What Do We Mean by Distracted Driving?

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Advancing Transportation Through Innovation

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Advancing Transportation Through Innovation Distracted Driving: Current Flot Topic "Distracted driving is unsafe, Google "distracted driving" = irresponsible and in a split second, its 46 million results consequences can be devastating." "Students get a 'crash course' in distracted driving" – www.distraction.gov – N. Andover Eagle-Tribune "How serious are the "Distracted Driving Laws dangers? Deadly serious" Stretch to Your Smartwatch" -www.endDD.org – www.slashgear.com "Distracted driving is a "Ending Distracted Driving is Everyone's deadly behavior." Responsibility." – AAA Foundation for - National Safety Council Traffic Safety



In the Good Old Days...

• All we did was put both hands on the wheel, head out on the highway, and pay attention to the road... right?









1956 Chrysler Highway Hi-Fi



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Decades of Diversions



Modern Technology: Ubiquitous & Ever Changing



https://www.google.com/glass/start/how-it-look







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Not to mention...







Early Driving Safety Research: Gibson & Crooks, 1938

• Field of Safe Travel: "The field of possible paths which the car may take unimpeded"



Fig. 1. The Field of Safe Travel and the Minimum Stopping Zone of a Driver in Traffic



Gibson & Crooks, 1938: "A theoretical field-analysis of automobile-driving"

- "Inattentiveness in the driver usually means that objects...not pertinent to locomotion stand out in his visual field and that *consequently his field of safe travel, if it exists at all, may become incorrectly bounded.*"
 - i.e. the *actual* field of safe travel may contract without the driver's awareness
 - While his *behavior* may not reflect this



Early Research in Attention &

- Senders et al. (1967): "The attentional demand of automobile driving"
- (aka why we need IRB)



Early Research in Attention & Driving

- Brown (1965)
 - Listening to music & speech programs on radio did not negatively impact driving
- Brown, Tickner, & Simmonds (1969)
 - Talking on a "radiophone" impaired some gapacceptance judgments
- Holahan, Culler, Wilcox (1978)
 - External visual distractions impaired reaction time to sign text
- Roughly 30 articles from 1970 2000



A Recent Explosion in Research





Milestone Papers on Distracted Driving

- Alm & Nilsson (1995)
 - Driving simulator while doing memory task on phone
 - Longer brake reaction time & higher workload; no increase in headway
- Redelmeier & Tibshirani (1997)
 - Epidemiological study, compared phone records of drivers to determine risk of talking on phone
 - Found 4x increase in risk within 5 minutes of crash
- Strayer & Johnston (2001)
 - Used a very basic driving simulator (tracking task)
 - Natural conversation on cell phone increased risk of missing traffic signals, increased tracking error



Milestone Papers on Distracted Driving

- Strayer, Drews, & Johnston (2003)
 - Used hi-fi driving simulator & hands-free phone to study visual attention during casual cell phone conversations
 - Reaction time to a braking vehicle & sign recognition impaired by conversation
- Klauer, Dingus et al. (2006)
 - First large-scale naturalistic driving study (~100 vehicles)
 - Eyes-off-road >2s (out of 6) significantly increased risk
 - Dialing hand-held phone: 2.8x greater risk, but talking/listening hand-held device *no increased risk*
- Owens, McLaughlin & Sudweeks (2010; 2011)
 - On-road & test track experimental study
 - Handheld texting, dialing & music selection: greater task duration, # and duration of interior glances, mental demand, steering variance than baseline
 - Handheld conversation, voice-control not associated with performance deficits



How do we Effectively Study Driver Behavior?

Experimental Control

• Driving Simulators

- Tight experimental control, but lack realism
- Test Tracks (Smart Road)
 - Little/no traffic, subjectively less risk than public roads

• On-Road Experiments

• Drivers experience real road conditions, but with some control & oversight

Naturalistic Driving Studies

• Allows exploration of behaviors not otherwise available

• Epidemiological Studies

Completely real-world, but no control or detailed information



"Real-World" Validity

Is Driver Distraction Old News?

- Decades of research
 - Google Scholar "distracted driving": ~150,000 results
- Multiple methodologies
 - Epidemiological
 - Simulation
 - On-Road Experimental
 - Naturalistic



Fundamental Questions

- Looking away from the road = risky
- Cognitive distraction = ?
- Changing technologies
 - In-vehicle interfaces/touchscreens
 - Smartphones
 - *Big* smartphones?
 - Smartwatches
 - What's next?



New Data: SHRP2

• Largest ever naturalistic data collection effort



- 2010 2013; >3500 participants, 50M miles, ~2 PB of data
- Video, GPS, network sensors, radar, machine vision



Crash Risk Overview: Dingus et al. (2016)

- First overview of crash risk factors from SHRP2 Data
- Case-cohort approach (~1500 L1-L4 crashes crashes matched to random controls)
- Logistic regression used to calculate crash risk vs. "model driving" (alert, attentive sober)



Dingus et al. (2016)

- Distraction results:
 - Adjust radio: OR = 1.9 (1.2 - 3.0)
 - Adjust climate control: OR = 2.3 (1.1 5.0)
 - OR = 6.1 (4.5 8.2)- Texting:
 - Handheld talk:
 - Eating:

- OR = 2.2 (1.6 3.1)OR = 1.8 (1.0 - 3.3)



Cognitive Distraction: (Dingus, Owens et al. 2019)

- Examined risk of *primarily cognitive* tasks
- 905 Level 1-3 Crashes (excluded curb strikes)
 - *Single-task only* & no drowsiness or impairment
- Case-cohort baselines; not matched by driver
 - Compared to both "model" driving (e.g. no secondary tasks) & all-driving controls
- Included analyses of several hand-held tasks



Cognitive Distraction: (Dingus, Owens et al. 2019)

• Results (crash levels 1-3)

	Model Driving	All Driving
Talking/Listening Handheld	1.3 [0.8 – 2.0]	0.8 [0.5 – 1.2]
Talking/Listening Handsfree	0.4 [0.1 – 1.6]	0.3 [0.1 – 1.0]*
Interacting w/Passenger	1.3 [1.0 – 1.6]	0.8 [0.6 – 0.9]
Adjust Radio	1.6 [0.9 – 2.9]	1.0 [0.5 – 1.8]
HH Texting/Dialing	2.6 [1.7 – 3.9]	1.5 [1.0 – 2.2]

* OR = 0.25 [0.1 – 0.8] if includes other tasks, impairment, drowsiness



Case-Crossover Analysis of Cell Phone Usage: Owens, et al. (2018)

- Case-crossover analysis of cell phone usage
 - Matched cases (crashes) w/controls by same driver, similar conditions (weather, lighting, time of day, speed, etc.)
- 566 crashes (fewer due to matching reqs)
 - 1,749 matched baseline epochs
- Separate conditional logistic regression models for each task



Case-Crossover Analysis of Cell Phone Usage: Owens, et al. (2018)

• Results Summary (ORs):

	Model Driving	All Driving
Hand-Held Talking	1.2 [0.5 – 2.7]	0.9 [0.5 – 1.5]
Hands-Free Talking	ns	0.1 [0.0 – 0.8]
Texting	2.2 [1.1 – 4.6]	2.2 [1.4 – 3.4]
Overall Visual-Manual	1.8 [1.0 – 3.3]	1.7 [1.2 – 2.4]



Lots of Data – What's it all Mean?

- Really complicated to determine "risk"
 - Risk relative to what?
 - How do we define a task?
 - How do we define a critical incident? (crashes? Severe?)
- Take-homes from real-world studies:
 - Looking away from the road is risky!
 - Does not appear to be an increase in crash risk from cognitive tasks



The Future: Age of Complexity & Automation



2019 Tesla Model X





The Future: Multimodal Transportation

- Distracted walking
- Distracted...scooting?



www.forbes.com



https://www.nytimes.com/2017/10/23/business/honolulu-walking-and-texting-fine.html



Wrap it Up!

- Driver distraction is not a new problem
- But it's still being understood
- Changing with technology & social norms
- Fundamental truth:
 - You have to look at the road to drive safely!
- Perhaps eventually a non-issue with automation
 - ...eventually





Questions?

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