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Detection of Mind Wandering during Simulated Delegated Driving: Influence on Physiological Measurements

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Attentional state and accidents

- ❑ 90 % of the road accidents= Human error
- ❑ Inattention= 3rd factor in road accidents



DISTRACTION



**INATTENTION
MIND WANDERING**

Mind wandering and driving behavior

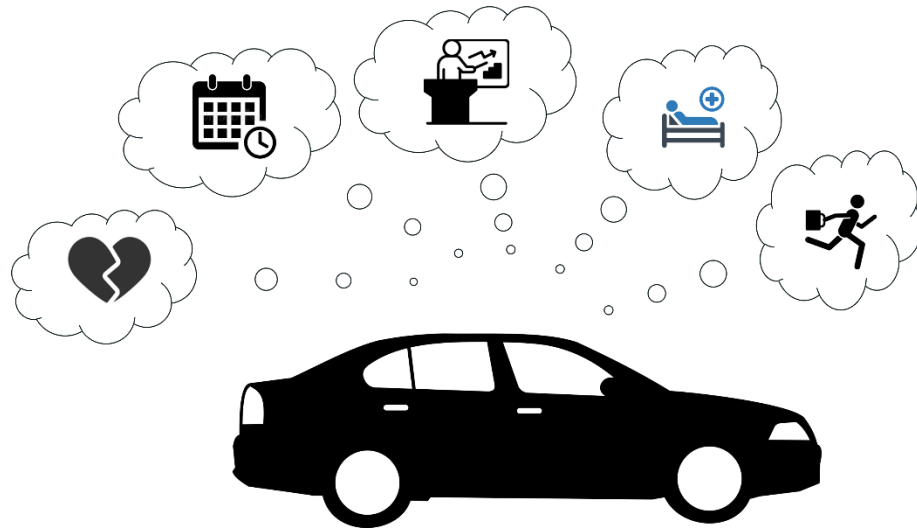
Very common phenomenon while driving
(*Berthié et al., 2015....*)



Consequences on driving behavior

- Alteration of driver's vehicle control
(*Lemercier et al., 2014*)
- Longer RT to sudden events, higher speed and shorter headway distance
(*Yanko et al., 2014*)
- Restriction of visual scanning
(*He et al., 2011; Lemercier et al., 2014*)

Mind wandering and accidents



Contributing factor in 50% of
distraction-affected fatal crashes
(Qin et al., 2019, Journal of safety Research)

Increase the risk of being responsible
for a traffic crash
(Galéra et al., 2012, BMJ)

Delegated driving: a solution?



INATTENTION +++



Monitoring driver's internal state: what are the possibilities?

- ❑ Link between Mind Wandering and autonomous system :
 - ❑ Parasympathetic system: Heart rate variability (*Ottaviani et al., 2015*)
 - ❑ Sympathetic system: Electrodermal measures (*Brishtel, 2020*)

Driver monitoring and delegated driving

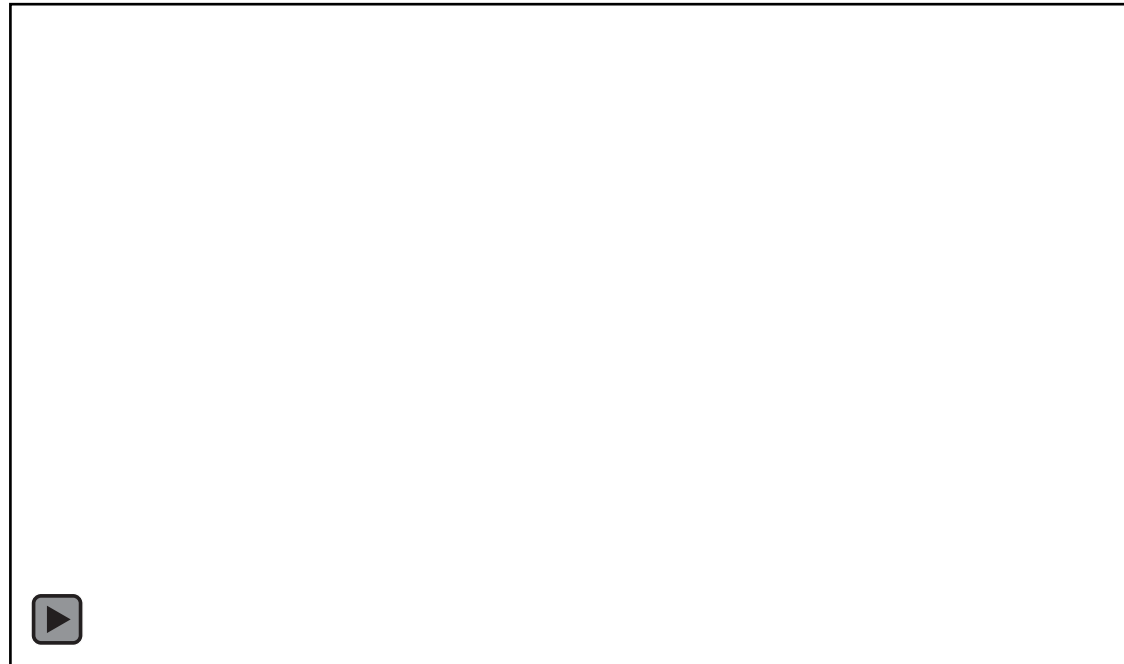
Define the impact of Mind Wandering on the physiological system during delegated driving



Electrodermal activity



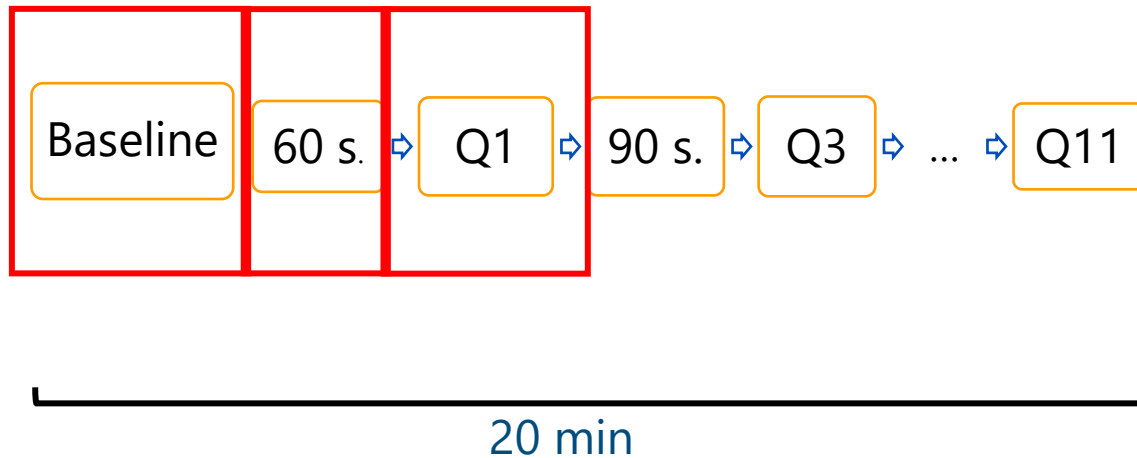
Cardiac and respiratory activities



Method



43 participants



On task ($M = 3,721$)

Mind wandering ($M = 5,744$)

Analysis

☐ Reactivity score

☐ To control variability between individuals

☐ For normalization – subtracting **baseline** scores from the **60 seconds before the onset of a questionnaire**



Cardiovascular data

Heart rate variability (RMSSD)

Probe * MW situation
 $F(10,451) = 1.047, p = .403$

Probe
 $F(10,451) = .467, p = .911$

MW situation
 $F(1,451) = .011, p = .916$

Breathing data

Respiratory rate (RR)

Probe * MW situation
 $F(10,451) = .916, p = .518$

Probe
 $F(10,451) = .410, p = .942$

MW situation
 $F(1,451) = 2.847, p = .092$

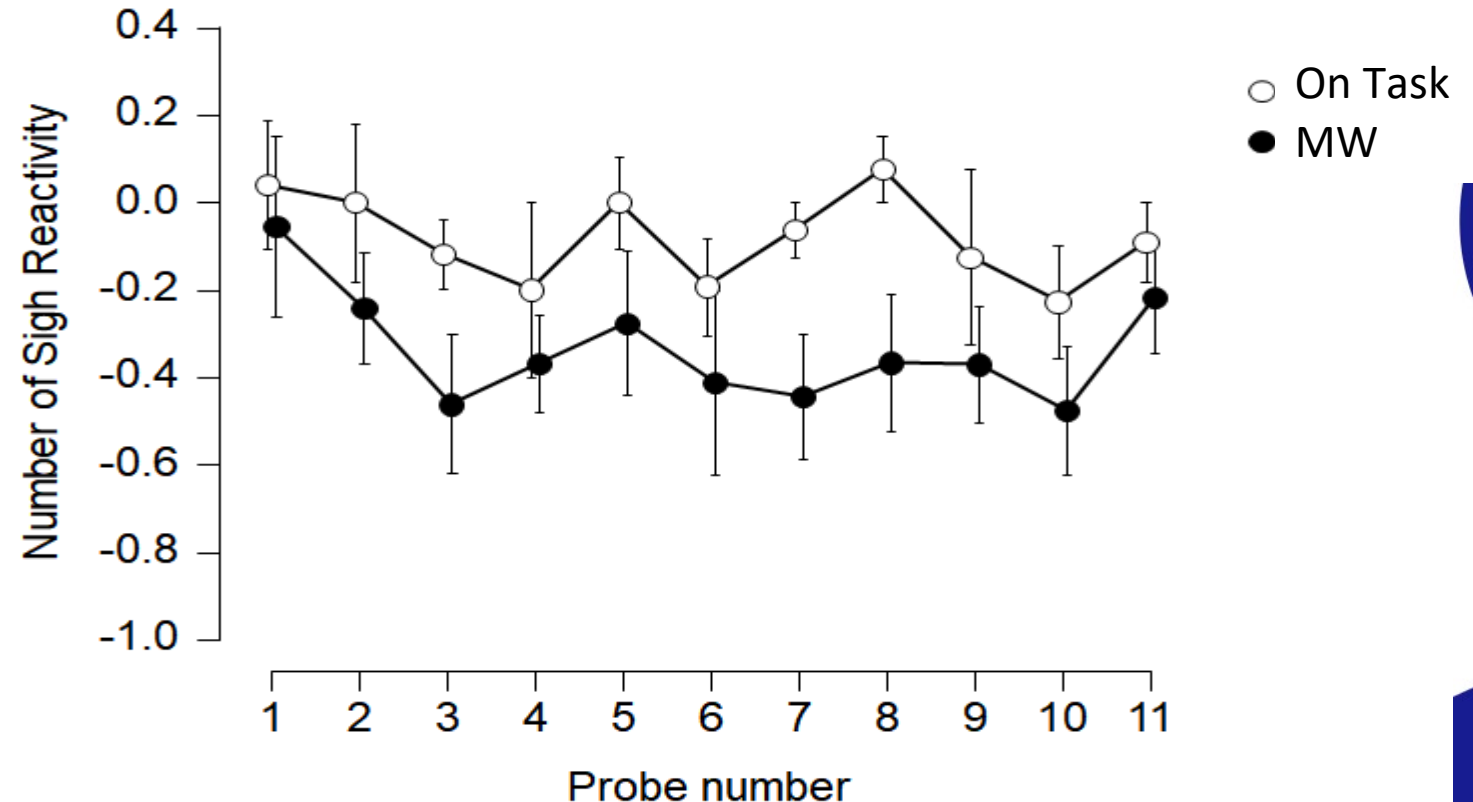
Respiratory data

□ Number of sigh

□ Probe * MW situation
 $F(10,451) = .210, p = .995$

□ Probe
 $F(10,451) = .861, p = .570$

□ MW situation
 $F(1,451) = 12.871, p < .001$



➔ When individuals had wandering thoughts, they had a low number of sighs

Electrodermal measures

□ Number of phasic electrodermal responses

□ Probe * MW situation

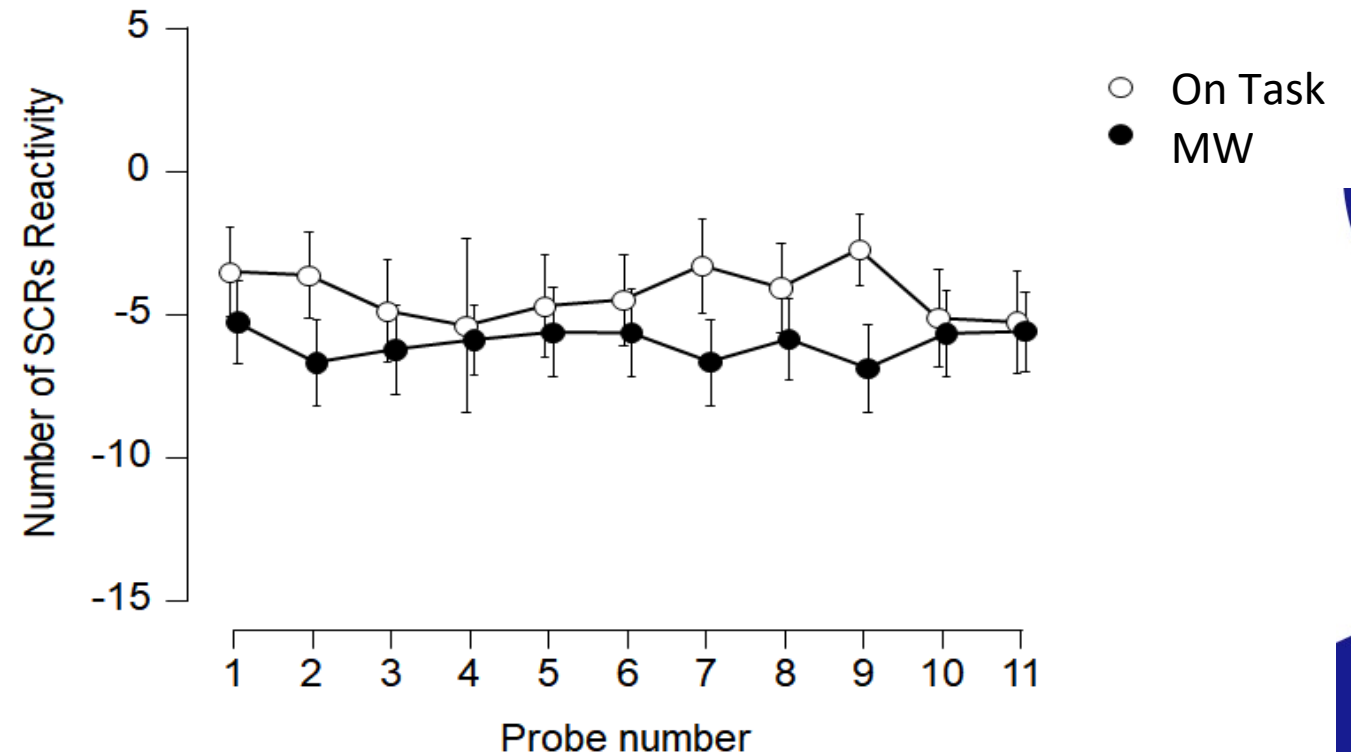
$F(10,451) = .273, p = .987$

□ Probe

$F(10,451) = .084, p = 1$

□ MW situation

$F(1,451) = 5.123, p = .024$



➔ When individuals had wandering thoughts, they had a low number of SCRs irrespective of probe time

Conclusion

- **Respiratory and Electrodermal Effects:** The mind-wandering situations resulted in fewer sighs and phasic electrodermal responses than the “on task” situations.
- **Diminished Task Engagement:** MW is linked to reduced task engagement, potentially leading to less supervision and driving unrelated thoughts during autonomous driving.
- **No Cardiovascular Impact:** No significant effect on cardiovascular activity, but more sensitive measures like the pre-ejection period (PEP) could better assess attentional engagement.
- **Electrodermal and Respiratory Signatures:** specific electrodermal and respiratory patterns associated with wandering thoughts.
- **Verification Needed for Manual Driving:** While the findings are based on delegated driving mode, their reliability in manual driving scenarios needs further verification.
- **Importance of Continuous Monitoring:** It is crucial to use portable tools, like smartwatches, to continuously monitor drivers' physiological responses to detect degraded attentional states during driving.

Perspectives

- Classification model

- Other measures:
 - EEG
 - Eye-tracking system?

- Type of driving unrelated thoughts:
 - Intentional vs spontaneous
 - Negative vs positive emotion ...

Thank you for your attention



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