Assessment of drivers' attentional performance using the ANTI-V

Javier Roca[1], David Crundall[2], Cándida Castro[1], Mª Fernanda López-Ramón[1], & Juan Lupiáñez[1]

[1] School of Psychology, Universidad de Granada (Spain)
[2] Accident Research Unit, The University of Nottingham (United Kingdom)

Introduction

Three Attentional Brain Networks[1]

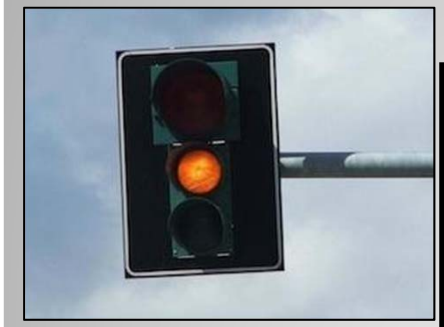
- **The three attentional brain networks[1]:**
  - **Alertness**: Temporal preparation (phasic alertness - **PhA**) and sustained attention (vigilance - **V**).
  - **Orientation (O)**: Attending specific areas or objects
  - **Executive Control (EC)**: Ignoring distracters
- **Attentional Networks Tests: ANT / ANTI /ANTI-V**
  - **Evidence**: Behavioural[2], neuroimage[3], and measurement properties[4] studies.
  - **Applications**: children, dementia, depression, anxiety, **driver behaviour**…

Introduction

Attention and Driving Performance

Driving is an attentional task

Temporal preparation (**PhA**)



Sustained attention (**V**)

Orienting attention (**O**)

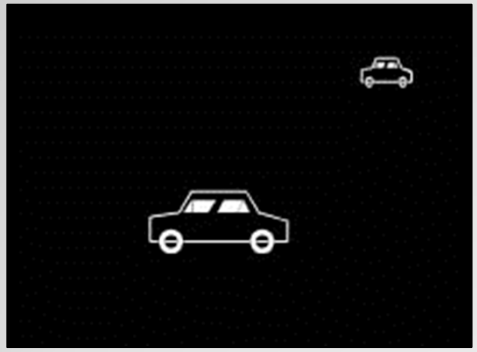
Ignoring distracters (**EC**)

Introduction

Attention and Driving Performance

ANT measures <> Driving performance

- **Weaver et al. (2009)[5]:**
  - Useful Field of Vision > ANT Global RT (R^2=.69) & EC (R^2=.21)
  - Manitoba Road Test > ANT Global RT (R^2=.56)
    - **But no association with PhA, O or EC!! Why…?**



Introduction

Attention and Driving Performance

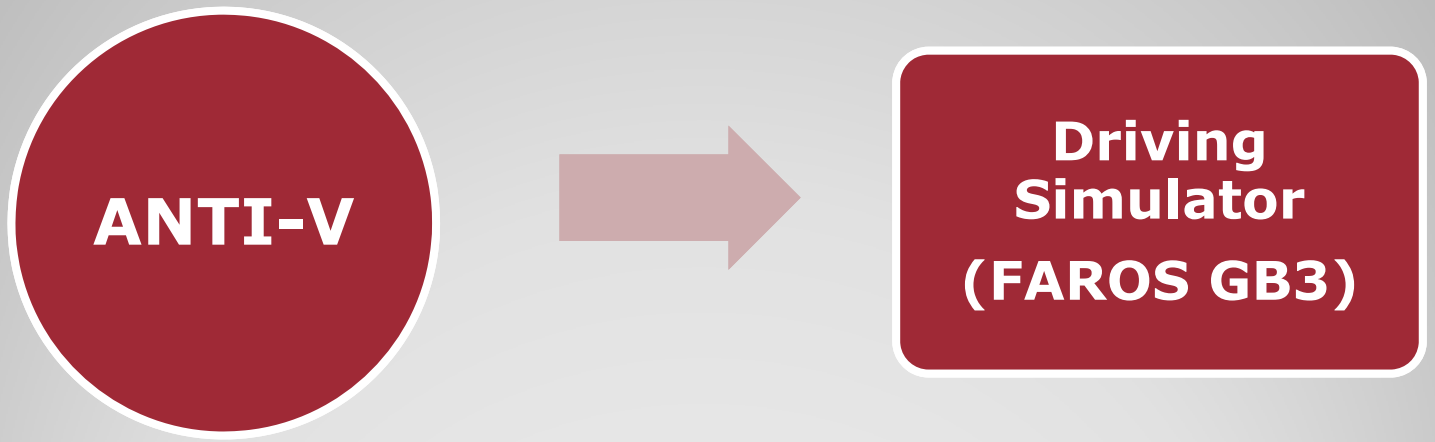
ANT measures <> Driving performance

- **Weaver et al. (2009)[5]:**
  - Useful Field of Vision > ANT Global RT (R^2=.69) & EC (R^2=.21)
  - Manitoba Road Test > ANT Global RT (R^2=.56)
    - **But no association with PhA, O or EC!! Why…?**

The Manitoba Road Test is a wide-range performance measure (too unspecific!!)

Aim of the study

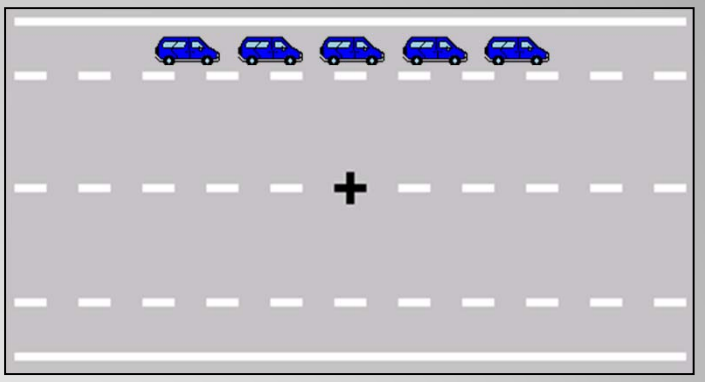
To analyse the role of the attentional networks on driver behaviour



Method

The ANTI-Vigilance (ANTI-V)[6]

- Assessment of drivers' **attentional performance**:
  - **PhA** - Phasic Alertness
  - **O** - Attentional Orientation
  - **EC** - Executive Control
  - **V** - Vigilance[6,7]



- **PhA** is **more reliable**[4] and **independent** of **O**[8] than in previous versions.
- **Full Description**[6]: Roca, Castro, López-Ramón, & Lupiáñez. (2011). *Journal of Neuroscience Methods, 198*(2), 312-24.

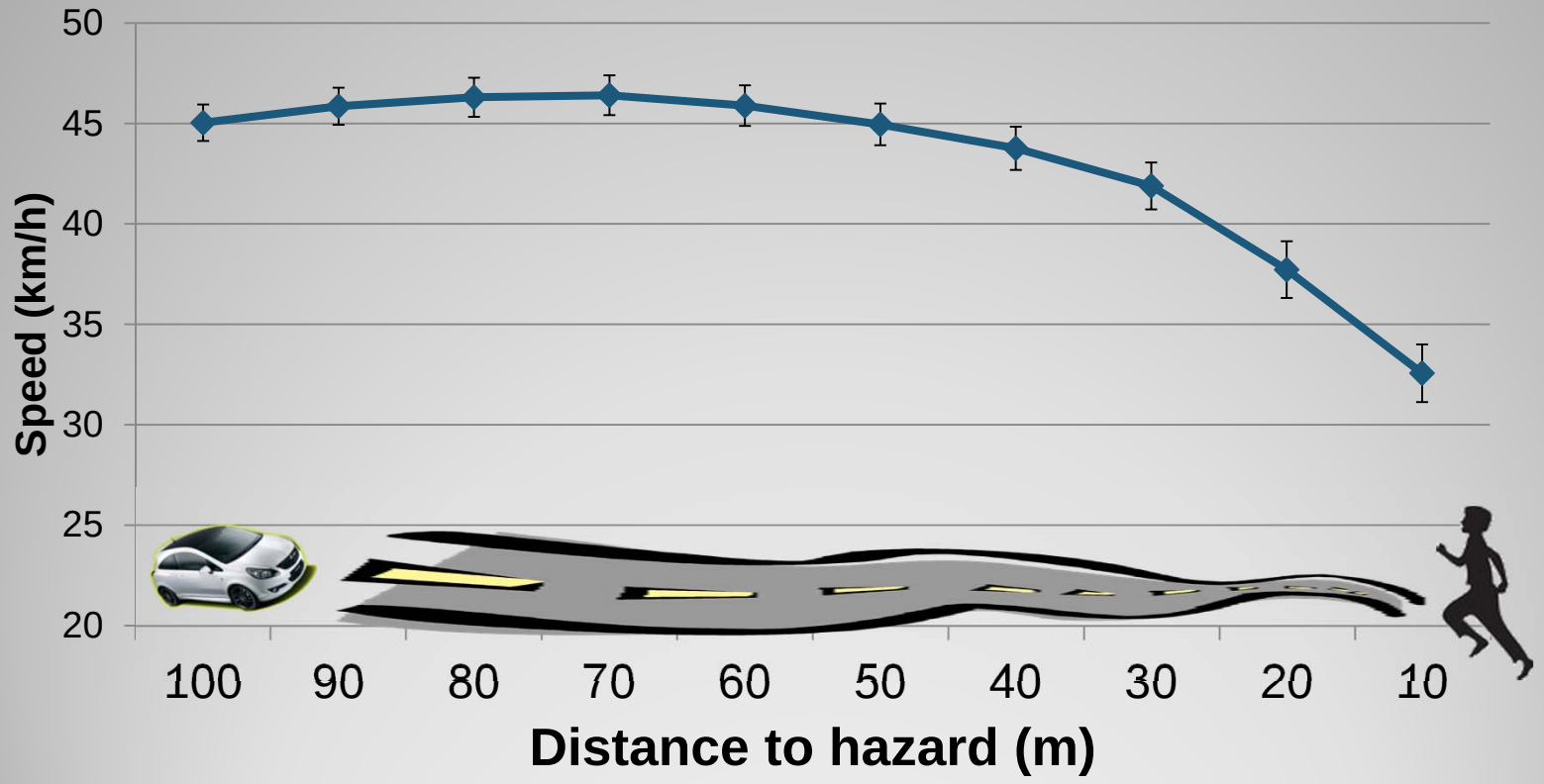
Method

Driving Simulator (Faros GB3)

- **Realistic Vauxhall Corsa cabin**: car seat, pedals, steering, gearbox, speedometer, etc.
- Driving environment: **Virtual city** in three 19” LCD monitors (90º width x 21º height)
- **Nine hazardous situations** in a 10 minute itinerary[9].
- **Measures** in each situation:
  - Speed change (km/h)
  - Braking distance (m)
  - Number of crashes

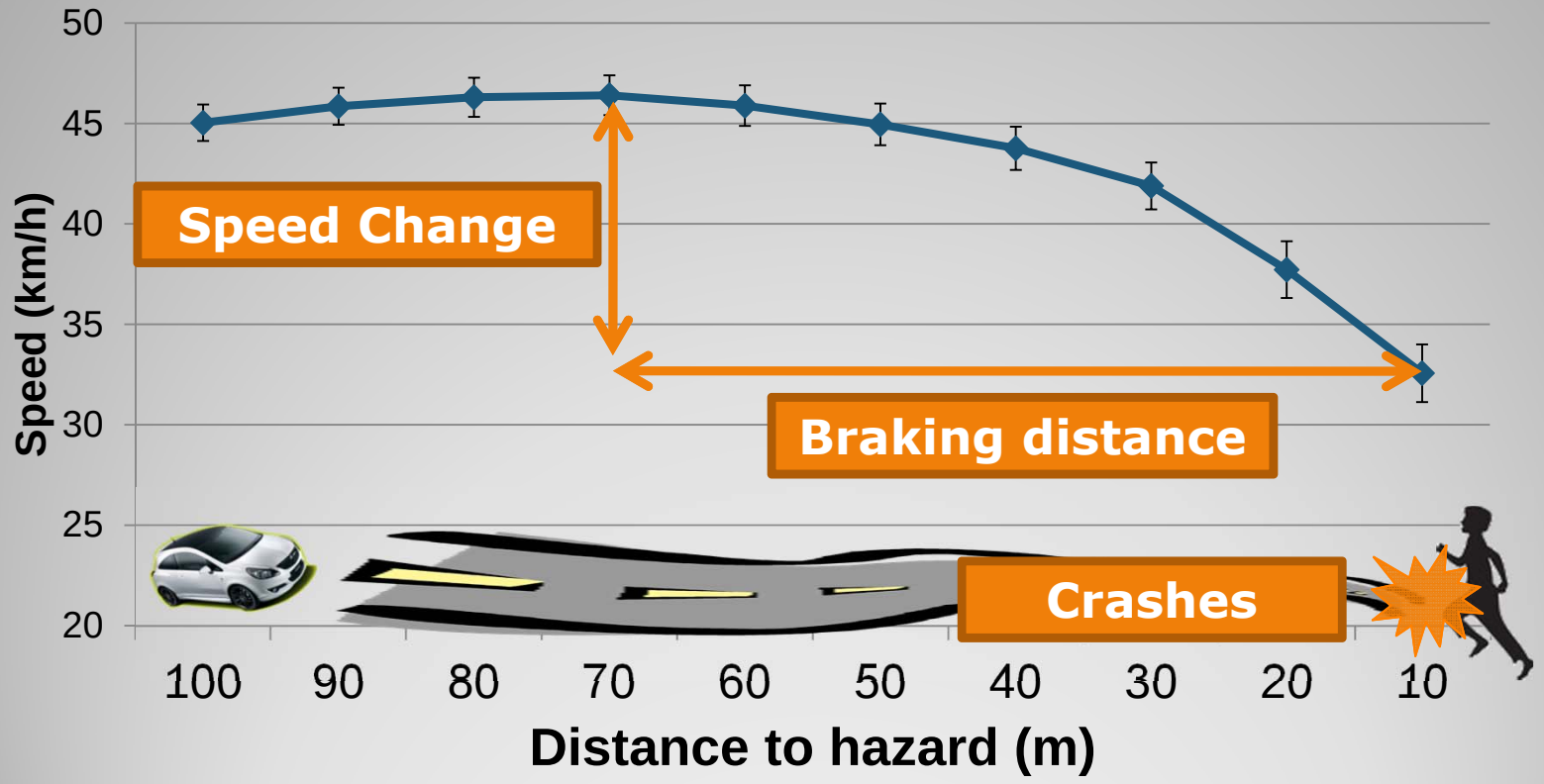
Method

Approach Speed



Method

Approach Speed



Method

Crundall et al. (2010, 2011)[9,10]

- **In these situations:**
  - **Safety trained drivers** reduce their speed sooner and to a greater extent.
- **Three categories of hazards:**
  - Behavioural Prediction (**BP**)
  - Environmental Prediction (**EP**)
  - Dividing and Focusing Attention (**DF**)
- **EP hazards** are the ones that best distinguish between novice and experienced drivers

Method

Three categories of hazards[9]

- **Behavioural Prediction (BP)**: 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.
  - An **oncoming motorcycle** invades participants' trajectory.
  - A **vehicle waiting** in a side road moves forward unexpectedly.

Method


23986592
00:02:25:14

Three categories of hazards[9]

- **Environmental Prediction (EP)**: The hazard is hidden by environmental elements.
- For example:
  - There is a parked **truck** and a man carrying a box that steps out from behind.
  - There is a parked **ice-cream van** and a child steps out from behind.
  - There is a **blind bend** and a vehicle is stopped after.

Method


23619527
00:03:08:15

Three categories of hazards[9]

- **Dividing and Focusing Attention (DF)**: Multiple sources of potential risk are present, before one becomes the actual hazard.
- For example:
  - A **bus is parked** on the left side of the road (potential hazard) and a **pedestrian crosses** from the right (hazard)
  - **Several cars** are approaching a crossroad (potential hazards) and one of them **fails to give way** (hazard)
  - **Two pedestrians are waving** to each other from either side of the road (potential hazards) and **one of them steps into the road** (hazard).

Method


Mon Jul 31 15:58:50

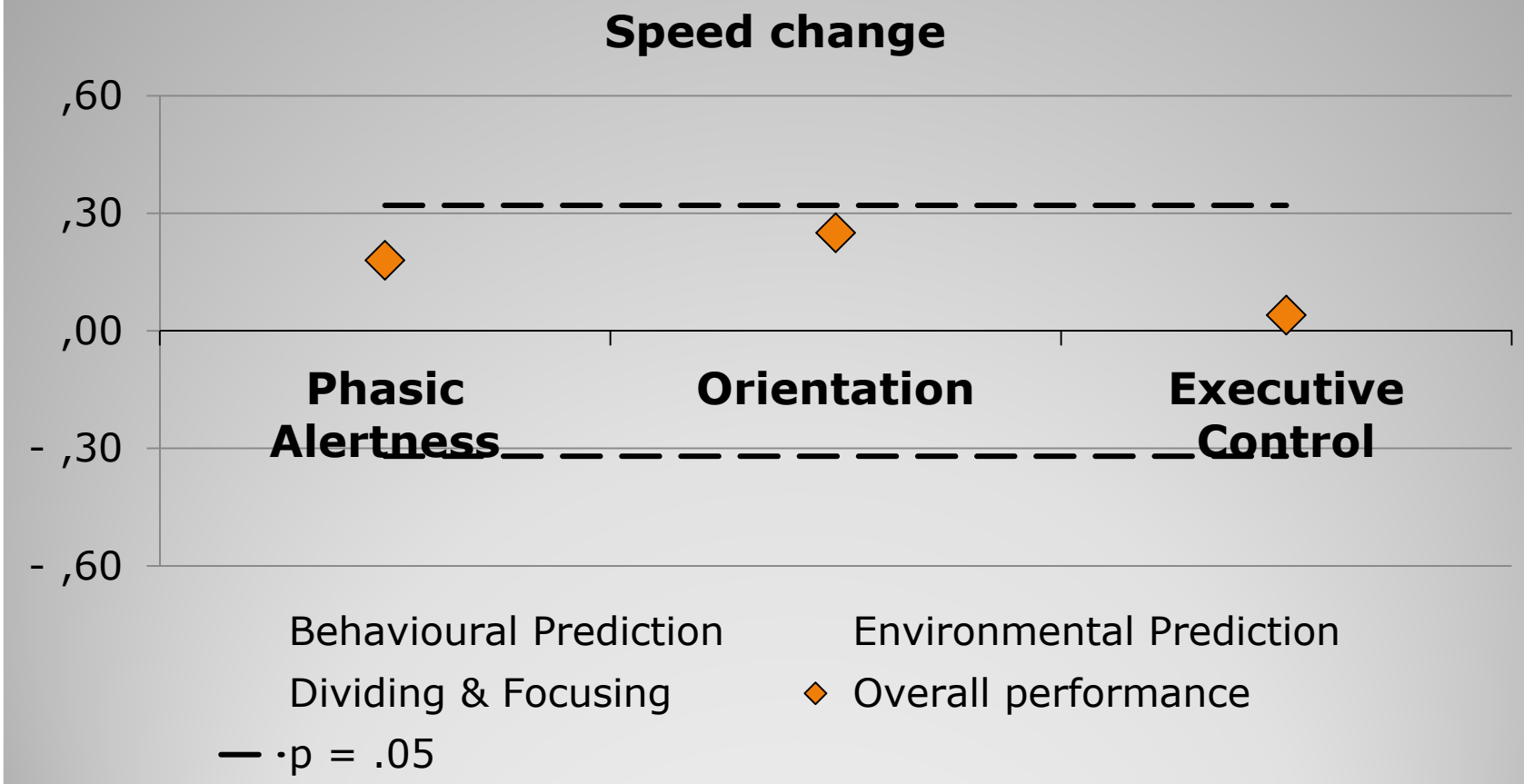
Participants

- **Sample**: N = 42 drivers
- **Gender**: 22 males (52%)
- **Age**: 22 ± 4 years
- **Driving Experience**: >12 months
- **Location**: Nottingham

Method

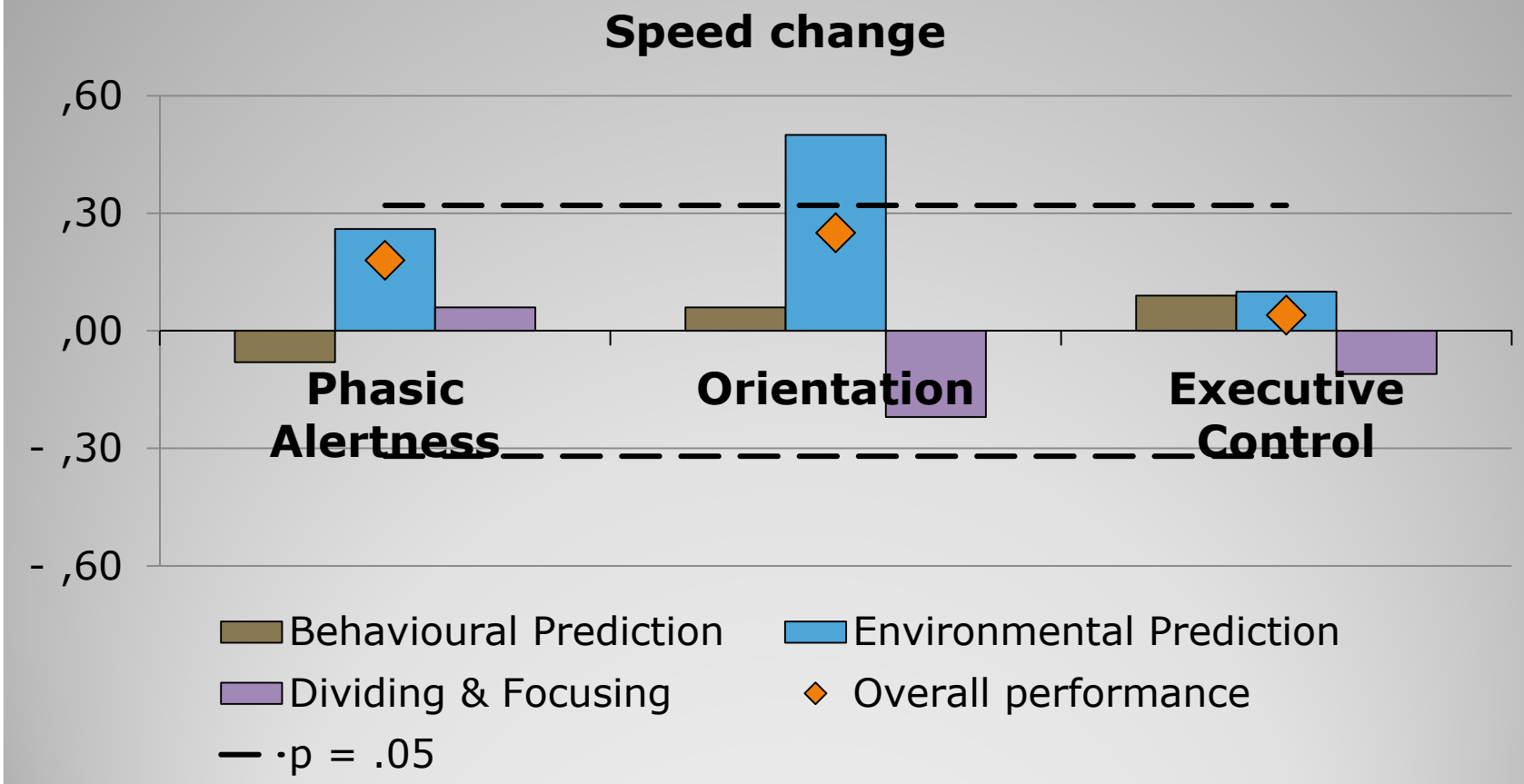
Results

Correlations ANTI-V and Faros GB3



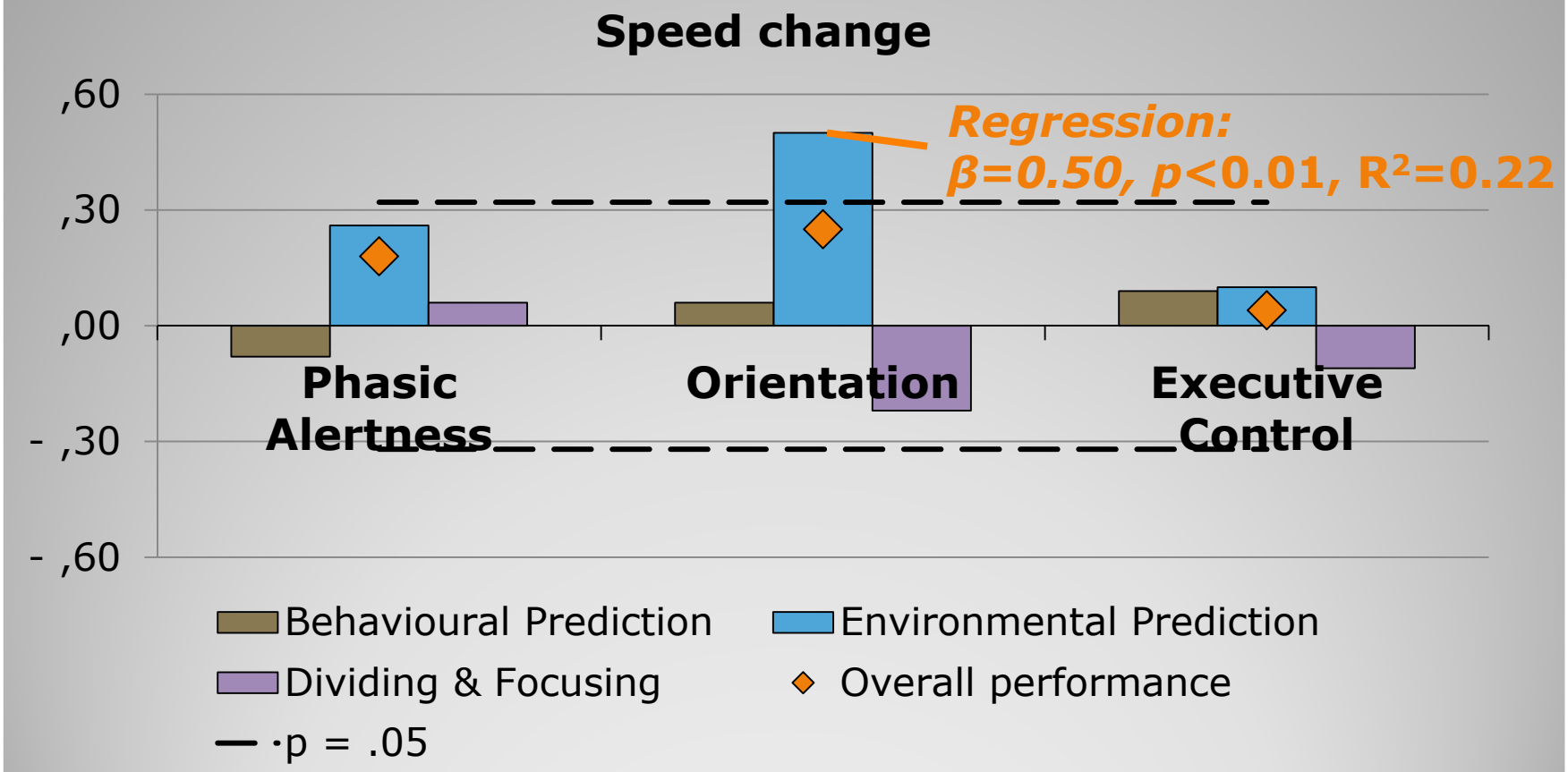
Results

Correlations ANTI-V and Faros GB3



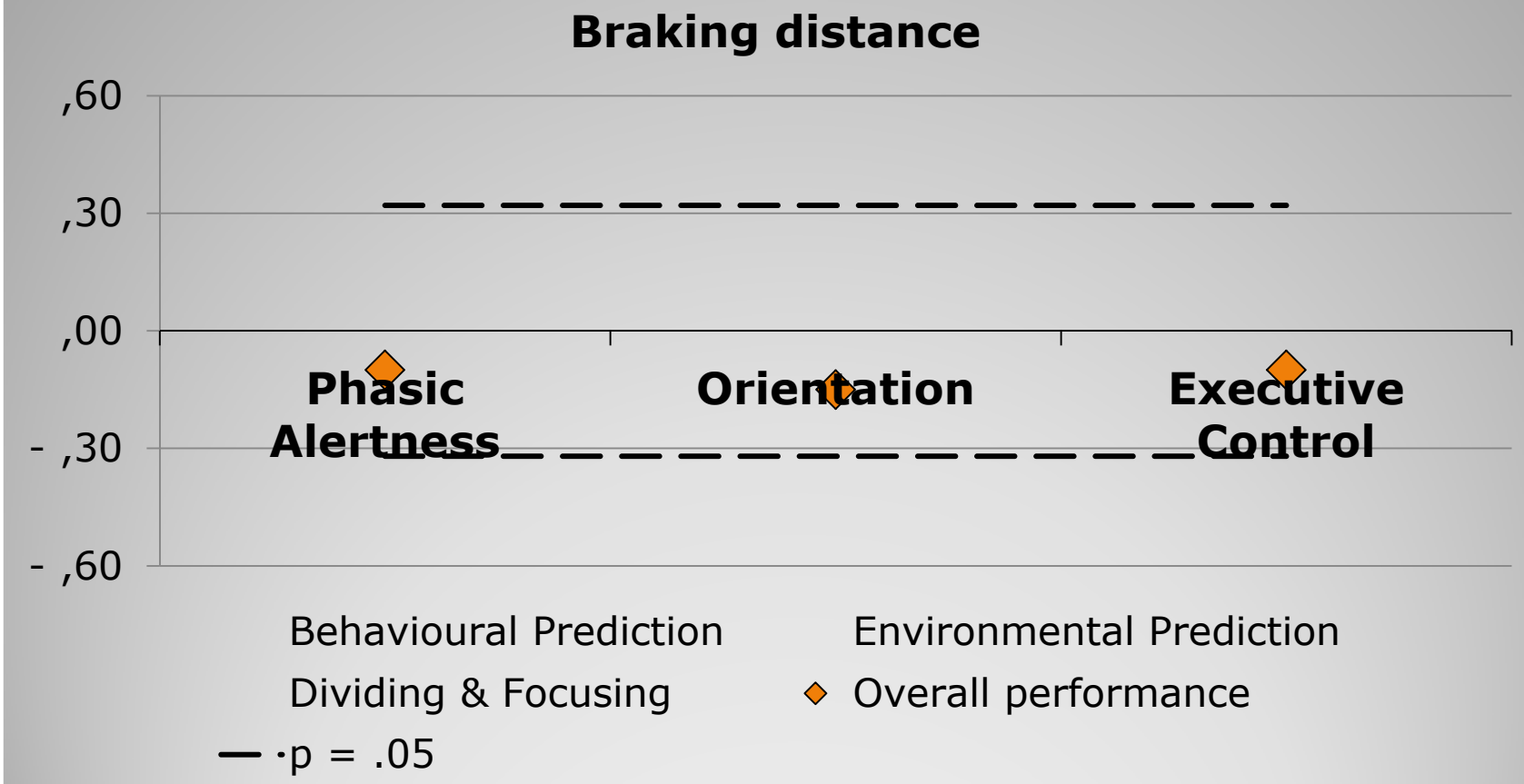
Results

Correlations ANTI-V and Faros GB3



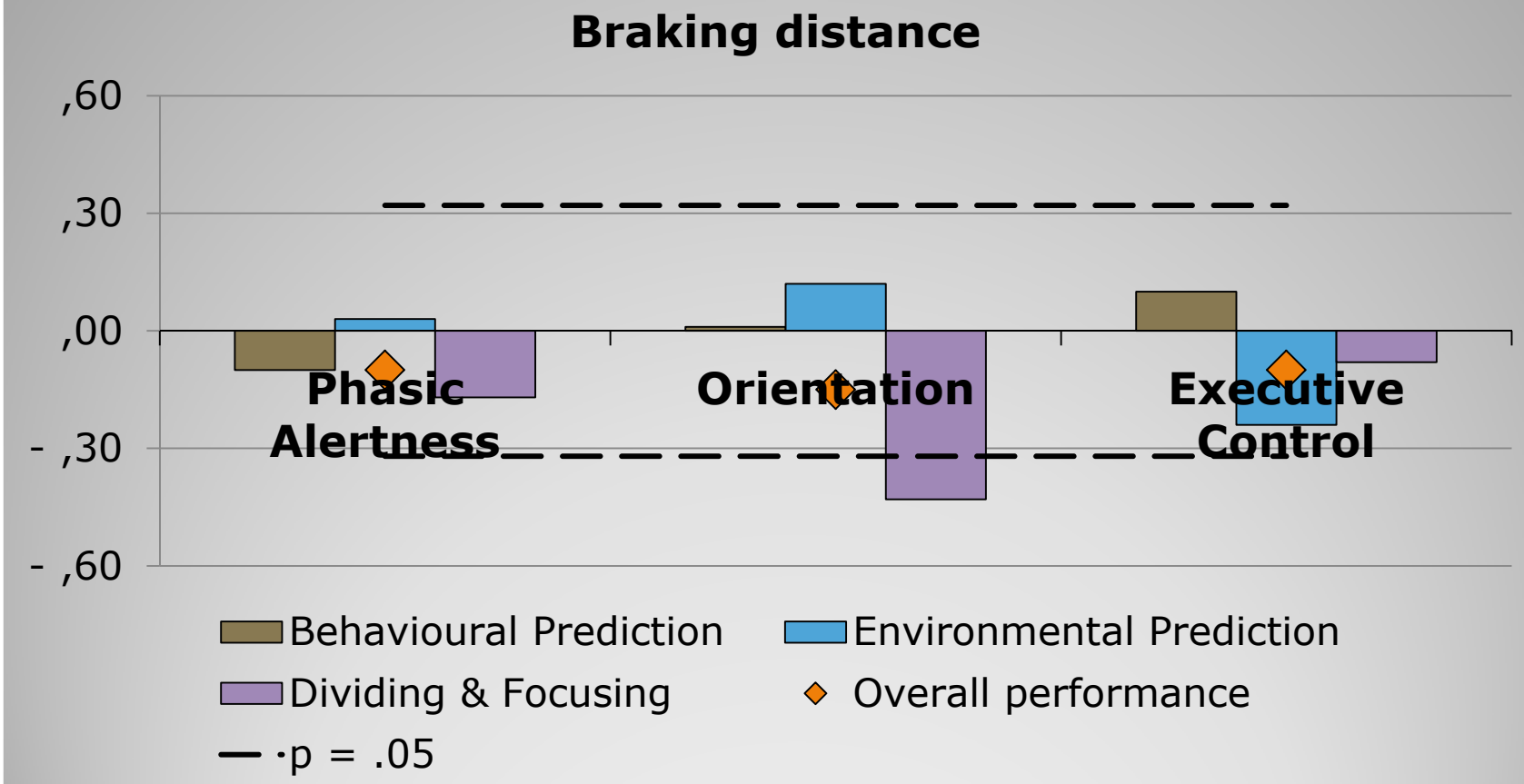
Results

Correlations ANTI-V and Faros GB3



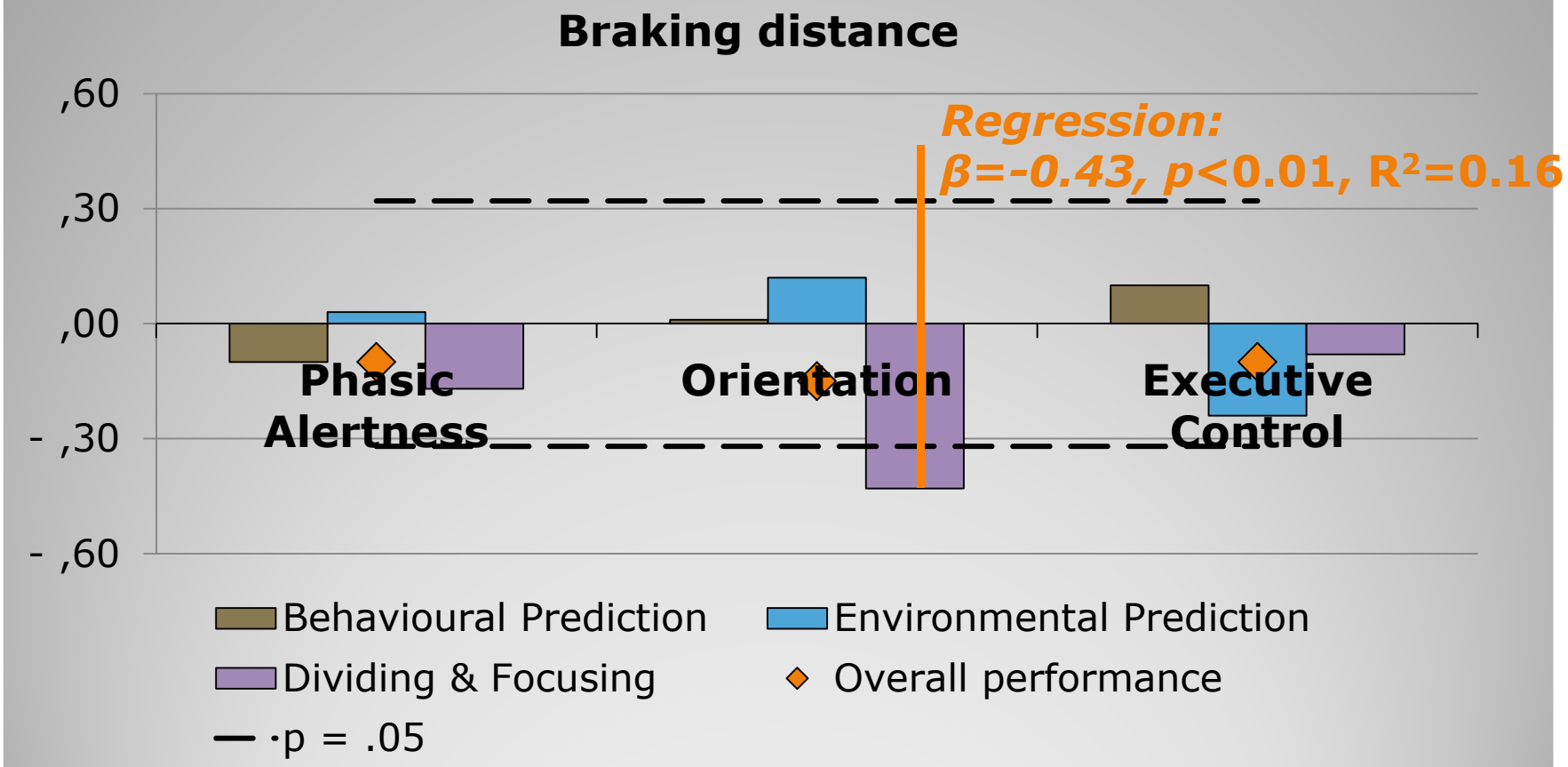
Results

Correlations ANTI-V and Faros GB3



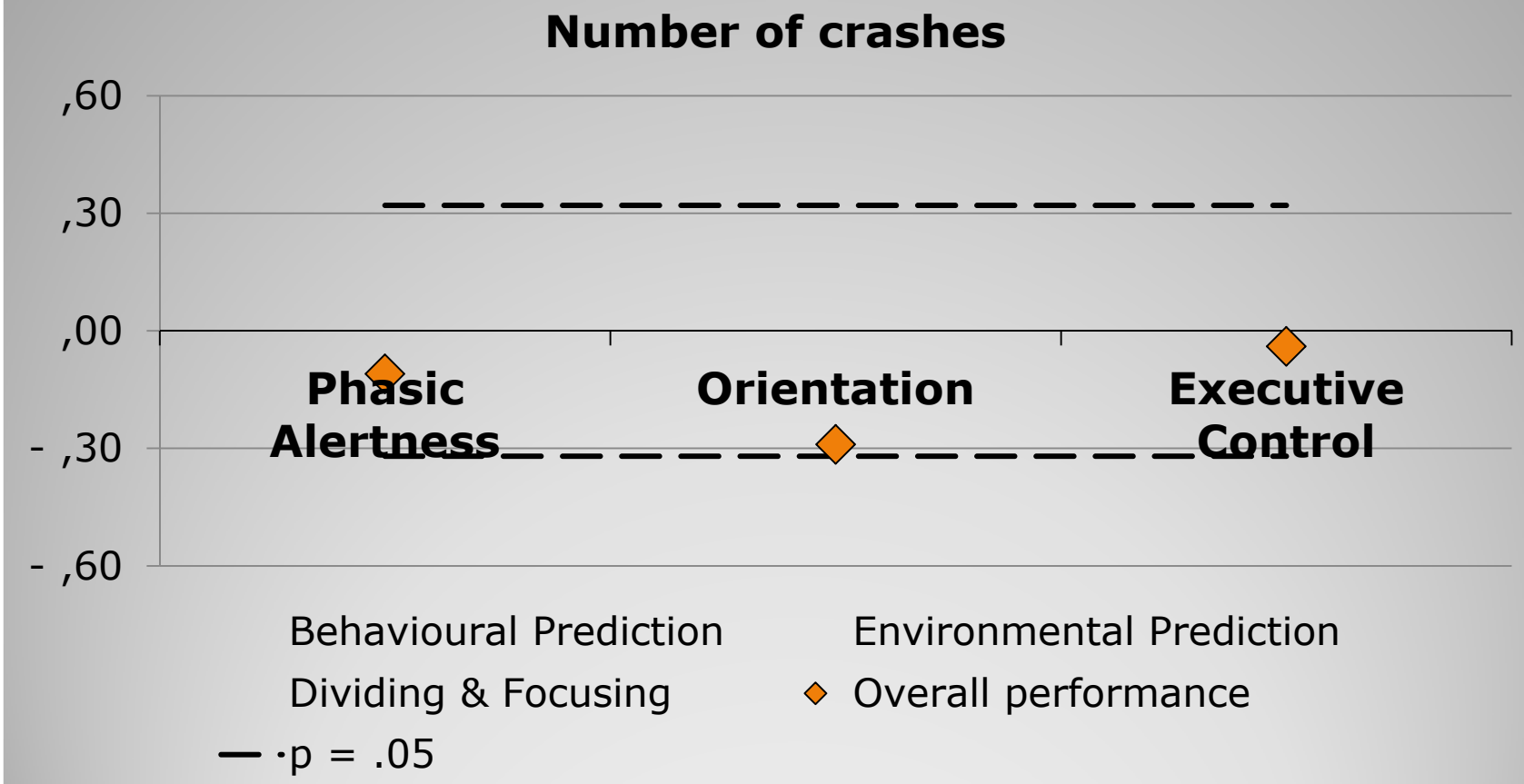
Results

Correlations ANTI-V and Faros GB3



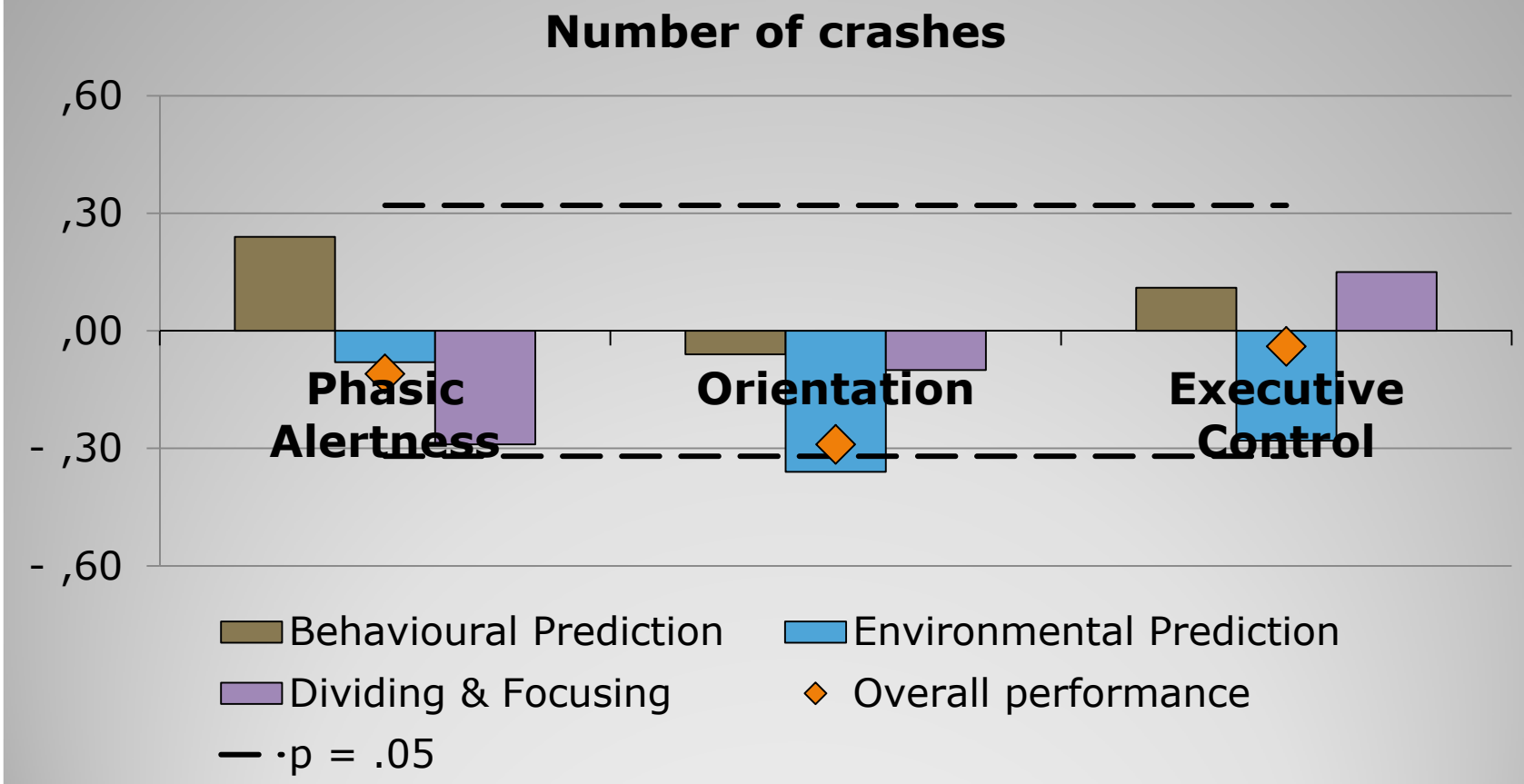
Results

Correlations ANTI-V and Faros GB3



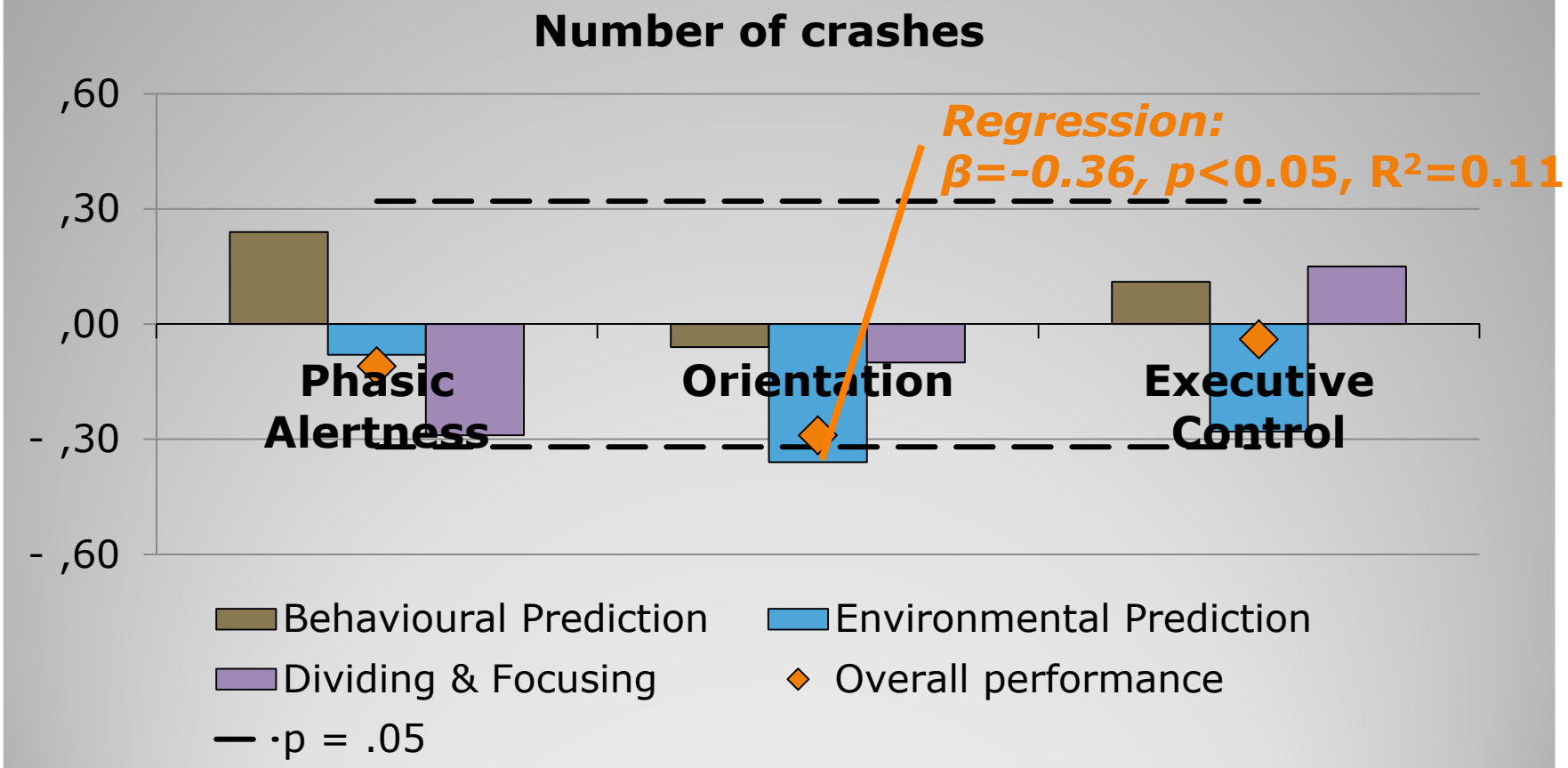
Results

Correlations ANTI-V and Faros GB3



Results

Correlations ANTI-V and Faros GB3



Results

Conclusions

Conclusions

Higher ability to use visual spatial cues

(Orienting score in ANTI-V)

Greater speed change and fewer crashes

(**Environmental Prediction**)

Safer!

Reduced braking distance

(Dividing & Focusing)

Distractive?

- **Qualitative differences arise!**
- **General driving performance measures hide relevant differences**

Thank you for your *specific* attention!

Contacting author:
Javier Roca (jroca@ugr.es)

ugr | Universidad de Granada

The University of Nottingham

Funding provided by ***Ministerio de Ciencia e Innovación*** (SEJ-2007-61843, PSI-2008-03595, EUI2009-04082, PSI-2010-15883), and ***Junta de Andalucía*** (PO7-SEJ-02613).

Also, we would like to thank the ***Dirección General de Tráfico*** **(DGT)** and the ***Fundación para la Seguridad Vial*** **(FESVIAL)** for their support.

Extra material

References (1)

1. **Posner, M.I. (2008).** Measuring Alertness. *Annals of the New York Academy of Sciences*, *1129*, 193–199.
2. **Fan, J., McCandliss, B. D., Sommer, T., Raz, A., & Posner, M. I. (2002).** Testing the efficiency and independence of the attentional networks. *Journal of Cognitive Neuroscience*, *14*(3), 340–347.
3. **Fan, J., McCandliss, B.D., Fossella, J., Flombaum, J.I., & Posner, M.I. (2005).** The activation of attentional networks. *Neuroimage*, 26, 471– 479.
4. **Ishigami, Y. & Klein, R. M. (2010).** Repeated measurement of the components of attention using two versions of the Attention Network Test (ANT): Stability, isolability, robustness, and reliability. *Journal of Neuroscience Methods*, 190, 117–128.

Extra material

References (2)

6. **Weaver, B., Bédard, M., McAuliffe, J., & Parkkari, M. (2009).** Using the Attention Network Test to predict driving test scores. *Accident Analysis and Prevention*, *41*, 76–83.
7. **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, 198(2), 312-324.
8. **Roca, J., Fuentes, L., Marotta, A., López-Ramón, M.F., Castro, C., Lupiáñez, J., & Martella, D. (submitted).** *The effects of sleep deprivation on the attentional functions and vigilance*.
9. **Callejas, A., Lupiáñez, J., Funes, M. J., & Tudela, P. (2005).** Modulations between Alerting, Orienting and Executive Control Networks. *Experimental Brain Research*, *167*(1), 27-37.

Extra material

References (3)

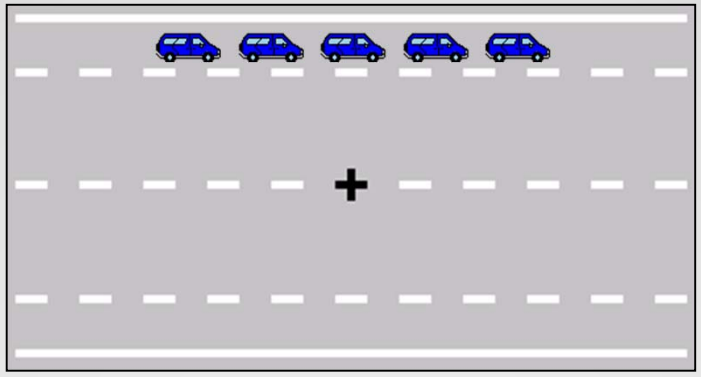
10. **Crundall, D., Andrews, B., van Loon, E., & Chapman, P. (2010).** Commentary training improves responsiveness to hazards in a driving simulator. *Accident Analyses and Prevention, 42*, 2117-2124.
11. **Crundall, D., Chapman, P., Trawley, S., Collins, L., van Loon, E., Andrews, B., & Underwood, G. (in preparation).** *Developing a typology of hazards: How different drivers respond to different hazards*.

Extra material

ANTI – V

INSTRUCTIONS:

- Imagine that you are working in a Centre for Traffic Management and you are **studying the drivers' parking habits**.
- Your task is to determine the **direction of the central car** of the row.



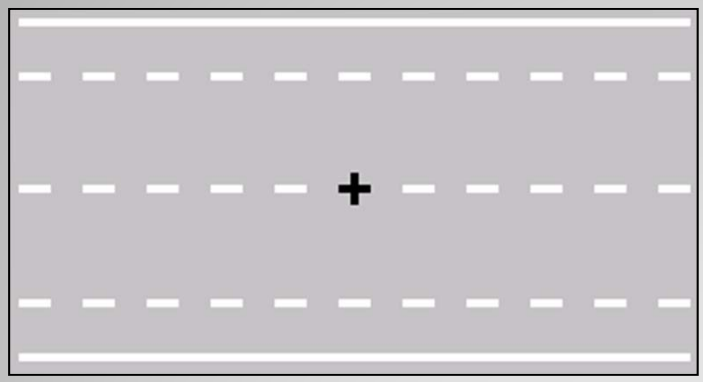
Method

Roca, Castro, López-Ramón, & Lupiáñez. (2011).
Journal of Neuroscience Methods, 198(2), 312-24.

ANTI – V

Scene 1 of 4

400 – 1600 ms

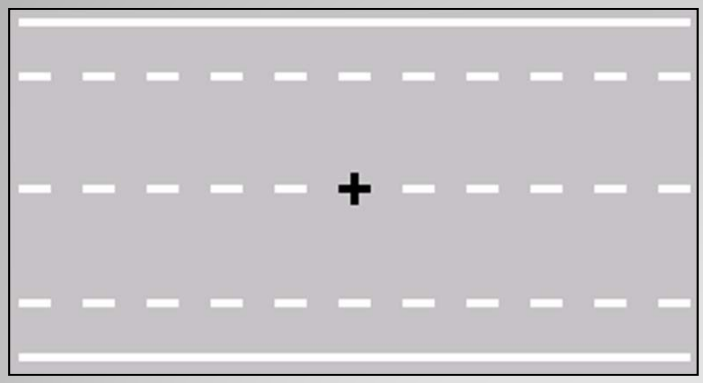


Method

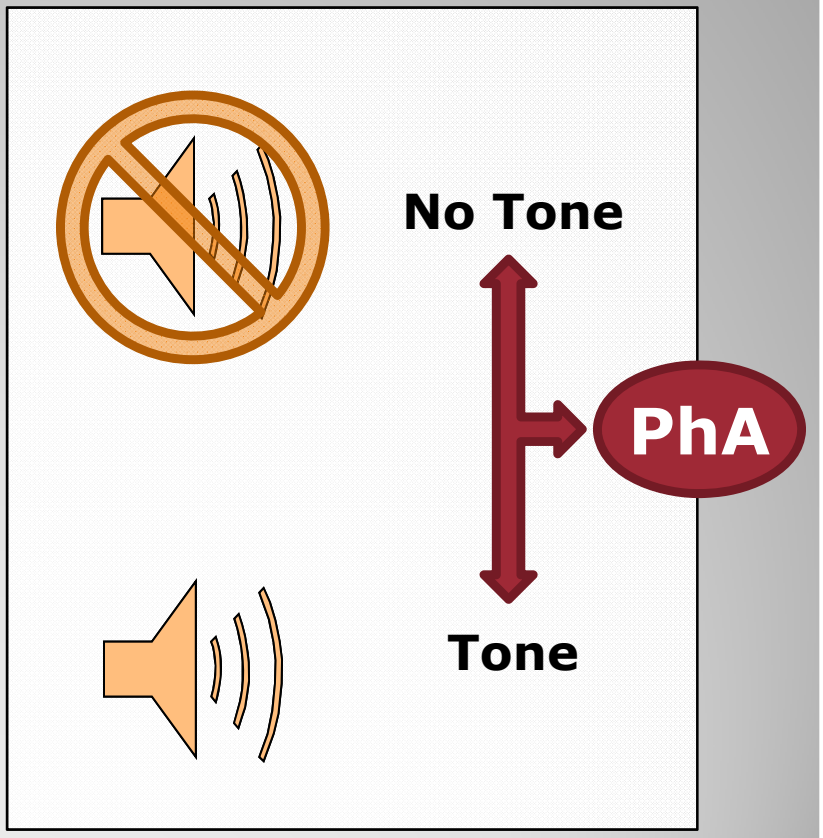
Roca, Castro, López-Ramón, & Lupiáñez. (2011).
Journal of Neuroscience Methods, 198(2), 312-24.

ANTI – V

Scene 2 of 4
400 ms



Duration:
50 ms

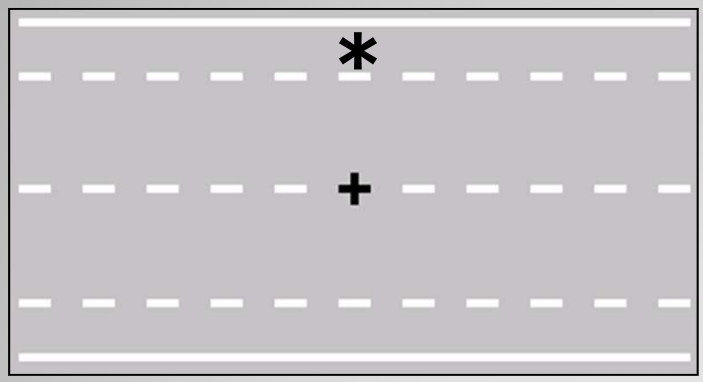


Method

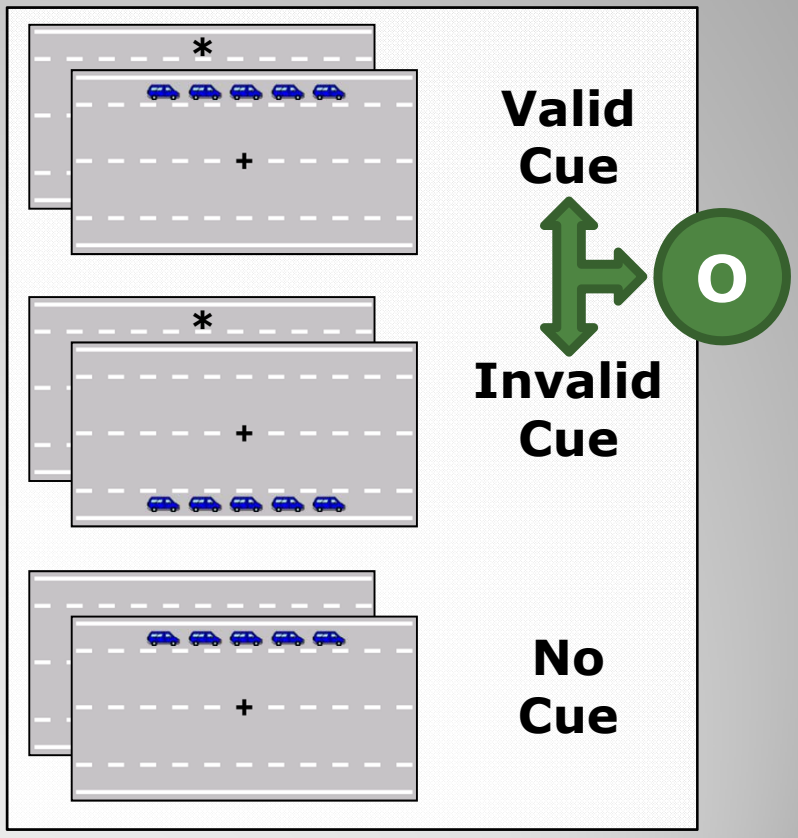
Roca, Castro, López-Ramón, & Lupiáñez. (2011).
Journal of Neuroscience Methods, 198(2), 312-24.

ANTI – V

Scene 3 of 4
100 ms



Duration:
50 ms

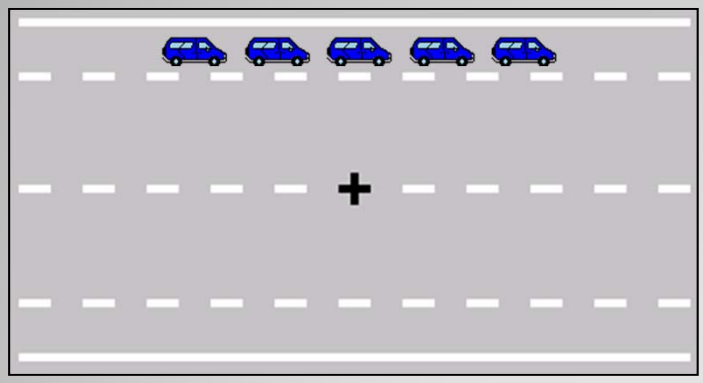


Method

Roca, Castro, López-Ramón, & Lupiáñez. (2011).
Journal of Neuroscience Methods, 198(2), 312-24.

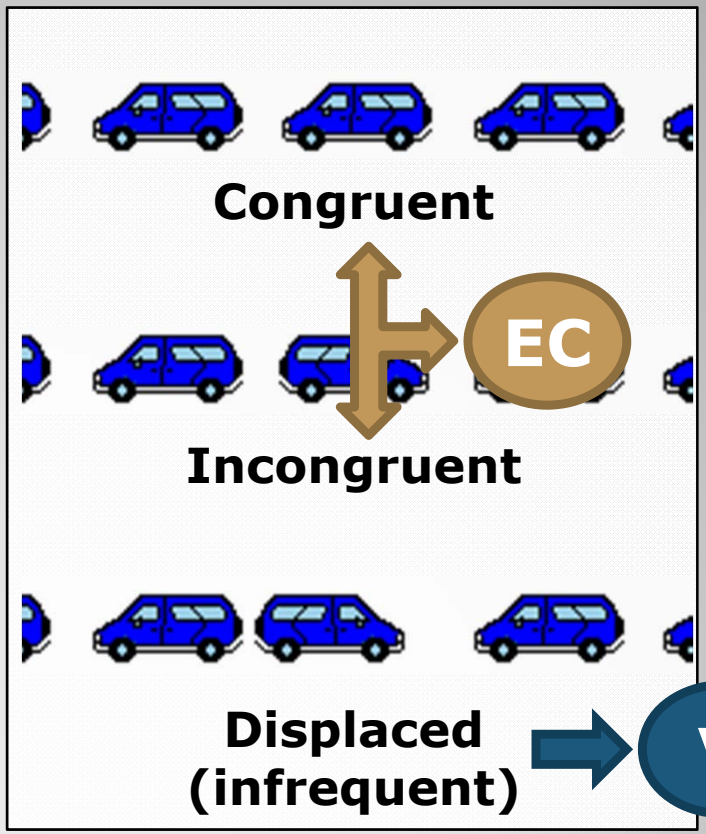
ANTI – V

Scene 4 of 4
1800-3000 ms



Duration:
200 ms

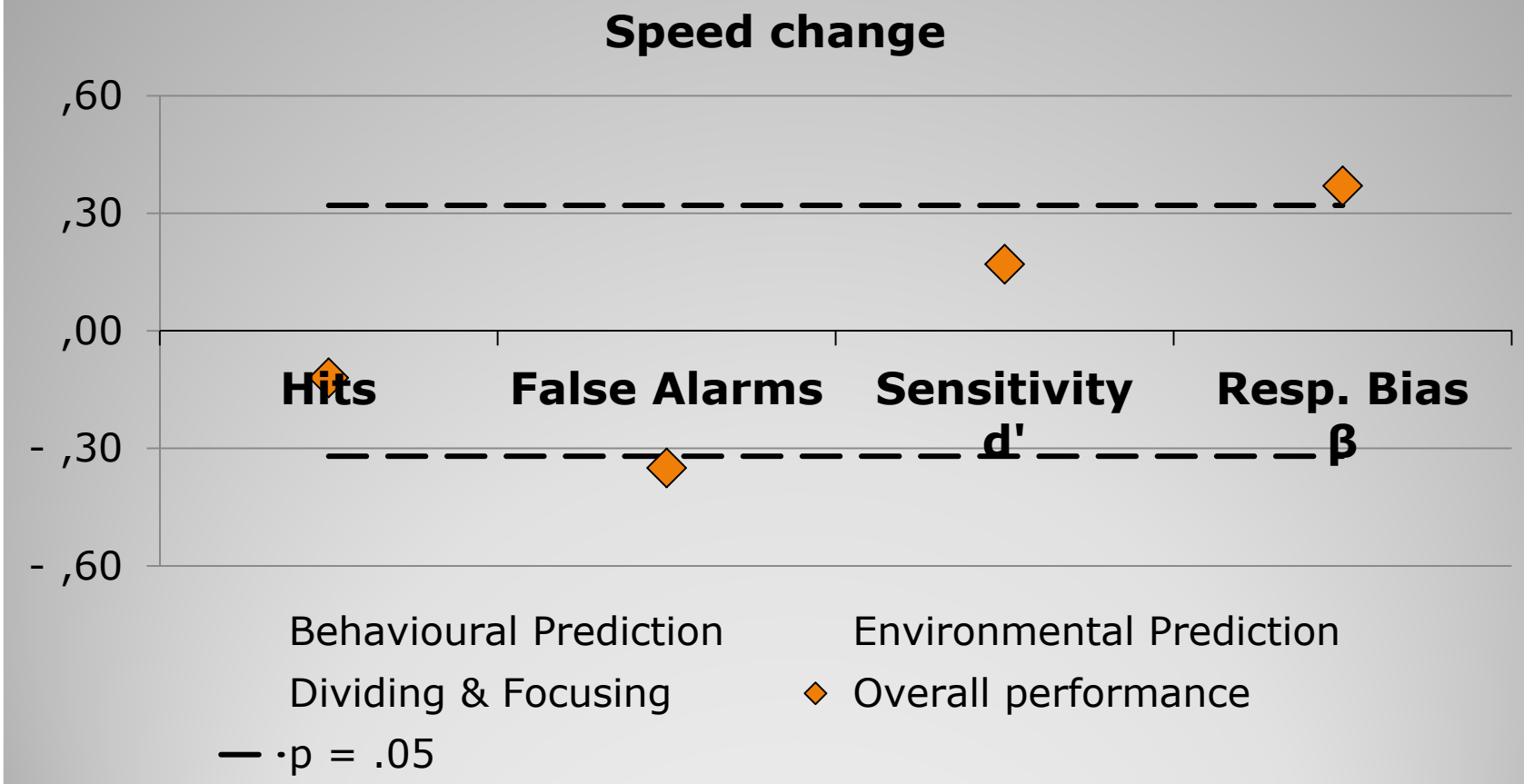
Trial Duration: 4100 ms



Method

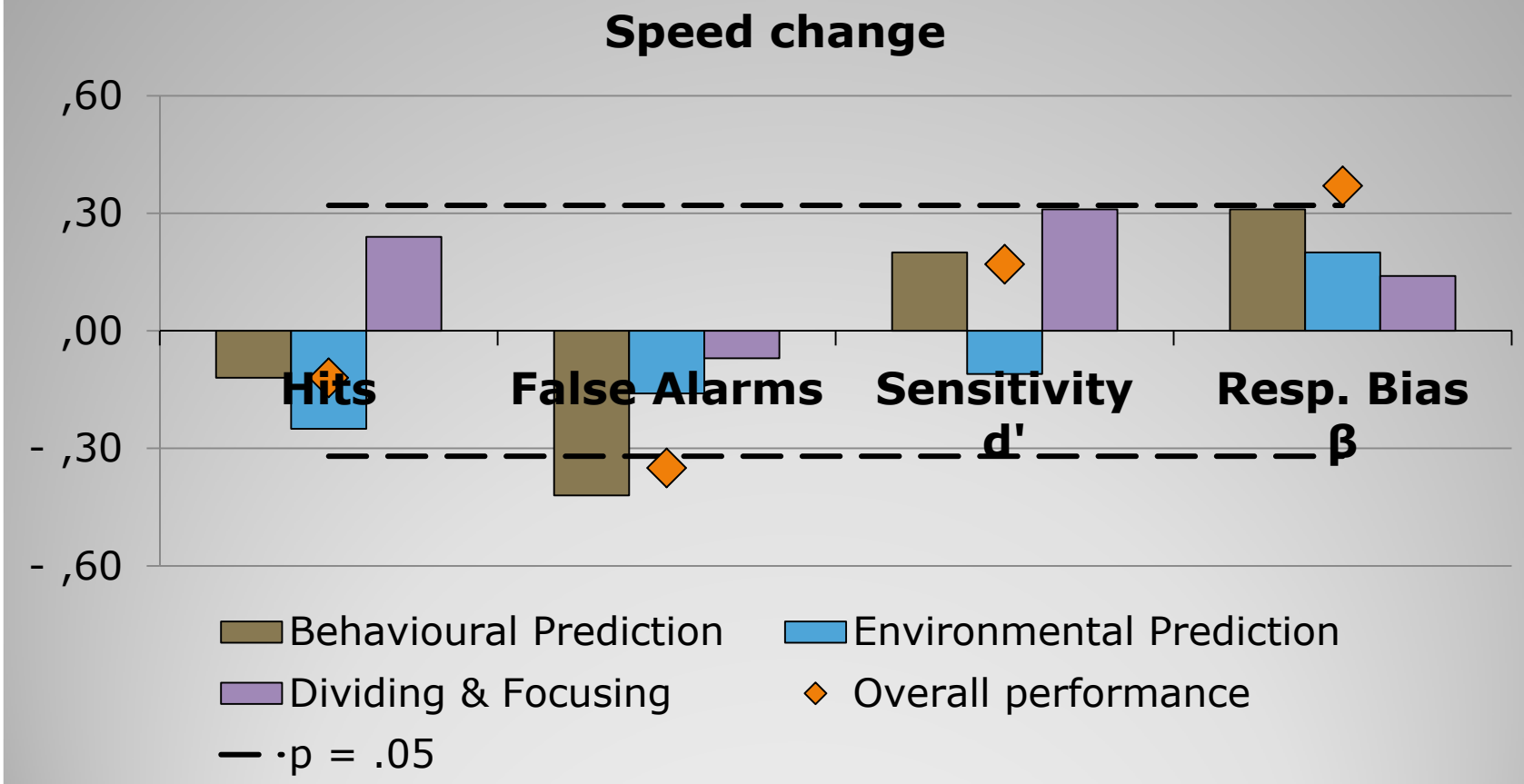
Roca, Castro, López-Ramón, & Lupiáñez. (2011).
Journal of Neuroscience Methods, 198(2), 312-24.

Correlations ANTI-V and Faros GB3



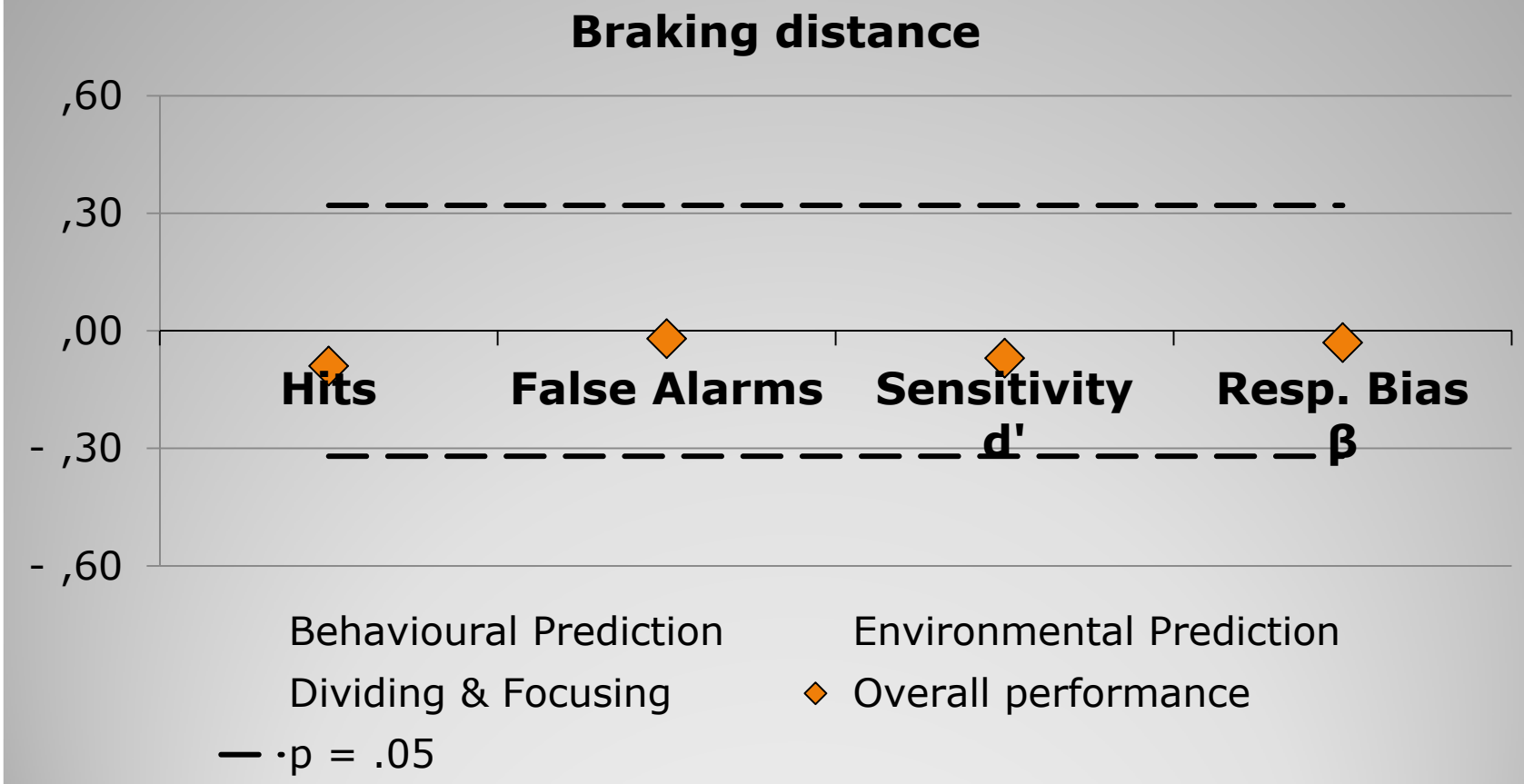
Results

Correlations ANTI-V and Faros GB3



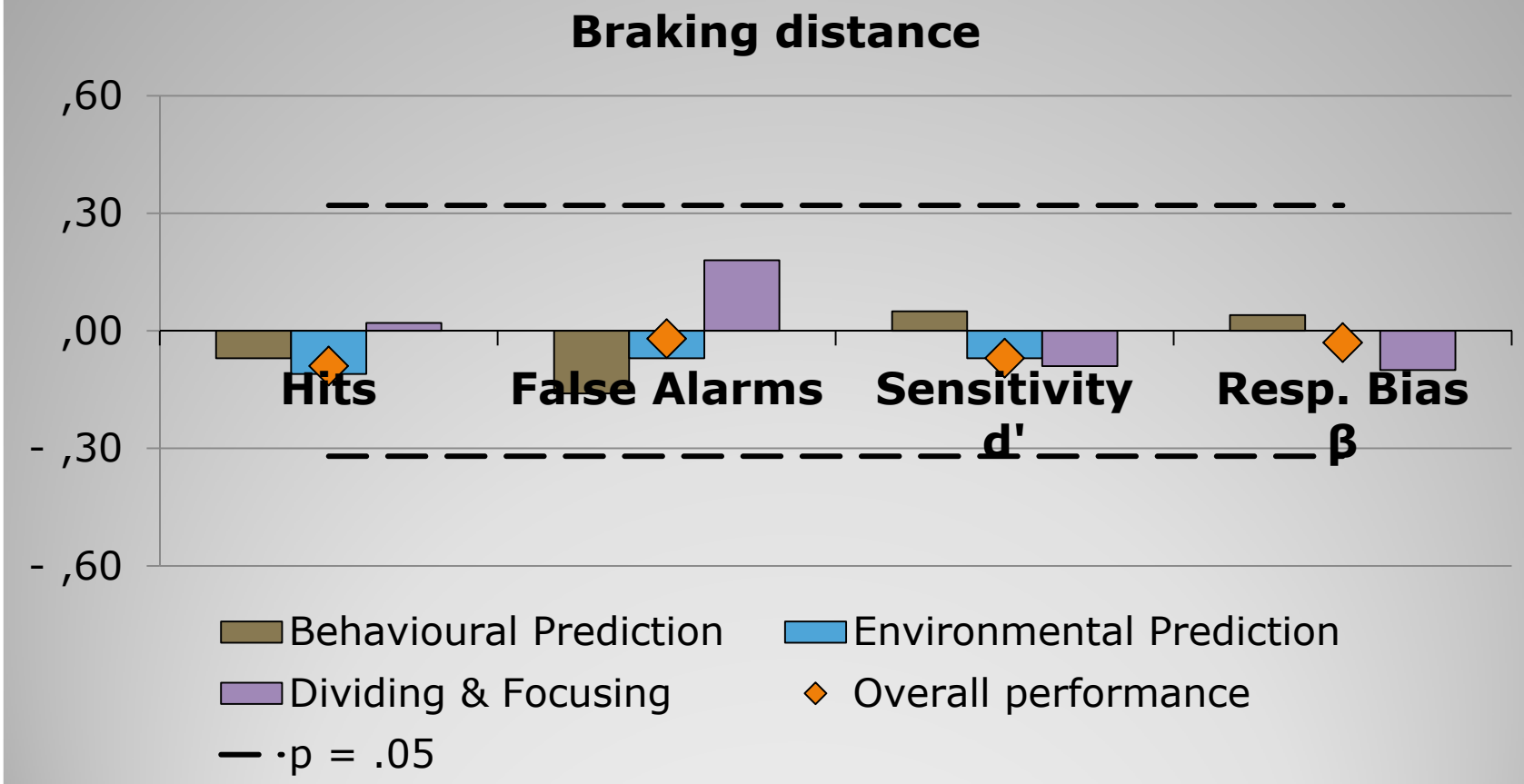
Results

Correlations ANTI-V and Faros GB3



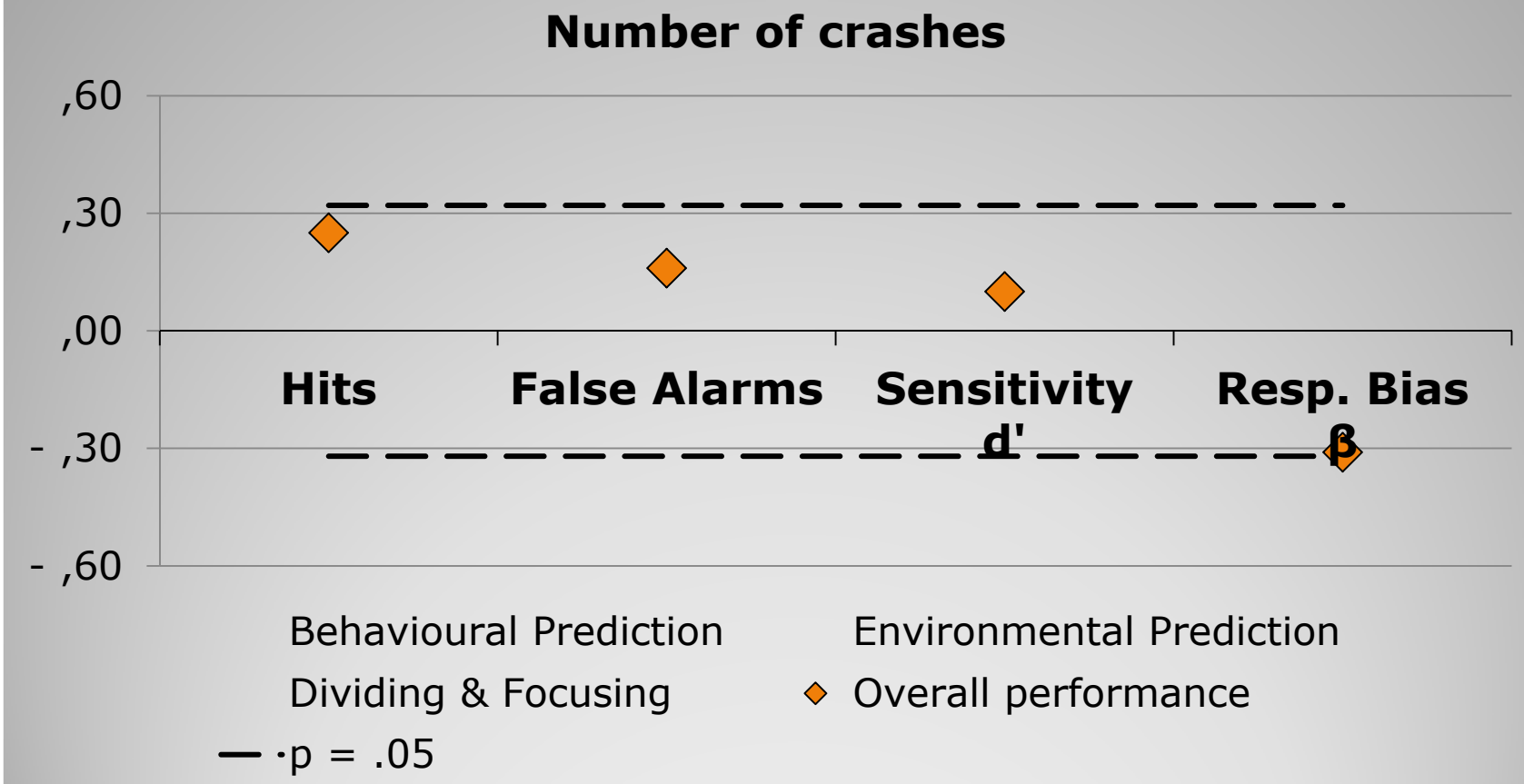
Results

Correlations ANTI-V and Faros GB3



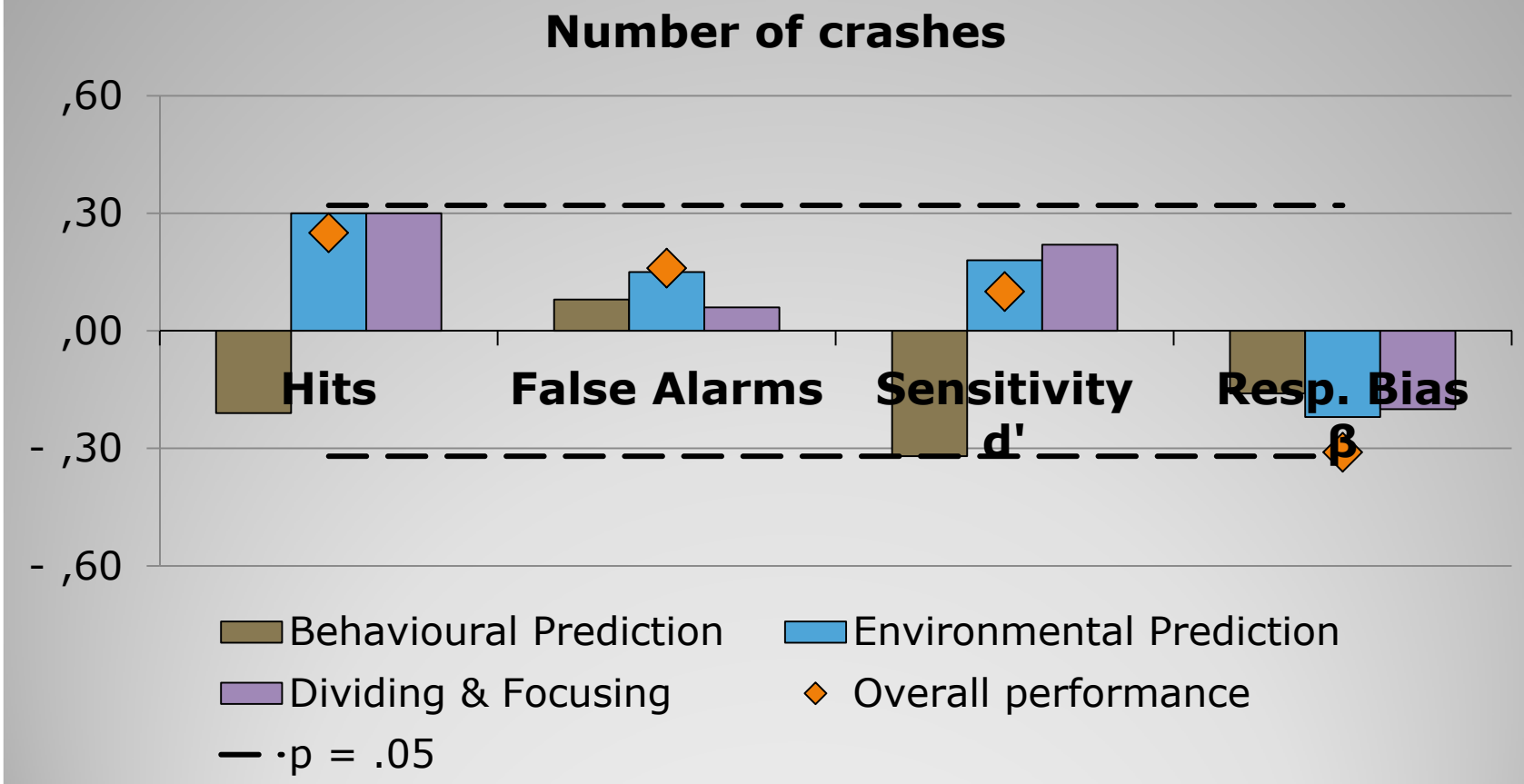
Results

Correlations ANTI-V and Faros GB3



Results

Correlations ANTI-V and Faros GB3



Results

Limitations

- **Other qualitative differences (PhA and EC) were suggested, but not confirmed.**
  - Further studies with bigger **sample sizes**, different **measures**, and/or different **situations**.
- **Vigilance (V) was not significantly associated with any situation.**
  - Participants were quite **alert and awake**.
  - The driving task was **too short**.
- **Results are only based on associations between variables.**
  - Convergent evidence from **different methods** will be helpful to confirm these results.