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Examining Young Driver Behaviors Using Driving Simulation and Neuroimaging

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Overview

- **Background & Introduction**
  - **Young Drivers**
  - **Teen Passengers**

- **Measuring behaviors**
  - **Driving Simulation**
  - **Eye movements**
  - **Neuroimaging**

- **Ongoing study: fNIRS & Driving Simulation**
  - **fNIRS**
  - **Brain regions**
  - **Experimental protocols**

Background & Introduction

Young Drivers

- **Motor Vehicle Crashes are the leading cause of death for teenagers in the United States**

- **Youth 15-20 years old**
  - **9% of U.S. population (2007)**
  - **6% of driving population**
  - **But, 19% of fatalities in US in 2007 related to young drivers**

- **Annual cost of Motor Vehicle Related Fatal & Non Fatal Injuries = $ 99 billion (CDC, 2010)**
- **Annual cost for Teen injuries = $ 14 billion (CDC, 2010)**

Background & Introduction

Young Drivers + Peer Passengers

- **Peer passenger presence is a risk factor for teen drivers**
  - **Especially male drivers**
  - **Especially multiple peer passengers**

- **Naturalistic studies have shown that teens drive worse when with passengers**

- **Epidemiological studies have shown higher crashes and higher fatalities when peer passengers are present**

  - **Why??**

Background & Introduction

Measuring driver behavior

- **Approaches**
  - **Naturalistic**
    - **Instrumented vehicles**
  - **Experimental**
    - **Driving Simulators**

- **Measures**
  - **Driving simulation/vehicle kinematic measures**
  - **Eye movements**
  - **Neuroimaging**
    - **(teenage brain’s activity is different from that of adults)**

Background & Introduction

Past simulator study

- **Driving simulator study**
  - **Teen drivers with confederate passengers**

- **Simulator measures (driving risks)**
  - **Teen drivers took more risks in the presence of a passenger**

- **Eye movement measures**
  - **Teen drivers scanned less widely in the presence of passengers**
  - **Scanning patterns resembled those of cognitively loaded drivers**

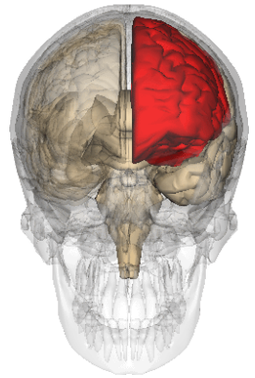
fNIRS & Driving Simulation

Neuroimaging

- **Functional Magnetic Resonance Imaging (fMRI)**
  - **High resolution**
  - **Deep brain scanning**
  - **Experimental limitations**
  - **Costs**

fNIRS & Driving Simulation

Neuroimaging



- **Functional Near Infra Red Spectroscopy (fNIRS)**
  - **a non-invasive optical brain imaging**
  - **in vivo measurements of oxygenated and deoxygenated hemoglobin in cortical tissue**
  - **to study regions in the prefrontal cortex of drivers performing an ecologically valid driving simulation task.**

- **TechEN CW6 equipment**
  - **continuous wave approach**
  - **up to 32 lasers and detectors.**

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fNIRS & Driving Simulation

fNIRS

- **Brain activity is fueled by glucose metabolism**
- **Increased neural activity results in increased glucose & Oxygen consumption**
- **Increases local cerebral blood flow to active brain areas**
- **Oxygen is transported by Oxygenated Hemoglobin (O2Hb) in the blood**
- **As oxygen is withdrawn for metabolism there is an increase in Deoxygenated Hemoglobin (HHb)**

fNIRS & Driving Simulation

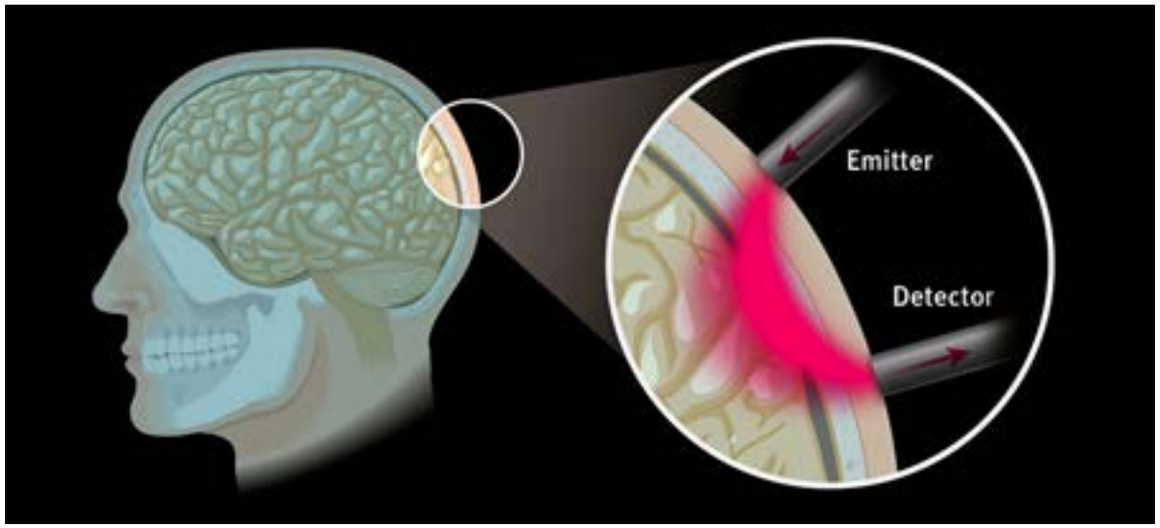
fNIRS

- **O2Hb and HHb have optical properties in the near-infrared light range (700 to 900 nm)**
- **This makes it possible to measure change in their concentration using optical measures such as fNIRS**

fNIRS & Driving Simulation

fNIRS

- Optodes are used to shine near-infrared light into regions of interest
- Emitters shine light into the skull
  - The light penetrates the scalp in a banana shape
- Reflected light is measured by receivers
- The amount of absorbed light relate to when and where the brain is active



fNIRS & Driving Simulation

Neuroimaging

	fMRI	fNIRS
Spatial Resolution	8-27 mm^3	1-10 cm^3
Temporal Resolution	Slow (1-2 sec)	Fast (50 Hz)
Measurement parameter	Mix of blood volume, blood flow, and O_2 metabolism	[Hb] and [HbO]

fNIRS & Driving Simulation

The Study

- **Driving simulation study**
  - **Teen drivers, with confederate peer passengers**
  - **Driving simulation will introduce and latent risks**

- **Driving Simulator**
  - **Realtime Technologies Incorporated (RTI) desktop version.**

- **Brain regions of interest**
  - **Response inhibition, Incentive processing, cognitive control**
  - **Ventrolateral Prefrontal Cortex, Dorsolateral Prefrontal Cortex, Orbitofrontal Cortex.**

fNIRS & Driving Simulation

The Study

- **Hypotheses:**

1. **There will be a significant interaction of age group by passenger condition, such that teenage drivers demonstrate higher risky driving behavior in a simulator when driving with a peer passenger compared with driving alone**

2. **Age group by passenger condition comparisons will demonstrate differential neural activation in selected PFC regions between groups and conditions resulting in a significant age group by passenger condition interaction.**

fNIRS & Driving Simulation

The Study

- **Status:**
  - **Interface of driving simulator and fNIRS**
  - **Identification of brain region, fNIRS optodes & head regions**
  - **Simulator drives**
  - **Recruitment ongoing**
  - **Data collection is imminent**
  - **Results?**

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Thank you

Questions?

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