THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Distracted Driving and TBI

Despina Stavrinos, PhD

Associate Professor of Psychology

Director, Translational Research for Injury Prevention (TRIP) Lab

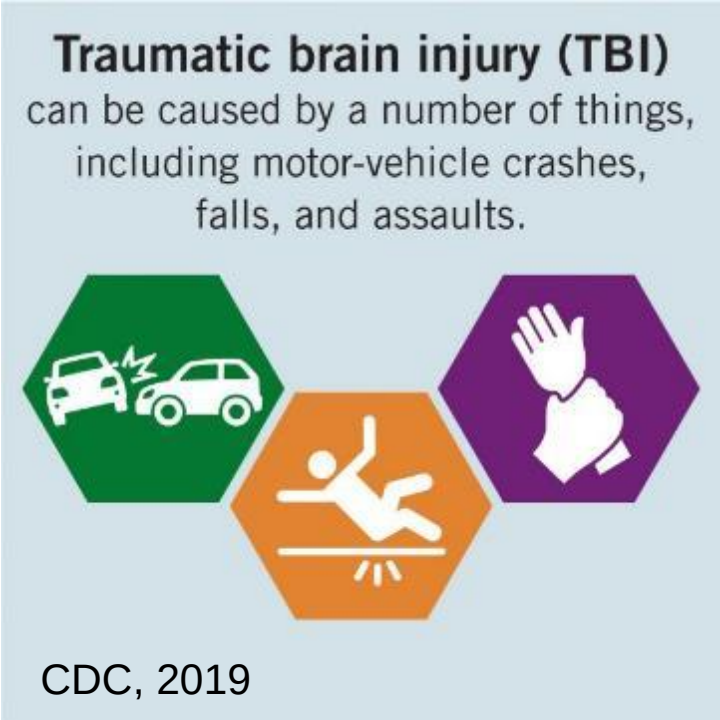
University of Alabama at Birmingham

Conflicts of Interest: None

TRIP LAB

Overview

- TBI Prevention
  - UAB's Distracted Driving Initiative
- Driving after TBI
- Future Challenges and Opportunities



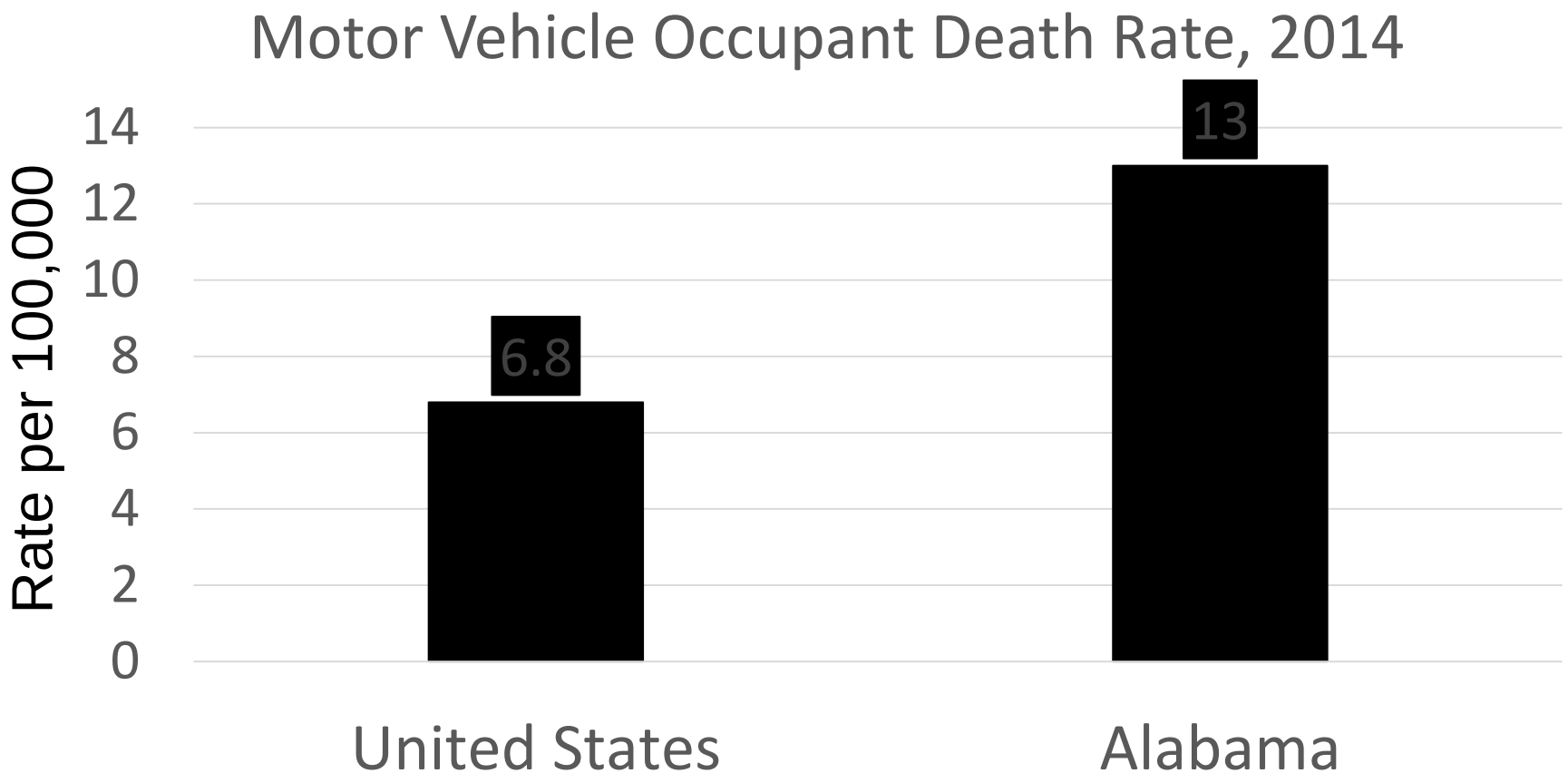
Road Injuries & Fatalities

- 8th leading cause of death worldwide *(WHO, 2018)*
- Leading cause of death for people ages 5-24 in the U.S. *(CDC, 2018)*
- 2nd leading cause of death for people ages 25+ in the U.S *(CDC, 2018)*
- Average of 102 die each day in U.S. *(NHTSA 2018)*
- Costs U.S. over $700 billion dollars per year *(WISQARS, 2017)*

 # 1 cause of MVCs: Driver Error

Composition of US Fatalities, NHTSA, 2016

Alabama MVC-fatality Rate 2x U.S.



CDC, 2018

Distracted Driving: An Epidemic

- MVCs involving driver distraction (2017 data)
  - 3,166 killed
  - 391,000 injured
  - 9% of fatal crashes
    - Largest proportion: young drivers

Defining Distracted Driving

…the diversion of attention from activities critical for safe navigation to a competing activity


FosterSwift

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UAB's Distracted Driving Initiative

Dr. Despina Stavrinos, former U.S. Transportation Secretary Ray LaHood, and Dr. Russ Fine at the 1st National Distracted Driving Summit, September 2009

TRIP LAB

- Established in 2009
  - Research: $3 million in funding
  - Education: 100+ students
  - Outreach: ~ 10,000 students statewide

UAB THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

UAB TRIP Lab
Driving Simulator

TRIP
Translational Research for Injury Prevention
LABORATORY

ALABAMA DEPARTMENT OF TRANSPORTATION

HONDA
Honda Manufacturing of Alabama

Distracted Driving Performance

- Distraction Tasks
  - Electronics
  - Working memory tasks
  - Coin-sorting

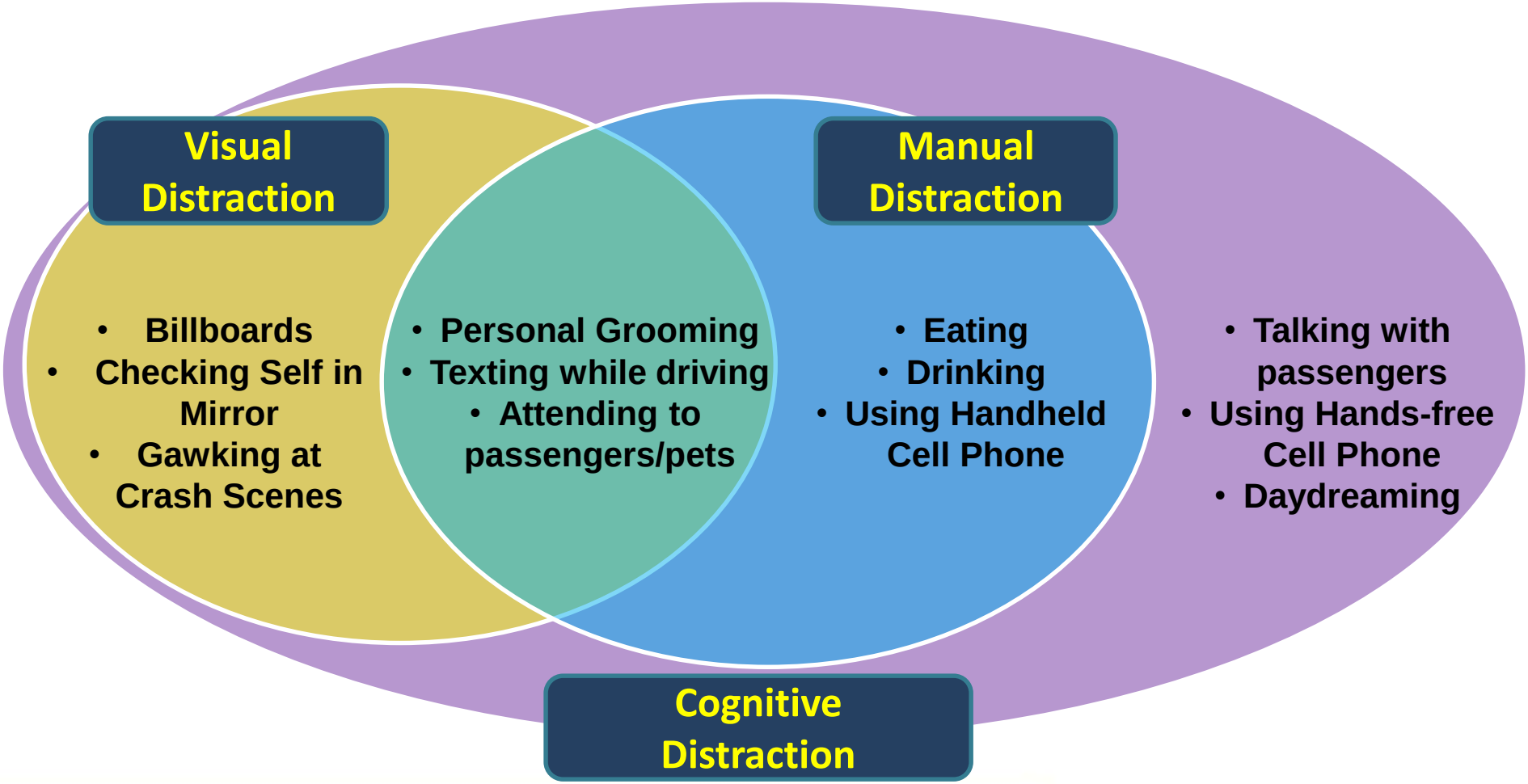
- Performance Measures
  - Lane deviations (swerving)
  - Reaction time
  - Speed
  - % time eyes of road
  - Crashes

Distraction Impacts All Drivers

- Teens and young adults (Stavrinos et al., 2015; Parr et al., 2016)
- Drivers with ADHD (Stavrinos et al., 2015)
- Drivers with ASD (Bishop et al., 2017)
- Older drivers (Stavrinos et al., 2015; Parr et al., 2016)
- Truck drivers (McManus et al., 2017; Stavrinos et al., 2016; Stavrinos et al., 2012)

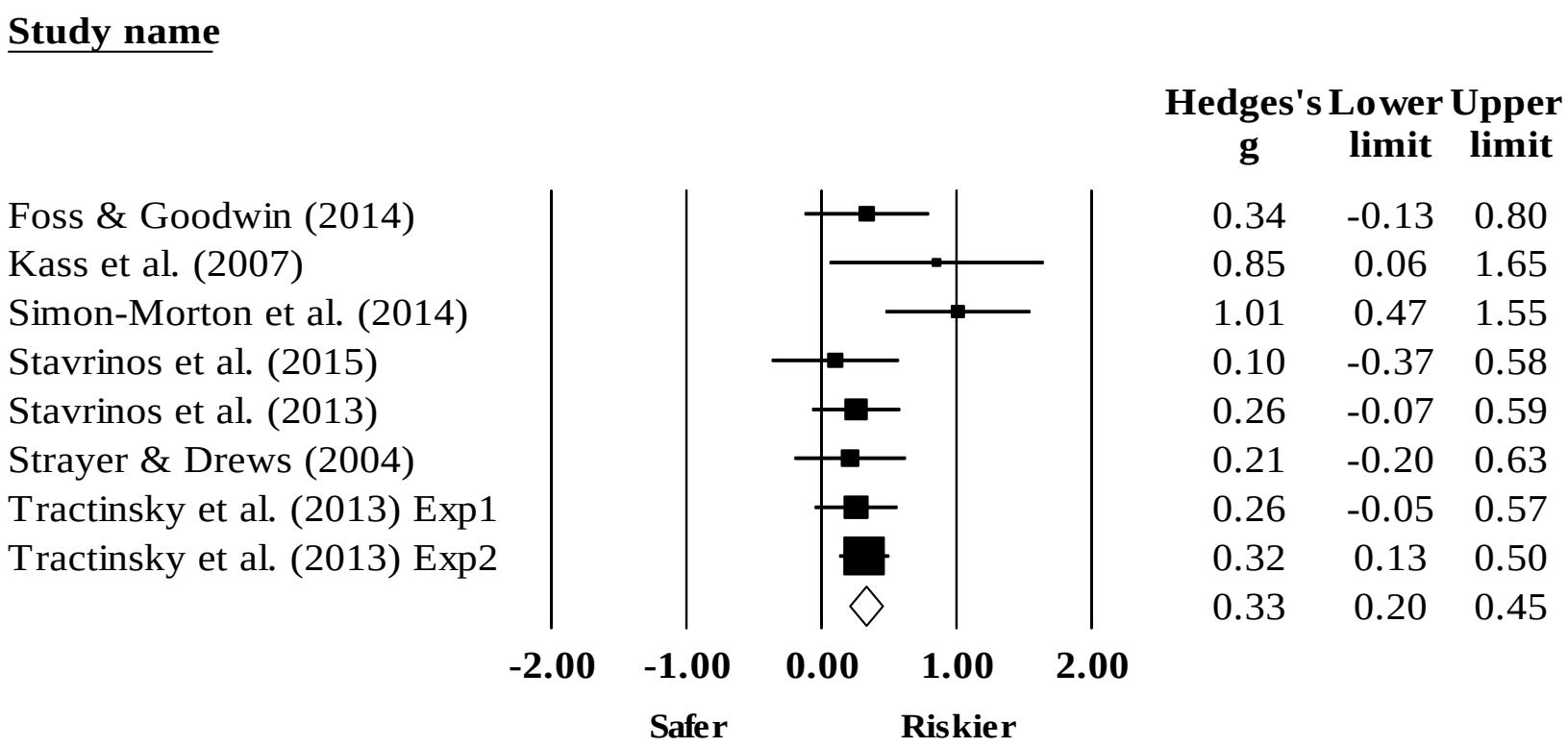
- But, not all tasks are equally detrimental…

Domains of Distraction



National Highway Traffic Safety Administration, 2013

Meta-Analysis of Adolescent Driver Distraction



Forest plot of effect sizes and their 95% CI of mobile technology-related distractions on pediatric driving safety.

Note. The squares representing effect sizes of each study are proportional to their weight in the meta-analysis. The diamond at the bottom of the plot represents the overall effect size in a fixed-effect model.

REACT: **R**oadway **E**xperience and **A**ttentional **C**hange in **T**eens

Funded by
Eunice Kennedy Shriver National Institute of Child Health and Human Development

- Objective: Characterize the roles of age and driving experience under varying levels of distraction
- Method: Longitudinal study of 220 adolescents: 16 and 18-year olds with and without driving experience
- Policy implications: optimal age for licensure and limitations imposed on young drivers

Novice Driver Visual Scanning Patterns

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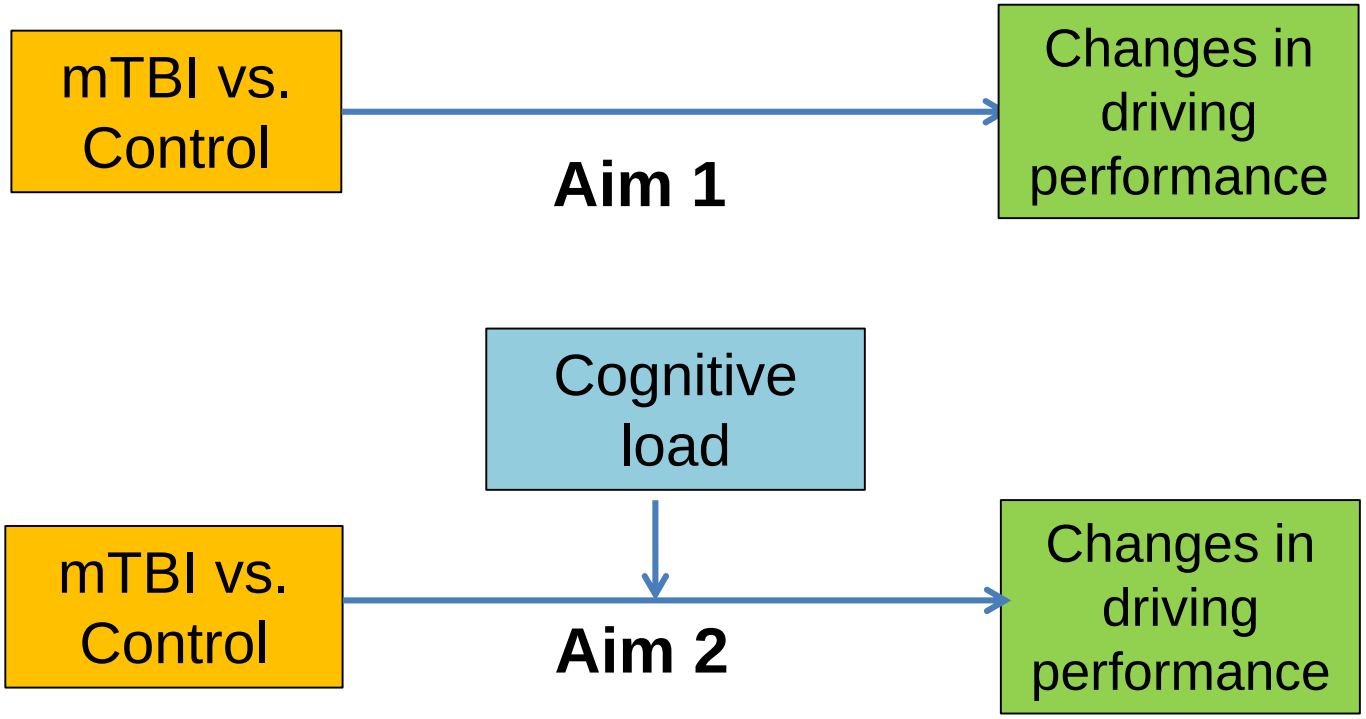
Driving AFTER TBI

Fitness to Drive after Mild TBI in Teen Drivers

Funded by
UAB (Stavrinos, PI) & Ohio State (Yang, PI) Intramural Grants

- Clinical practice guidelines in Canada and Australia recommend -- “no driving within 24 hours of a mTBI”
- In the US, no guidance about when to safely return to drive after mTBI, although physicians commonly prescribe physical and cognitive rest
- Evidence-based guidelines are urgently needed to inform clinical care

Aims


mTBI vs. Control
Changes in driving performance
Aim 1
Cognitive load
mTBI vs. Control
Changes in driving performance
Aim 2

Study Participants

- mTBI cases:
  - ✓ Teen drivers 16 to 20 years
  - ✓ Physician-confirmed mTBI diagnosis
  - ✓ Recruited from concussion clinics at two university hospitals < 2 weeks of mTBI
- Matched controls:
  - ✓ No history of TBI
  - ✓ Matched on sex, age (± 6 months), athlete status (yes/no), and type of license (full/intermediate)

Study Design

- A prospective study with repeated measures
- Two assessment time points: < 2 weeks of injury and 4 weeks post-injury
- Two study sites: OSU and UAB
- Two study groups: mTBI cases and matched controls
- Driving Simulator

Main Measures-Driving Outcomes

CONTINUOUSLY-RECORDED MEASURES OF VEHICLE CONTROL

Driving Performance	Operational Definition
Standard Deviation of Speed	Fluctuation in driving speed
Standard Deviation of Lane Position	Standard measure of steering variability

EVENT-ONLY RECORDED MEASURES OF DRIVER RESPONSE

Driving Performance	Operational Definition
Braking Reaction Time	Time between the presentation of stimulus and first force applied to brake (sum of Neurological Time + Foot Removal Time + Motion Time)
Total Braking Reaction Time	Time between the presentation of stimulus and 200 Newtons (N) of force applied to brake pedal (sum of Braking Reaction Time + Time to apply 200 N of force to brake pedal)

Main Measures-mTBI Related

Domain	Measure
Acute signs, symptoms, mental status	Injury Report Form
Post-mTBI symptoms	Post-Concussive Symptom Scale (PCSS)
Balance	Balance Error Scoring System (BESS)
Neurocognitive variables	Axon Sports Computerized Cognitive Assessment Tool (CCAT)

Preliminary Results

- mTBI cases = 16
- Matched controls = 16
- Mean age (years): 17.6
- Males: 37.5%
- White: 72.7%
- Average time (days) from injury to symptom resolution (symptom free or return to pre-injury level): 20.1
- % of symptoms resolved within 3-weeks: 60%
- Average time (hours) to the first driving simulator assessment after enrollment: 55.2; after injury: 88.2

Difference between mTBIs and controls

Driving Outcomes	mTBI Mean ± SD	Control Mean ± SD
Standard deviation of speed (mph)	4.3±1.6	3.6±1.3
Standard deviation of lane position (mph)	0.8±0.2	0.7±0.2
Average braking reaction time (s)	1.5±0.6	1.3±0.5

Driving performance decrements acutely post-mTBI that improve over time

- Acutely post-injury, increased cognitive load was associated with *increased speed variation* for teens with mTBI (p = .04), but not for controls (p = .79).
- mTBI cases displayed significantly *higher standard deviation of lane position* (p < .001) and *slower brake reaction time* (p = .002) from acutely post-injury compared to 4-week follow up.
- However, *controls displayed no difference* in standard deviation of lane position (p = .28) or brake reaction time (p = .55) between the two time points.

Acute neurocognitive functioning correlated with driving performance

- Slower processing speed measured acutely post-injury was positively correlated with *increased standard deviation of lane position* (r = .71, p = .003) in teens with mTBI but not in the matched controls.

- Pre-post data showed *no increase in post-concussion symptoms*, suggesting the driving simulator testing was safe (e.g., pre-testing PCSS = 18.3; SD = 17.4 and immediately following driving simulator testing PCSS = 19.7; SD = 5.7; p = .312).

Conclusion

- Teen drivers with a mTBI show simulated driving performance decrements acutely post-injury as compared to matched healthy controls;
- These decrements are further exacerbated in conditions of increased cognitive load;
- Teen drivers with a mTBI also show significant improvement in simulated driving performance from acutely post-injury as compared to 4-week follow up.

Study Team

- Investigators:
  - Ginger Yang (co-PI; Nationwide)
  - Benjamin McManus, PhD (UAB)
  - Drew Davis, MD (UAB)
  - Kathy Monroe, MD (UAB)
  - Thomas Novack, PhD (UAB)
  - James Robinson, MD (UA)
  - Thomas Kerwin, PhD
  - Keith Yeates, PhD
  - Richard Rodenberg MD
  - James MacDonald, MD
  - Michael Tiso, MD
  - Don Stredney, MS
  - Jennifer Bogner, PhD

- Research Teams at:
  - UAB and OSU

- Collaborators:
  - NCH/OSU/UAB Athletic Trainers
  - NCH/OSU/UAB Contracted Schools
  - Children's of Alabama Concussion Clinic
  - University of Alabama Sports Medicine

- *… and our study participants!*

Simulated Driving Assessment of Fitness-to-Drive Following Moderate-to-Severe TBI

Funded by
UAB Functional Neurorecovery Grant

- Objective: Examined the ability of a high-fidelity driving simulator to assess driving performance in individuals who have sustained a moderate-to-severe TBI

- Method: Participants drove through series of driving modules; half were released to drive (n=7) and half were considered never to be able to return to driving (n=7); neurocog assessment

- Implications: Development of an objective clinical assessment tool with external validity

Simulator Scenario Development

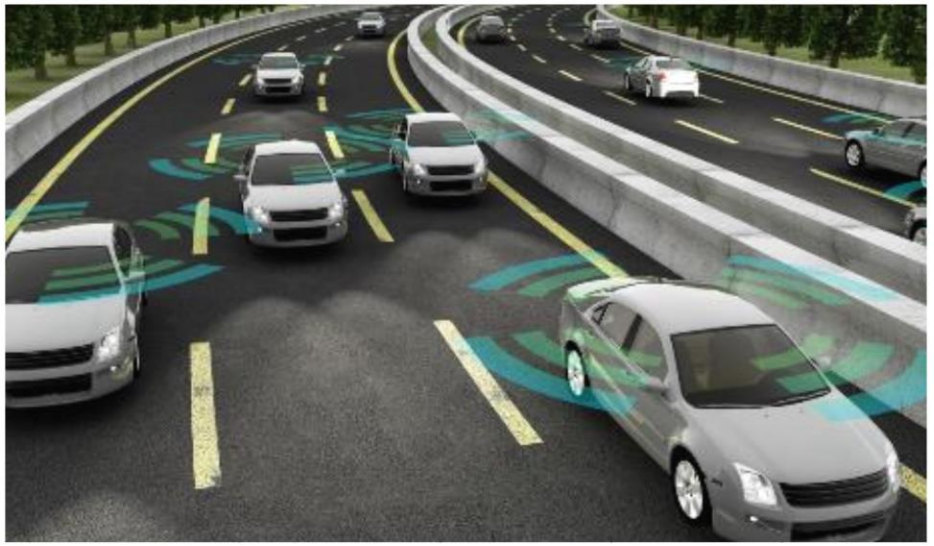
1 and 2	3	4	5

- Module 1: Basic Vehicle Operation
- Module 2: Secondary Task
- Module 3: Car Following
- Module 4: Divided Attention
- Module 5: Left Turns at Intersections

Preliminary Results

- Non-drivers showed more lane variability than active drivers (t = 2.39, p = .04, partial η^2 = .36).
- For active drivers, higher order cognitive processes (i.e., working memory) were associated with driving metrics, suggesting convergent validity.

Future Challenges and Opportunities



Strategies to Reduce Distracted Driving

- **Education and Outreach**
  - Driver Education
  - Media
- **Advocate Strong Laws**
  - Enhanced Penalties
  - More enforcement
- **Technology**
  - Advanced Driver Support Systems
- **Enforcement**
  - Partnerships with law enforcement

Distracted Driving Goals

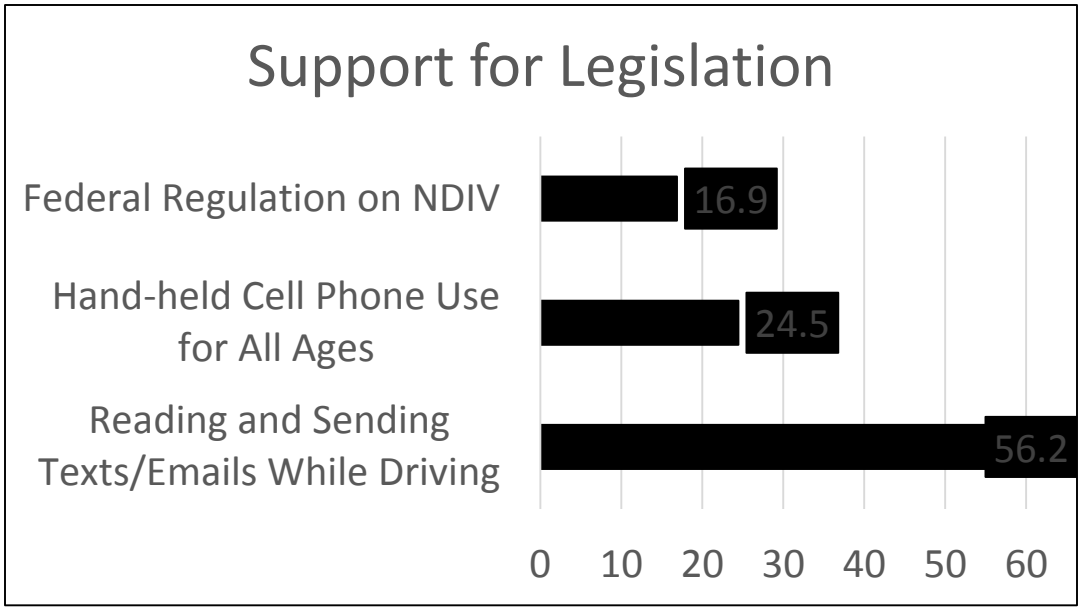
- **Educate Drivers** about distracted driving and its consequences
- **Inspire People** to change attitudes/behaviors
- **Encourage Passengers** to speak up
- Make **Socially Unacceptable** the use of phones while driving

Traffic Safety Culture

- Conflicted feelings about phone use while driving
  - Most know its unsafe but do it anyway
  - Most hate when others do it but then do it themselves
  - They hate the risk but love the convenience
- VERY FEW say they never use the phone while driving
  - Those who don't are more likely to be older (55+), without kids at home and/or not employed full time

Adolescents' Perspectives on DD Legislation

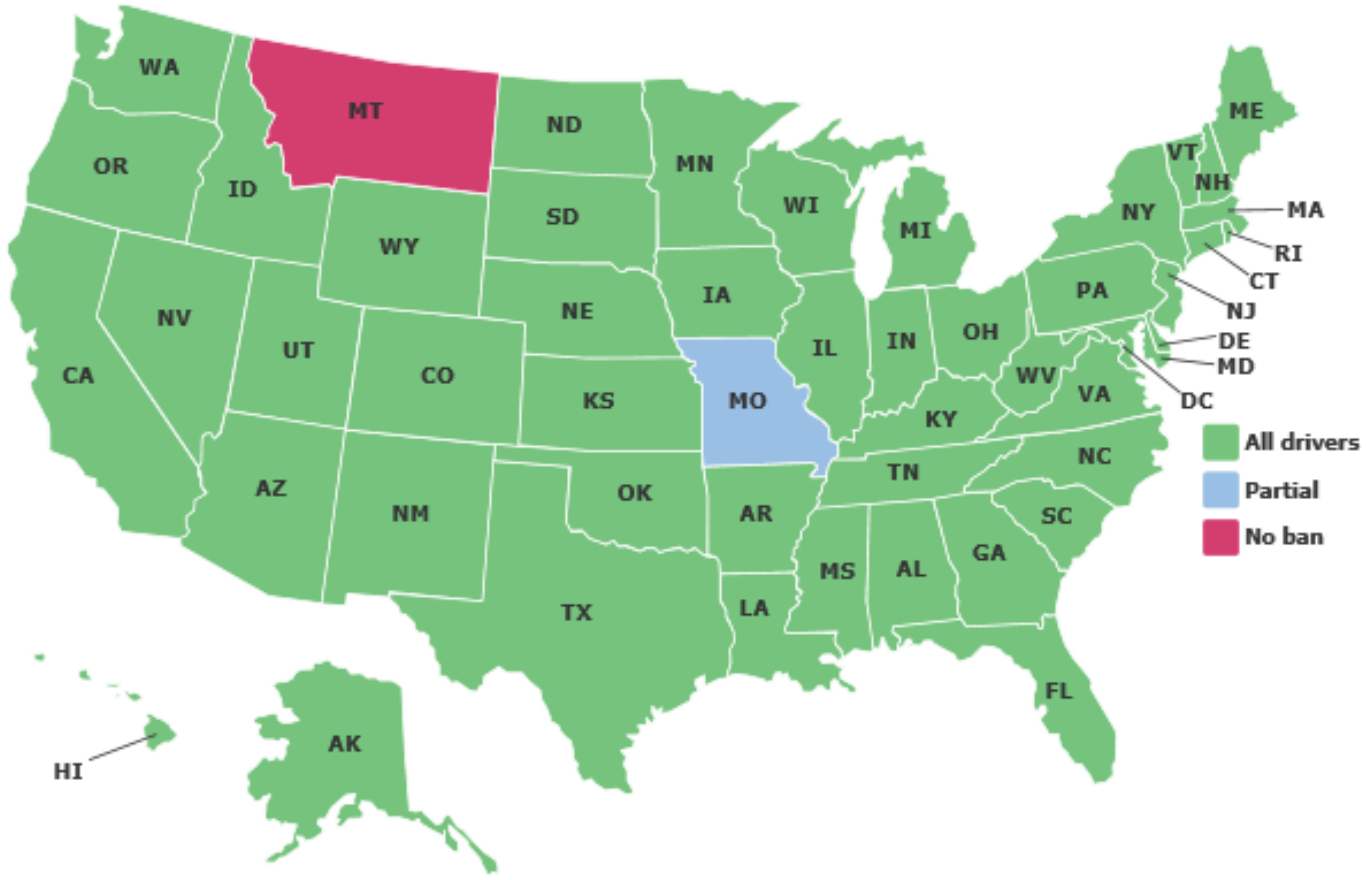
- Lack of compliance undermines bans to curtail risky behavior
- 379 high school driver's education students (ages 15-19) reported



Pope, Mirman, & Stavrinos, 2018

Opportunities: Policy

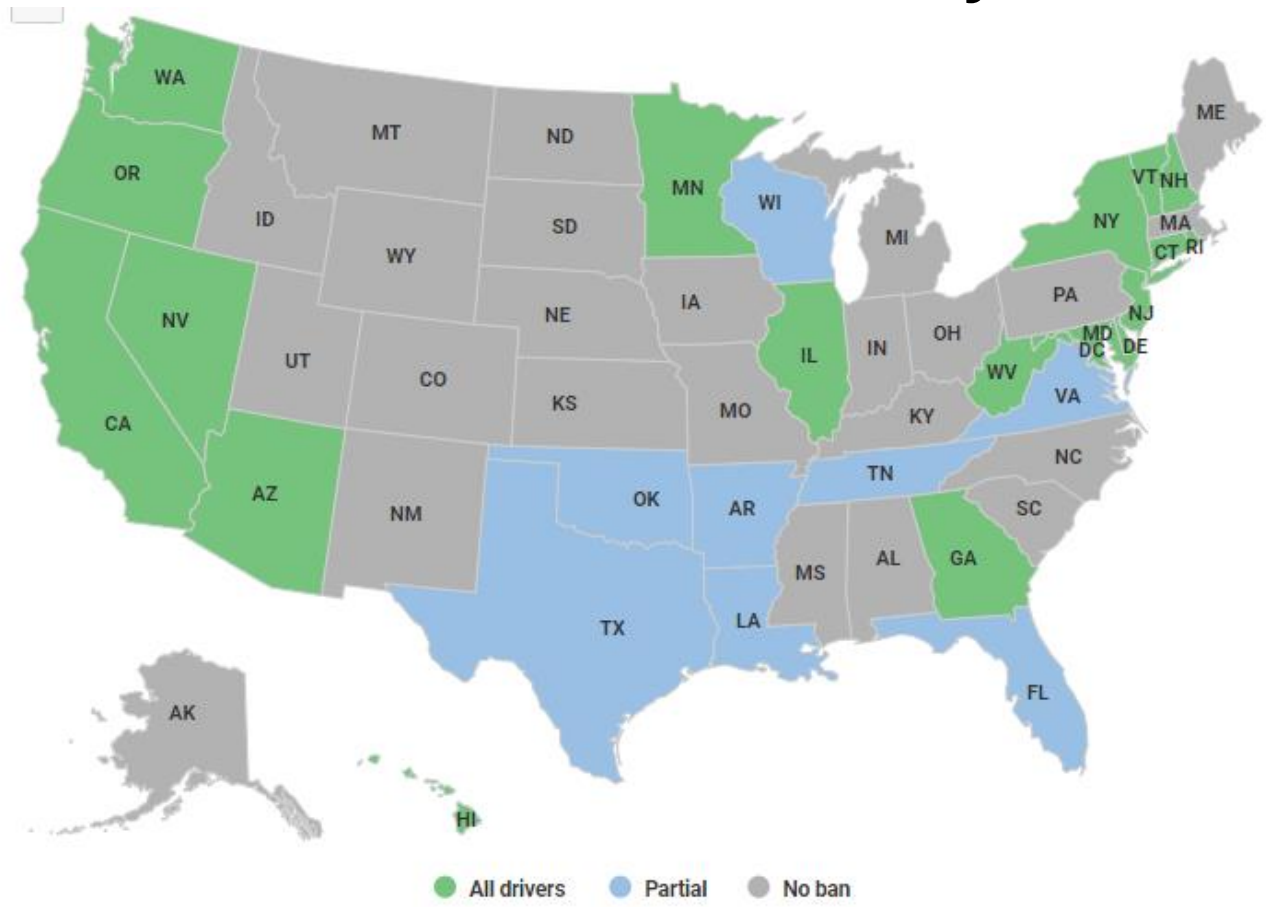
Texting Bans as of May 2019



Insurance Institute for Highway Safety, 2019

Opportunities: Policy

Hand-held Bans as of May 2019



Insurance Institute for Highway Safety, 2019

Impact on Our Community

Mother of teen killed in distracted driving wreck accepts diploma in her memory

018 at 12:45 AM CDT - Updated August 15 at 11:47 AM

(WBRC) - The mother of a teen killed in a texting and driving wreck accepted the she would've received Tuesday night.

We were there for the emotional graduation ceremony.

This is a day most teens and their parents look forward to.

But after Camryn Callaway, 17, was killed in a distracted driving wreck earlier this year, her mother knew she wouldn't get to see her daughter in her cap and gown walking across the stage.

So on Tuesday, her mother Michelle Lunsford accepted her daughter's diploma in her memory.

Community Outreach

- Summer workshop for high school students
- Summer internships for undergraduate students
- High school assemblies in the Greater Birmingham area
- URKEYS2DRV events with Children's of Alabama
- In-house TRIP Lab/simulator tours

Collaborators

UAB

- Civil, Construction, and Environmental Engineering
- Computer and Information Sciences
- Epidemiology
- Neurobiology
- Nursing
- Pediatric Emergency Medicine
- Pediatric Rehabilitation
- Physical Medicine and Rehabilitation
- Preventive Medicine
- Psychiatry and Outpatient Clinics
- Psychology
- Sports Medicine
- Surgery

External

- AAA of Alabama
- Alabama Department of Public Health
- Alabama Department of Transportation (ALDOT)
- Children's Hospital of Alabama
- Children's Hospital of Philadelphia
- Cincinnati Children's Hospital
- Elborn College
- Ferdowsi University of Mashad, Iran
- Georgia Institute of Technology
- Honda Manufacturing of Alabama
- Nationwide Children's Hospital
- Penn State
- Regional Planning Commission of Greater Birmingham (RPCGB)
- School Systems
- Texas A&M University
- UHaul International, Inc
- University of Alabama
- University of Florida
- University of Iowa
- University of Pennsylvania
- University of Washington
- Virginia Tech Transportation Institute

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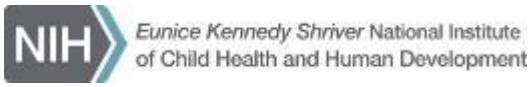

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Questions?

Despina Stavrinos, Ph.D.
Associate Professor
Director, TRIP Laboratory
Department of Psychology
University of Alabama at Birmingham
P: 205.934.7861
email: dstavrin@uab.edu

TRIP
Translational Research for Injury Prevention LABORATORY

Lab website:
www.triplaboratory.com