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Physical and Cognitive Demands Associated with Police In-vehicle Technology Use: A Naturalistic Study

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INTRODUCTION

- Crash reports from various states in the U.S. have identified an alarming number of crashes involving police vehicles.
- The crashes are mainly caused by officers' interactions with different in-vehicle technologies.
- Previous studies have assessed officers' interaction with in-vehicle equipment and found negative physical (e.g., extreme torso rotation and shoulder elevation) and cognitive effects (e.g., driving distraction) (Donnelly et al., 2009; McKinnon et al., 2014; Zahabi & Kaber, 2018).
- However, those assessments were limited to specific equipment, short exposure time, and were typically conducted in laboratory settings with simulated environments.
- The **objective** of this study was to conduct a naturalistic driving study to identify the most physically or cognitively demanding human-technology interactions in police vehicles.

METHOD

- **Participants: 10** police officers from state-wide departments participated in a 3-hr ride-along
- **Equipment:**
  - BioStamp Npoint wearable sensors
  - Pupil Labs eye tracking glasses
- **Measures:**
  - Perceived workload
  - Physiological measures of cognitive load (percentage change in pupil size)
  - Muscle activity (sensors were placed on three muscles: Brachioradialis , Triceps Brachii , Medial deltoid)

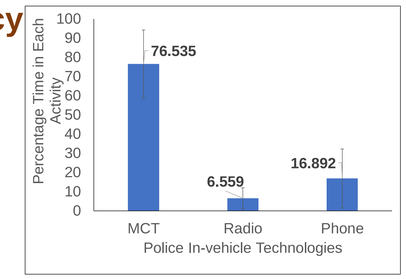
BioStamp Wearable Sensors

Pupil Labs Eye Tracking Glasses

RESULTS

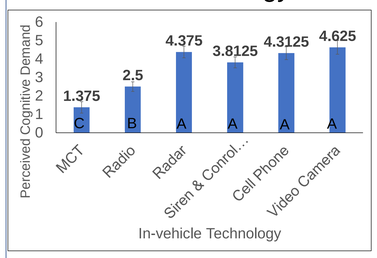
Technology use frequency

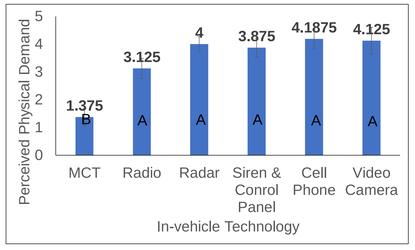
- MCT is the most frequently-used technology for police officers while driving.



Perceived demands

- MCT is perceived as the most physically and cognitively demanding in-vehicle technology.





Driver activity load index (DALI)

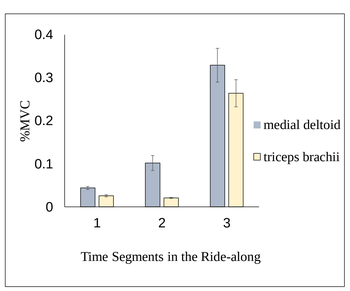
- A significant effect of primary patrol officer experience on the response ($F(1,7) = 6.33$, $p = .04$)
- Officers with more experience as a patrol officer perceived more workload

Percentage change in pupil size (PCPS)

- Significant effect of police departments ($F(3,5.91) = 18.28$, $p = .0021$) on pupil size
- Officers from the less populated cities were found to have the lowest PCPS (lowest cognitive load)

%MVC

- Significant effect of ride-along duration ($F(1,94.8) = 4.12, p = .045$) on the %MVC for the medial deltoid muscle
- Significant effect of ride-along duration on the response ($F(1,112.1) = 15.17, p = 0.0002$) for the triceps brachii
- %MVC increased with the time



CONCLUSIONS

- MCT is the most frequently used in-vehicle technology for police officers. Our findings are in-line with prior investigations using subjective ratings and driving simulations (e.g., Zahabi and Kaber, 2018a)
- MCT is perceived to be the most physically and cognitively demanding in-vehicle technology for police officers. This finding is in-line with officers' perceptions in other states (e.g., North Carolina, Kansas).
- Officers with more experience as a patrol officer had higher workload as indicated by DALI results. The findings might be due to their level of experience with new technologies.
- Officers who were working in more congested areas experienced higher cognitive workload. This might be due to more license plate checks in congested areas.
- The EMG and eye-tracking measures did not reveal any significant effect of the in-vehicle technology type on driver physical and cognitive workload. This might be due to frequent switching between the tasks.
- Future investigations should validate the findings of this study with higher sample size and in longer durations.

APPLICATIONS

- This study provided a comprehensive physical and cognitive mapping of the interactions between officers and different in-vehicle technologies.
- The findings may be used by vehicle manufacturers and technology developers to optimize future vehicles and in-vehicle equipment design to best fit human capabilities and improve safety.

ACKNOWLEDGMENT

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