Comparing drivers' performance in simulated hazardous situations with the functioning of the three attentional networks

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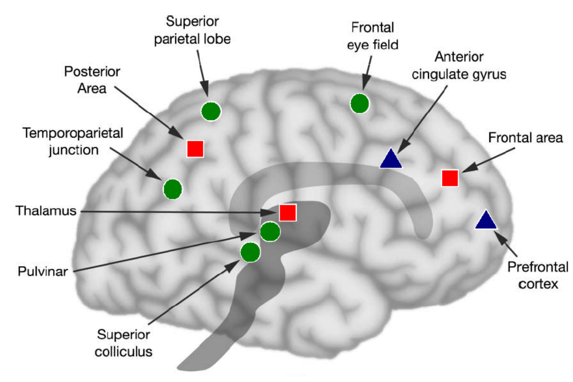
OBJECTIVE OF THE STUDY

To analyse how differences in attentional functioning influence drivers' behaviour.

Are differences in attentional functioning differently associated with drivers' performance in particular hazardous driving situations?

INTRODUCTION

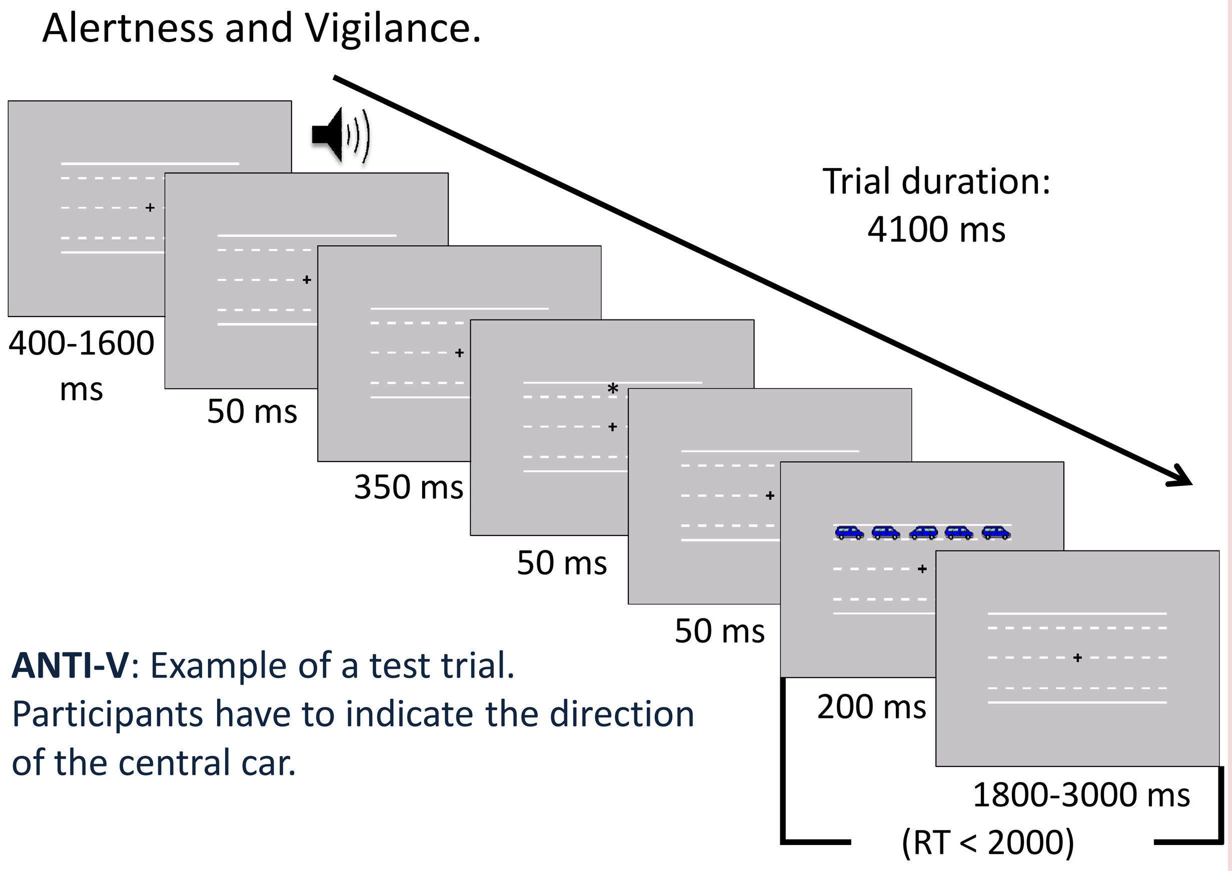
The current work is based on the **Three Attentional Networks Model** proposed by Posner and his collaborators (Posner, 1990; Posner & Petersen, 1994).



Attentional Network	Functions	Assessment Tasks
Executive Control	Ignoring distracters and resolving cognitive conflict	Stroop, Simon or flanker tasks
Spatial Orienting	Allocating attentional focus on relevant areas or objects	Valid / invalid / absent spatial cues
Alerting	**Phasic alertness**: Increased readiness after warning signals **Tonic alertness or vigilance**: Maintaining attention over prolonged periods.	**Phasic alertness**: Comparing performance with/out warning signals **Tonic alertness or vigilance**: Simple reaction time or detection of rare stimuli

MEASURING ATTENTIONAL PERFORMANCE

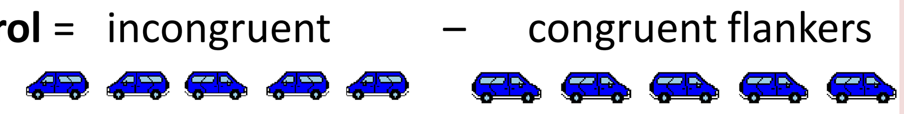
The **ANTI-V** (Roca et al., 2011) is a PC-based **neurocognitive test** to assess participants' performance in **four attentional functions**: Executive Control, Spatial Orienting, Phasic Alertness and Vigilance.



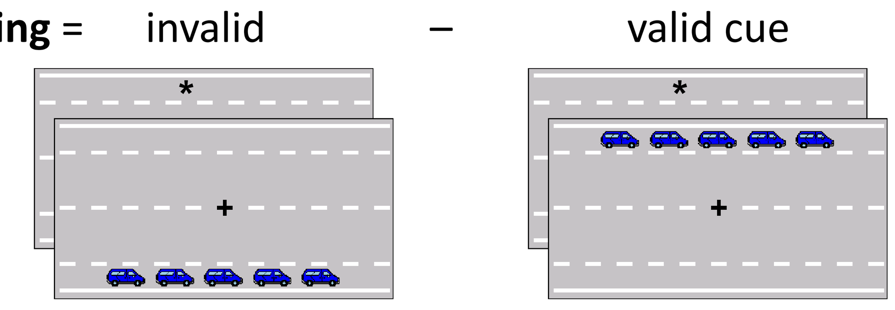
ANTI-V: Example of a test trial. Participants have to indicate the direction of the central car.

In the ANTI-V, **attentional scores** are obtained comparing perfor-mance in different experimental conditions:

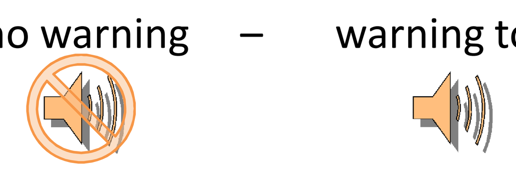
Executive Control = incongruent – congruent flankers



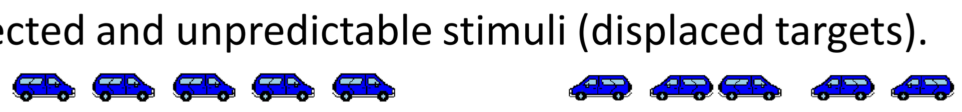
Spatial Orienting = invalid – valid cue



Phasic Alertness = no warning – warning tone



Vigilance = hits & sensitivity (d') detecting infrequent, unexpected and unpredictable stimuli (displaced targets).



METHOD

Participants: N = 42 drivers, age = 22 ± 4, students at the University of Nottingham (United Kingdom)

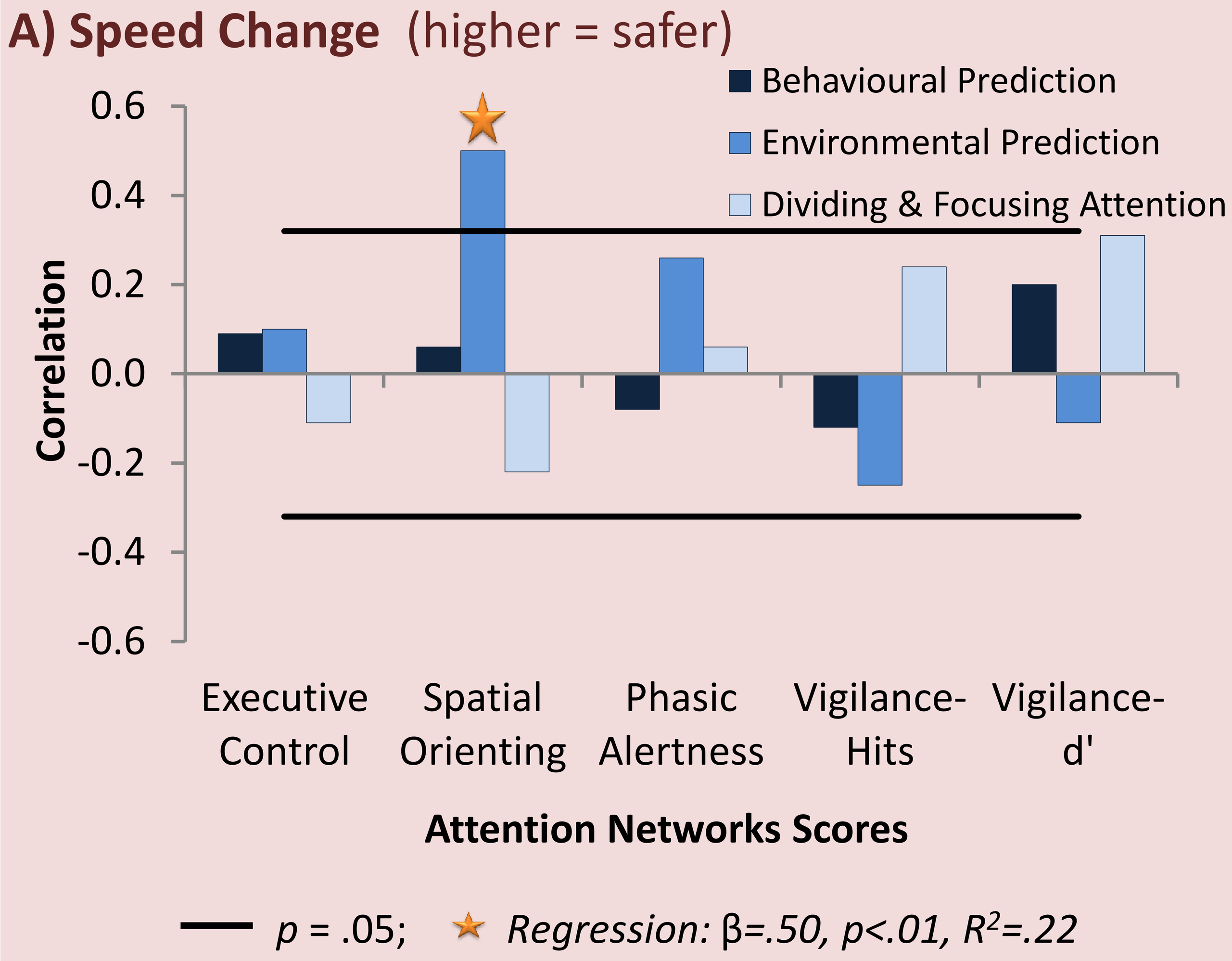
Measures for attentional performance: Scores form the Attention Network Test for Interactions and Vigilance (ANTI-V) by Roca et al. (2011).

Measures for driving performance: Three performance indicators (speed change, braking distance and number of crashes) in three categories of hazardous driving situations (Behavioural Prediction, Environmental Prediction and Dividing and Focusing Attention situations) in a simulator.

Analyses: Correlations and regression models.

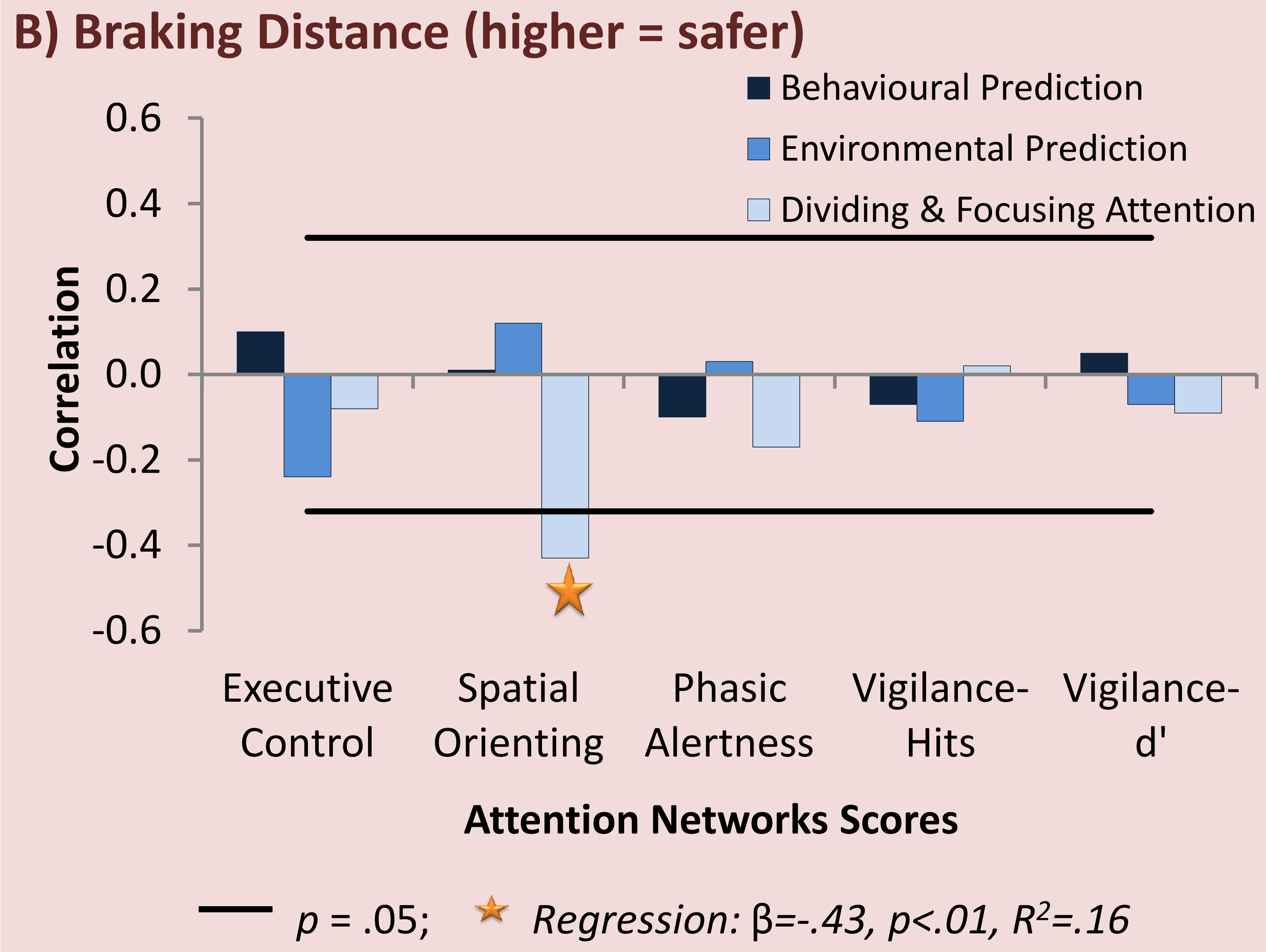
RESULTS

A) Speed Change (higher = safer)



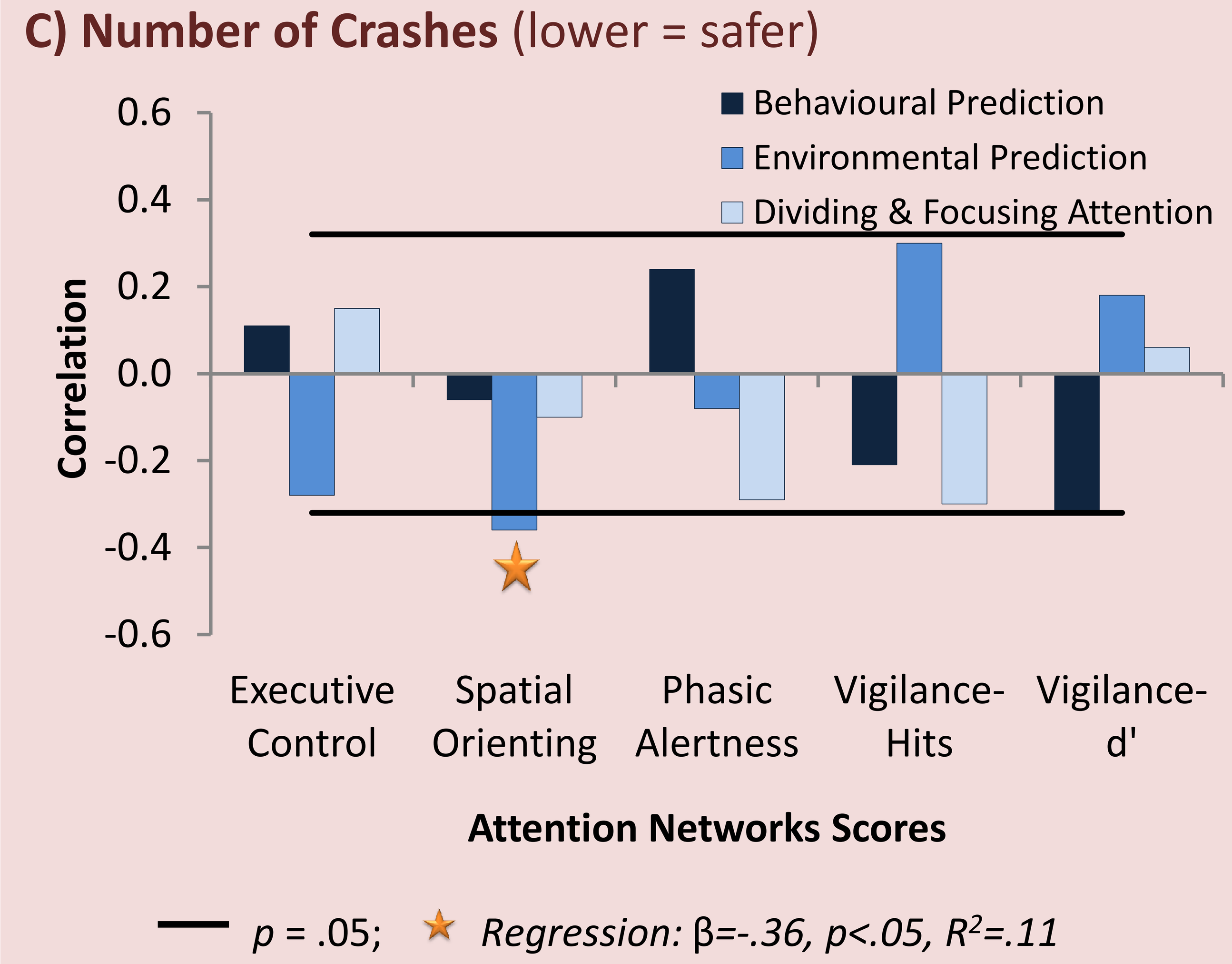
— $p = .05$; ★ *Regression:* $\beta=.50$, $p<.01$, $R^2=.22$

B) Braking Distance (higher = safer)



— $p = .05$; ★ *Regression:* $\beta=-.43$, $p<.01$, $R^2=.16$

C) Number of Crashes (lower = safer)



— $p = .05$; ★ *Regression:* $\beta=-.36$, $p<.05$, $R^2=.11$

MEASURING DRIVING PERFORMANCE (SIMULATOR)

Realistic **Vauxhall Corsa** cabin

Driving environment: **virtual city**

Duration: **10 minutes**

Nine hazardous situations

Measures in each situation: **Speed change** (km/h), **braking distance** (m) and number of **crashes**.

Crundall et al. (2010, 2011): In the nine situations, safety trained drivers reduce their speed sooner (higher braking distance) and to a greater extent (higher speed change). They also have fewer crashes.

THE NINE HAZARDOUS TRAFFIC SITUATIONS

Three categories of hazards (Crundall et al., 2010, 2011):

- **Behavioural Prediction**: A visible pedestrian or another vehicle becomes suddenly a hazard. For example:
  - A child pedestrian standing visibly between two parked cars, suddenly steps out in front of the car.

- **Environmental Prediction**: The hazard is hidden by an environmental element (precursor) For example:
  - There is a blind bend and a vehicle is stopped after.

- **Dividing and Focusing Attention**: Multiple sources of potential risk are present, before one becomes the actual hazard . For example:
  - Two pedestrians are waving to each other from either side of the road (potential hazards) and one of them steps into the road (hazard).

DISCUSSION

- Individual measures in attentional functioning are **differently associated** with simulated driving performance in specific hazardous situations.
- Higher scores in **Spatial Orienting** were associated with safer driving performance, only in situations with a **single environmental precursor** anticipating the hazard source (Environmental Prediction).
- On the contrary, in situations with **multiple potential hazards**, higher orienting scores were associated with delayed braking (Dividing and Focusing Attention).

CONCLUSION

- **Participants whose attention is more strongly captured by exogenous events:**

  (a) may more efficiently detect and resolve a hazard source anticipated by an environmental precursor in the traffic environment,

  (b) but, in complex hazardous situations, focusing attention on a specific element in the traffic environment would imply partially neglecting other potential hazard sources.

REFERENCES

Crundall, D., Andrews, B., van Loon, E. & Chapman, P. (2010). Commentary training improves responsiveness to hazards in a driving simulator. Accident Analyses and Prevention, 42, 2117-2124. // **Crundall, D., Chapman, P., Trawley, S., Collins, L., van Loon, E., Andrews, B. & Underwood, G. (2012).** Some hazards are more attractive than others: Drivers of varying experience respond differently to different types of hazard. Accident Analyses and Prevention, 45, 600-609. // **Posner, M.I. (1994).** Attention: the mechanism of consciousness. Proceedings of the National Academy of Sciences, 91(16), 7398-7402. // **Posner, M. I. & Petersen, S. E. (1990).** The attention system of the human brain. Annual Review of Neuroscience, 13, 25-42. // **Roca, J., Castro, C., López-Ramón, M.F. & Lupiáñez, J. (2011).** Measuring vigilance while assessing the functioning of the three attentional networks: The ANTI-Vigilance task. Journal of Neuroscience Methods, 298(2), 312-324.

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