systems.

Working Principle

fNIR uses the reflection of infrared light pulses to monitor changes in blood oxygenation which correlate with localized neuronal activity in the brain, comparable to that of functional magnetic resonance imaging (fMRI). Because "guilty knowledge" has been associated with local changes in blood oxygenation in the cortex, fNIR is an excellent candidate for the evaluation of brain activity during a number of cognitive and emotional tasks, including the detection of deception.

Conventional Methods of Deception Detection	Conventional methods of detecting deception suffer from a lack of specificity differentiating "guilt" from "anxiety." Not all culpable individuals feel guilty, and *many innocent* individuals feel anxious when being questioned. Depending on the method used, this can result in an unacceptably high level of false positives (identifying innocent individuals as guilty), or an unacceptably low level of sensitivity (misidentifying guilty individuals as innocent.)
fNIR – Optical Sensor to Detect Deception	fNIR measures changes in blood oxygenation due to neural activity in the cortex of the brain. Because neural pathways in the brain mediate both the cognitive components of conscious deception, as well as emotional responses (e.g., guilt and fear), fNIR can be used to differentiate intentional deception as well as guilt, anxiety, or fear.

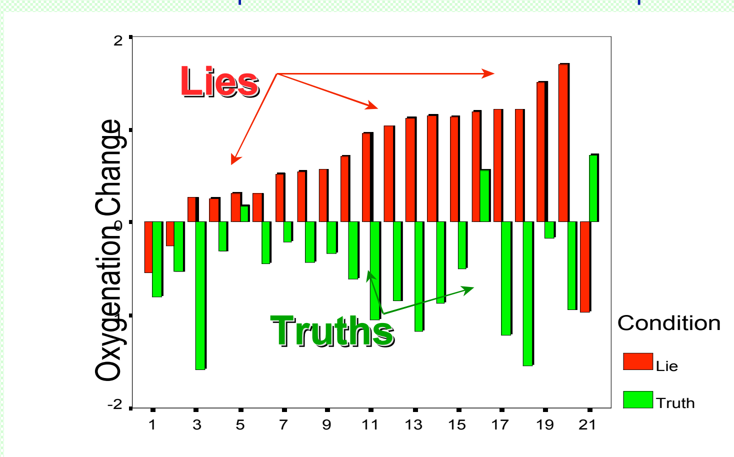


fNIR is a unique deception detector

- fNIR is the only stand-alone, **field-deployable** technology able to determine the localized brain activity underlying the cognitive components of intentional deception
- fNIR technology can be readily **integrated** with conventional and experimental methods that assess emotional responses, including infrared (IR) imaging, computer-based facial analysis, posture-sensitive chairs, and autonomic measures. fNIR can also **complement** other brain-based techniques, i.e., event-related brain potentials such as the P300 component.

Experimental Evidence

During a poker-like card game, 20 out of 21 subjects showed greater oxygenation over the same cortical area when they lied than when they told the truth.



Functional Optical Brain Sensor to Detect Deception
Research and Development Plan

R E S E A R C H & D E V E L O P M E N T

Expected Impact

Technologies such as fMRI and PET can directly measure neural activity underlying deception. However, they are unsuitable for field deployment such as airports, seaports and borders due to their prohibitive cost and physical constraints, and susceptibility to movement artifacts. The fNIR system can extend the application of these direct neuroimaging techniques into the field through its portability, rapid application time and the potential for hand-held instrumentation.

Research and Development Objectives	Actions
To expedite research and development	• Continue on-going experiments differentiating cognitive deception from anxiety • Conduct next critical phase of research to establish sensitivity and specificity under field-type conditions • Develop modular sensor to facilitate accurate, comfortable test • Refine algorithms to maximize sensitivity/specificity, minimize time needed to conduct evaluation • Update and refine end-user data-collection software • Conduct fMRI validation studies • Produce the first generation prototype
To prepare a plan for field testing and deployment options	• Conduct field testing • Collect stratified sample increasing diversity and sample size • Fine-tune design parameters for second generation design
Budget Estimate	

Teams	Roles
Dr. Scott C. Bunce Drexel University College of Medicine Clinical Neuroscience Research Unit Department of Psychiatry **Optical Brain Imaging Team** Drexel University School of Biomedical Engineering, Science, and Health Systems Philadelphia, PA	Dr. Scott Bunce is the Director of the Clinical Neuroscience Research Unit and a clinician in the Institute for Addictive Disorders and Outpatient Psychiatry. Dr. Bunce is experienced with EEG/ERPs as well as autonomic measures, and conducts research on emotion and the measurement of covert information in the brain. Since 2001, Dr. Bunce has been working in collaboration with Dr. Britton Chance of University of Pennsylvania and the Optical Brain Imaging Team of Drexel University. A founding father of fNIR technology, Dr. Chance conducted many of the original, landmark studies in the field, establishing optical spectroscopy as a safe, non-invasive and reliable imaging technique. He has developed and investigated the application of fNIR in several areas, including the detection of breast cancer, the detection of brain hematomas, and hemodynamics during cognitive function. The Optical Brain Imaging Team of the School of Biomedical Engineering, led by Drs. Banu Onaral and Kambiz Pourrezaei, has developed a reliable and user-friendly fNIR system for research on human cognition and emotion. The Drexel team brings together a spectrum of experts in biomedical device development, software and communication engineering, user interface design, digital signal processing and system integration.

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