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# Impact of driving unrelated thoughts on visual processing during manual driving

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## **CONTEXT: Driving and attention**



## **CONTEXT: Multitasking and driving**





#### Contributing factor in 1/3 of crashes

Wundersitz (2021) Traffic Injury Prevention



### **CONTEXT: Cognitive distraction**



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## **CONTEXT: Driving Unrelated Thoughts**



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 (Yanko et al., 2014)
- Higher speed (Yanko et al., 2014)
- Shorter headway distance (Yanko et al., 2014)
- Restriction of visual scanning (He et al., 2011; Lemercier et al., 2014)



## **CONTEXT: Driving Unrelated Thoughts**



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)



## **CONTEXT: Different kind of thoughts**



(from Christoff, 2016)



### **RESEARCH QUESTIONS**

1- Does electrophysiological data as ERPs may be used in the applied context of car driving to understand the impact of Driving Unrelated Thoughts (DUT) on visual information processing?

2- Do different DUT have the same impact?





### Event related potentials from EEG





# MIND WANDERING AND ERP:

a review from Kam et al. (2022) NeuroImage

• 26 ERP publications on MW impacts (from 2008 to 2021)

**N1**:

- Reduction of N1 amplitude in MW compared to on-task situations (N=6)
- No modification (N=3)

#### **P3**:

- Reduction of P3 amplitude in MW compared to on-task situations (N=12)
- No modification (N=7)

Interpretations Perceptual decoupling + higher cognitive impact?



### HYPOTHESIS

DUT may decrease N1 and P3 amplitudes related to the processing of visual information while driving



## METHOD





**Driving task on car simulator.** To follow a lead motorcycle and to release the accelerator pedal as soon as the brake light turns on (visual target)



### IMPACT OF DUT : Problem-Solving (PS) vs Mind-Wandering (MW)



$$\begin{split} Z\dot{A}^{\cdot} &\ll \pi^{-} v \ \dot{C} \ \dot{C} \ s \ z \ \dot{A}^{-} \ \ddot{i} \quad \mathcal{A} \overset{}{E} \dot{A}^{\cdot} \geq \mathbf{G} \overset{}{C} \overset{}{E} \overset{}{A} \overset{}{A} \overset{}{E} \overset{}{A} \overset{}{A} \overset{}{E} \overset{}{A} \overset{}{E} \overset{}{A} \overset{}{A} \overset{}{A} \overset{}{E} \overset{}{A} \overset{}{A} \overset{}{E} \overset{}{E$$



### March IMPACT OF DUT : Problem-Solving (PS) vs Mind-Wandering (MW)







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 $\begin{array}{c} \label{eq:product} \Pi & \mbox{if} \in \mathbb{R}^{+}, \mbox{if} \in \mathbb$ 



### IMPACT OF DUT with Warning signal : Problem solving (PSW) and Anger (AW)







 $Z\dot{A} \ll \pi^{-} v \dot{C} \oplus s z \quad \check{s}\tilde{A}^{\dagger} \oplus \oplus A \not{A} \quad \check{s}^{-} \dot{A} \mapsto A \quad \check{s}^{-} \dot{A} \mapsto A \quad \check{s}^{-} \dot{s}^{-} \dot{A} \mapsto A \quad \check{s}^{-} \dot{A} \mapsto A \quad \check{s}^{-} \dot{s}^{-} \dot{A} \mapsto A \quad \check{s}^{-} \dot{A} \mapsto A \quad \check{s}^{-} \dot{s}^{-} \dot{s}^{$ 



### Marning signal : Problem solving (PSW) and Anger (AW)



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## **TAKE-HOME MESSAGES**

#### Behavior

- MW like PS-related thoughts increase RT
- BUT, no increase of RT with ruminations induced by anger state
- Sound alert does not eliminate the deleterious impact of PS-related thoughts

#### • EEG

- Decrease of N1 and P3 amplitudes with DUT, but anger impacts only N1
- ERPs can reveal impact not visible at the behavioral level
- Other factors to take into account: arousal, involvement, task demands...

#### • Safety countermeasures

• Efficiency of sound alert in the presence of DUT?



### PERSPECTIVES

- From a fundamental point of view
  - Factors interacting with inner distraction (personality, emotion, the main task, ...)
- From a driving safety point of view
  - Monitoring (EuroNCAP)
  - Countermeasures





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Contents lists available at SciVerse ScienceDirect

Neuroscience Letters



Effectiveness of a Forward Collision Warning System in simple and in dual task from an electrophysiological perspective

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Neuroscience Letters 636 (2017) 134-139



Research article

Attention and driving performance modulations due to anger state: Contribution of electroencephalographic data



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