Towards understanding mobile device use in Commercial Motor Vehicle Drivers: Do drivers interact as a drowsiness countermeasure ?

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3rd International Conference on Driver Distraction and Inattention
Gothenburg, Sweden, September 4-6, 2013

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Outline

- Motivation
- Research Questions
- Key Concepts
- Method
- Results
- Summary & Conclusion

Motivation

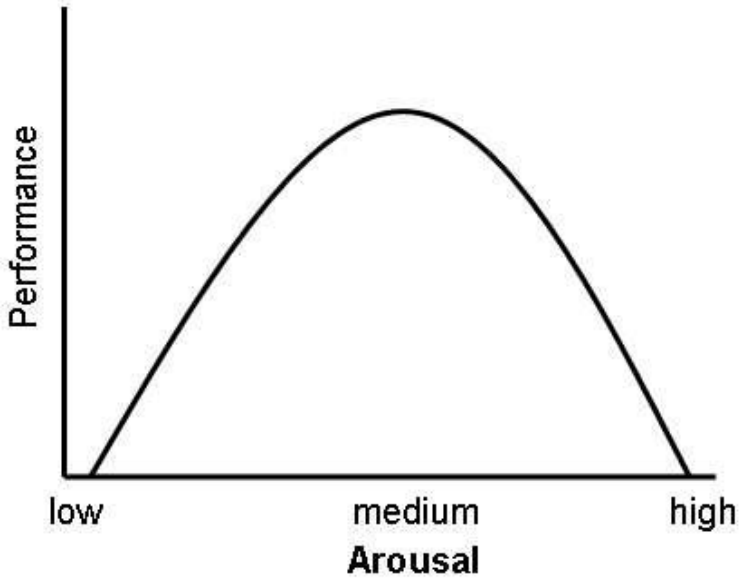
- Much focus on secondary tasks is negative impacts
- FMCSA has banned some secondary tasks
- Level of arousal may impact secondary task engagement
- Hypothesis: Secondary task engagement may support driver performance, especially at low arousal levels

Research Questions

- The current research examined the relationship between drowsiness and mobile device use
  1. How does the percent of mobile device use in the current research compare to estimates from other sources
  2. Whether the percent of mobile device use differs as a function of time of day (i.e., drowsiness)

Optimizing Arousal

- Yerkes and Dodson (1908): arousal and performance



- Hebb (1955): optimal level of arousal
- Curry, Meyer and Jones (2013): driving context

Circadian Rhythm and Drowsiness

- Time of day effects arousal via circadian rhythm
- Wylie et al. (1996):
  - Higher level of drowsiness at night vs. day
    - Especially evening to dawn
  - Performance decrements during high drowsy periods

Drowsiness Countermeasures

- Baker, Bowman, Nakata, and Hanowski (2008):
  - Drivers converse on CB radio to alert themselves
- Jellentrup, Metz, and Rothe (2011):
  - Morning block- decrease in blink duration during and 10 minutes after *first and second* phone calls as compared to 20 minutes before the calls
  - Afternoon block- decrease in blink duration during and 10 minutes after *first* phone call as compared to 20 minutes before the calls

Drivers and MDU

- Fitch et al. (2013):
  - Talking on hand-held cell phone lead to significant *decrease* in mean eyes-off-the-road time and lane deviations
  - Participants were talking on a cell phone, hand-held or hands-free, for 10.6% of the time
- National Occupant Protection Use Survey (NOPUS, 2011)
  - 5% of drivers used hand-held cell phone and 4% used hands-free cell phones; 9% total

Definitions

- Operational Definitions
  - Time of day: time based on the 24 hour Clock

Subtask	Definition
Dial Cell Phone	Dials phone, may include answering or hanging up
Text Message on Cell Phone	Text messaging, may include focusing on cell phone for period of time and pressing keys
Talk/Listen to Hand-Held Phone	Holds a hand-held phone to his/her ear
Talk/Listen to Hands-Free Phone	Has an earpiece in his/her ear and conversing
Talk/Listen to CB Radio	Appears to be conversing on CB radio
Interact with/Look at Dispatching Device	May include holding device on lap/steering wheel while using device. Typically kept on floor or passenger seat
Mobile Device Use (Including All Devices and Subtasks)	Performing any subtask listed above

Secondary Analysis Datasets

- Driver Distraction in Commercial Vehicle Operations (CVO)
  - Used Naturalistic Truck Driver Dataset (NTDS)
  - Data collection included video and logbook
  - Provided secondary task data from video
- ~ 4000 baseline epochs used (normal, non-eventful driving) to give picture of general device use
  - Estimate based on randomly selected epochs

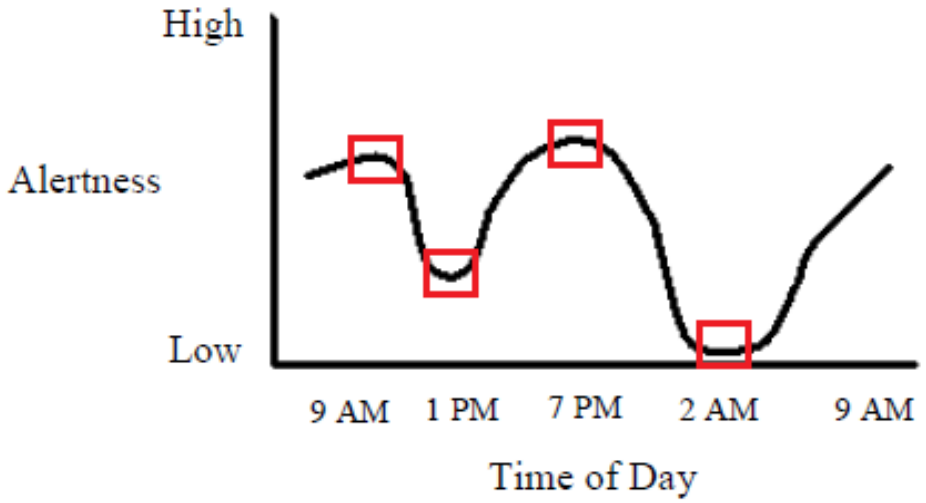
MDU Results: Comparing to Other Sources

- Used hand-held cell phone 4.3% of time; hands-free cell phone 4.0% of time = 8.3%
- Total mobile device use (cell phone, CB radio, and dispatching device) = 10.4%

- NOPUS (2011) = 5% + 4% = 9%
- Fitch et al (2013) = 10.6%
  - Light vehicle drivers

Circadian Bins

- Divided data into bins based on circadian rhythm high and low periods



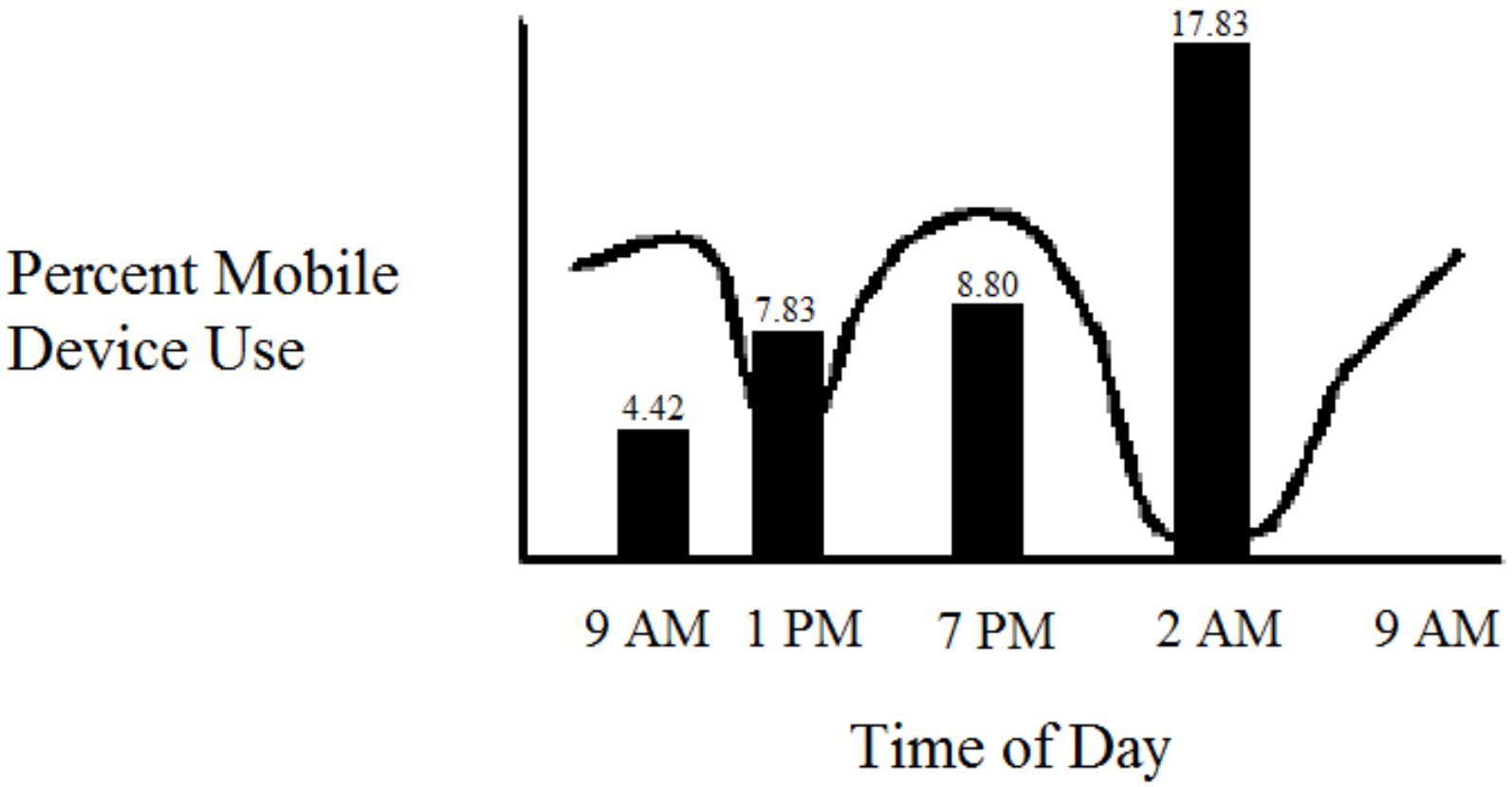
Bin	Time of Day
Low Morning Bin	2:00AM – 3:59AM
High Morning Bin	9:00AM – 10:59AM
Low Afternoon Bin	1:00PM – 2:59 PM
High Evening Bin	7:00PM – 8:59PM

Bin Analysis

- GLMM with logit link function: Predict the odds as a function of the presence of mobile device use for baseline epochs as a function of circadian bins
- Chi-square test: Percent of mobile device use change across bins?
- Calculate percent of MDU:

$$\frac{\text{Number of BL with mobile device use}}{\text{Total number of BLs}}$$

Results


Percent Mobile Device Use
4.42
7.83
8.80
17.83
9 AM
1 PM
7 PM
2 AM
9 AM
Time of Day

Results

- GLMM results: $p < .001$
- Chi-square
  - Significant differences in percent across bins
- Chi-square for each bin
  - Low morning bin (2:00 – 3:59 a.m.) had significantly higher percent of mobile device use than all bins

Summary

- MDU identified with the truck drivers in this study was comparable to other sources of MDU (NOPUS and Fitch et al.)
  - Further support for NDS *ecological validity*

- Low morning bin (circadian low) had the highest percentage of MDU (17.8%)
  - ~70% greater than the 10.4% when considering the entire dataset of MDU

Conclusions

- Findings provide support for hypothesis that drivers may engage mobile devices as a countermeasure to drowsiness
  - Optimizing arousal (Hebb, 1955)
  - Curry, Meyer and Jones (2013):

> *"What may be needed is to take an alternative perspective with regard to the entire issue of driver distraction and driver workload... it may be necessary to focus (instead) on optimizing the level of driver workload to increase involvement in the driving task (itself)."*

QUESTIONS?