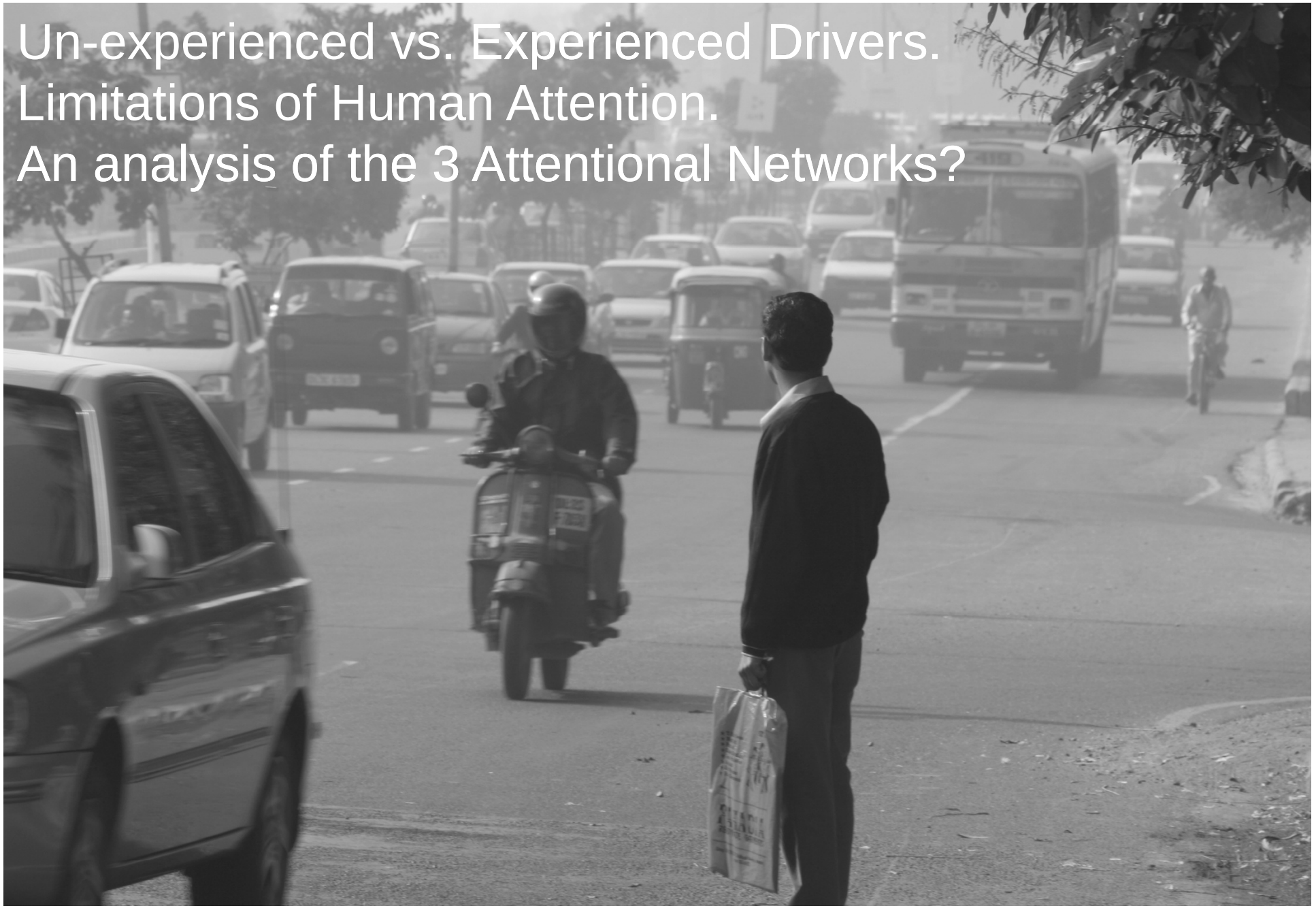
Un-experienced vs. Experienced Drivers. Limitations of Human Attention. An analysis of the 3 Attentional Networks?



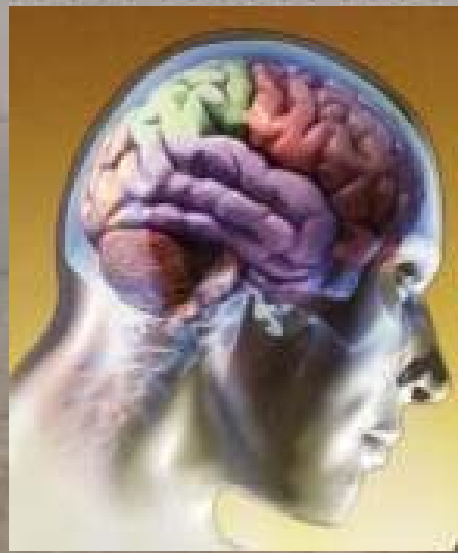
C., Castro*, D., Crundall, P., Chapman**, S. Trawley** & G. Underwood****

*** University of Granada, Spain ** University of Nottingham, United Kingdom**

Un-experienced vs. Experienced Drivers.

Limitations of Human Attention.

An analysis of the 3 Attentional Networks?



ATTENTIONAL NETWORKS:

ORIENTING

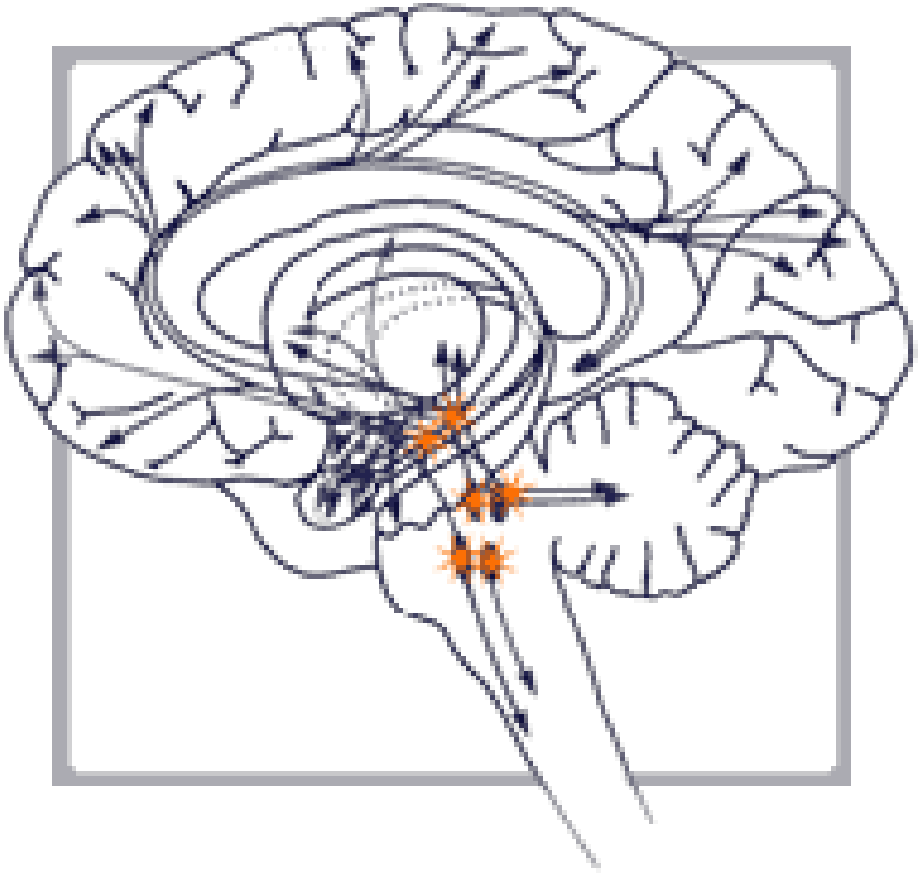
EXECUTIVE CONTROL

ALERTING

Safe driving relies on the Attentional Networks functioning correctly.

Alerting
Attentional
Network

Attentional
Executive
Control



Orienting
Attentional
Network

Posner 1978, 1987

1. ORIENTING

Orienting is manipulated by

presenting a cue indicating

where in space a person should focus attention

to direct attention to the cued location

either overtly by moving the eyes

or covertly without any eye movement

2. EXECUTIVE CONTROL

Is active when the cognitive system faces situations that involve: *(Norman and Shallice, 1986)*

- *planning,*
- *making a decision,*
- *detecting an error,*
- *giving a novel response or*
- *overcoming habitual actions*

TASKS dealing with: *CONFLICT,*
HANDLING NOVELTY
DETECTING ERRORS

3. ALERTING

can be considered as…

Phasic alertness

Non-specific activation occurs when a warning signal is presented prior to the target.

Studied by measuring the influence on reaction time (RT) of a signal that provides only temporal information.

Attention & Driving
Distraction & Driving

Driving is an example of an everyday task in which survival relies on attention and, particularly, on visual attention Recarte and Nunes (2008)

DISTRACTION

Explanatory concept for traffic accidents,

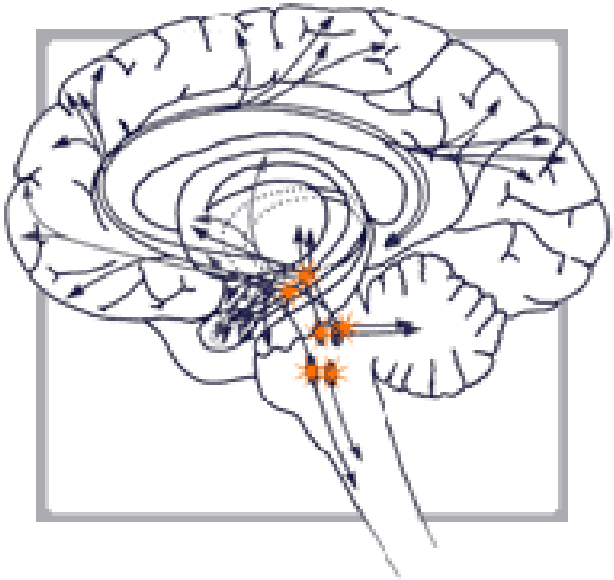
= attentional inefficiency:
a dysfunction in information processing
leading to increased risk and human error.

Neural Location of the 3 Attentional Networks

It is found using **Functional magnetic resonance imaging**

Alerting Attentional Network located at
FRONTAL & PARIETAL REGIONS (Right Hemisphere)

Attentional
Executive Control
FRONTAL CORTEX



Orienting
Attentional Network
SUPERIOR PARIETAL LOBE

Posner 1978, 1987

Attention /Driving

- Nelson, Tuttle and Backs (2007) examined the relationship between

  attentional abilities

  (selective, scanning, switching, sustained and divided)

  assessed with

  a computer-based test battery of questions and

  a **driving simulator**

  - Speed & Visual Search
  - Divided attention

ANTI-TASK:

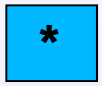
Fan, McCandliss, Sommer, Raz and Posner (2002)

Callejas, Lupiañez and Tudela (2002)*

Combines elements of:

Posner's cueing paradigm. ORIENTING

Valid



Invalid

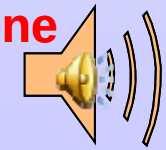
*

Eriksen & Eriksen flanker task EXECUTIVE CONTROL

<= <= <= <= <= Congruent

<= <= => <= <= Incongruent

Alerting tone ALERTING



Provides measures of 3 distinct functions of attention:

- Orienting – Alerting - Executive Function

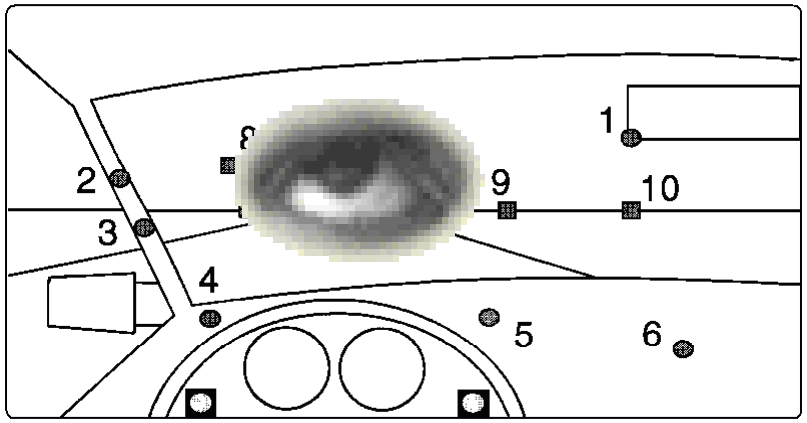
ANTI-Task & Driving

Using the Attention Network Test to predict driving test scores

Weaver, B., Bedard, M. McAuliffe, & Parkkari (2008)

ANT has good Concurrent validity with the Useful Field of View

UFOV



Visual Attention & Driving Experience

Underwood, Crundall and Chapman (2008)

SEQUENCES OF FIXATIONS =/= novice and experienced drivers =/= on three **types of roads** (rural, suburban and dual-carriageway)

Experienced drivers **show greater sensitivity overall,**

Changes in the distribution of attention.
Knowing better where to look,
Less distracted by events unrelated to the task of driving

Novice drivers are at **disproportionate risk of involvement** in a crash

Stereotypical transitions in visual attention.

They show a **roadway preview pattern:**

*alternating fixations between near and far views of the road ahead
* patterns involving mirror inspections, according to the road type

Research Aim

- Determining the driver's attention profile will provide information about her/his driving and therefore be useful for examining driving skills, for instance:
  - in impaired populations
  - training methods
  - …

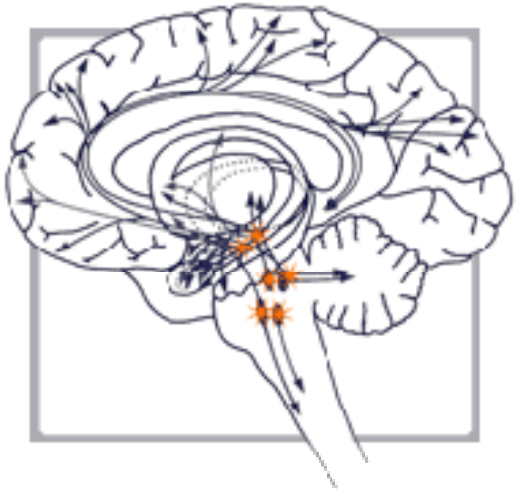
Research Aim

Is there a functional difference in the

3 ATTENTIONAL NETWORKS between

Novice

and Experienced drivers?



Stimuli

to manipulate

EXECUTIVE CONTROL: CONGRUENCY

The target display was made up of a target arrow that could point either to the left or to the right, and four flankers or arrows pointing to the:

left (<=) => => <= => =>

right (=>) => => => => =>

ALERTING

A 2000 Hz and 50 ms sound

*
+
*

ORIENTING

An asterisk presented at the same location as the target

(0.6° of visual angle above or below fixation point).

Instructions…

A series of five arrows will be shown in the centre of the screen.

Your task consists of saying in which direction the central arrow is pointing.

To answer, please press the following keys:

"c" if the central arrow points to the left <=

"m" if the central arrow points to the right =>

For instance, in this case you should press the “left” key:

<= <= <= <= <=

but in this case you should press the “right” key:

=> => => => =>

…Instructions

Sometimes the central arrow will point in the opposite direction to the other arrows. Please, remember:

You should pay attention to the direction of the central arrow.

=> => <= => =>

In this case you should press the “left” key.

In the centre of the screen a small cross “+” will appear. This is the fixation point. The arrows will appear above or below the fixation point.

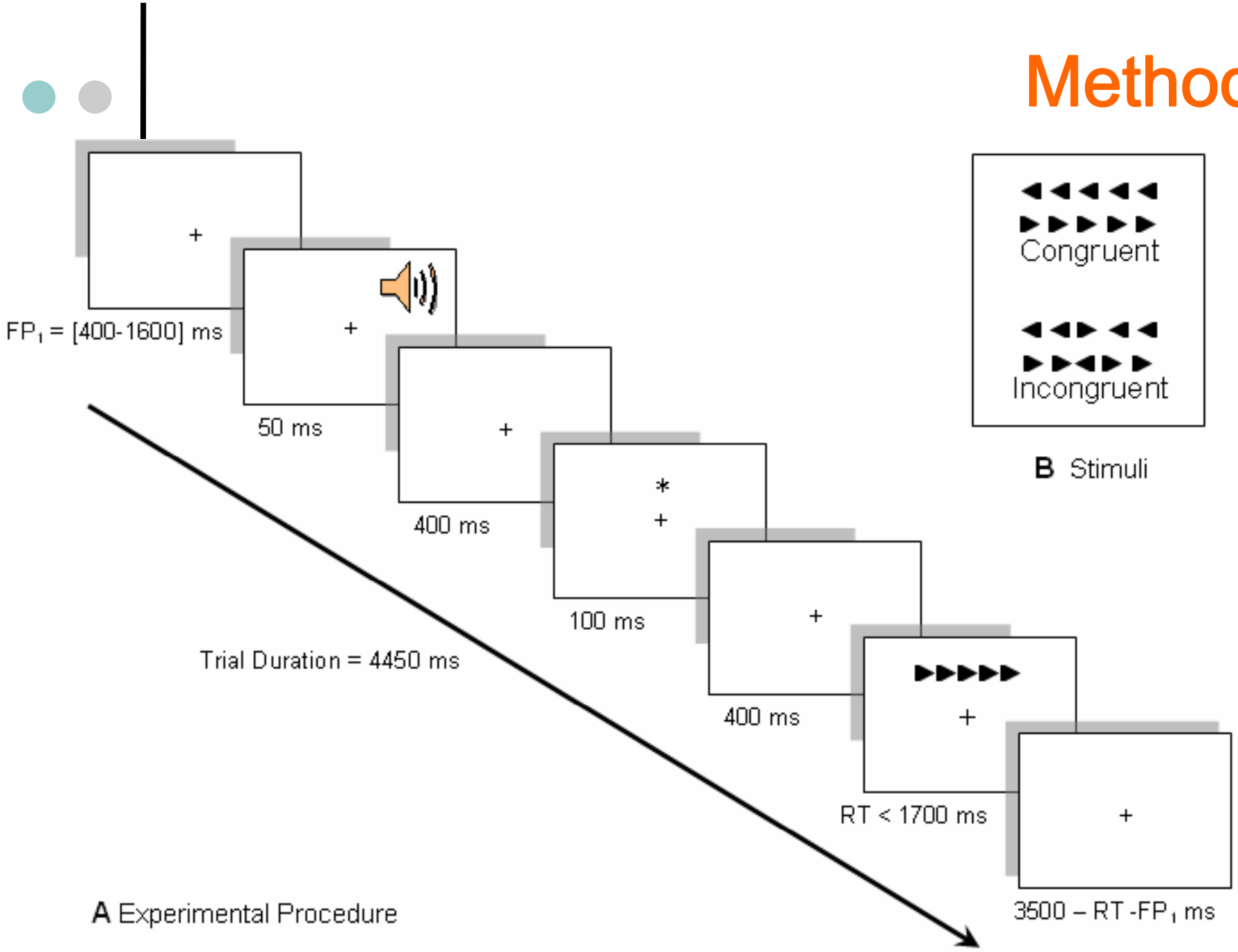
=> => <= => =>

(" + ")

=> => <= => =>

KEEP LOOKING AT the fixation point THROUGHOUT THE EXPERIMENT

Method


+
FP1 = [400-1600] ms
50 ms
400 ms
100 ms
400 ms
RT < 1700 ms
3500 – RT -FP1 ms
Trial Duration = 4450 ms
A Experimental Procedure
Congruent
Incongruent
B Stimuli

Method

Participants = 20 (from Nottingham, U.K.)

10 novice: 18-20 years old

10 experienced drivers: 25-40 years old

Design (2) X 2 X 2 X 3 **Reaction Time (RT) analysis**

4 variables were manipulated:

2 Groups of drivers: Novice, Experienced

2 Auditory/Alerting Signals: No Tone, Tone

2 Executive Control: Congruent, Incongruent

3 Orienting (Visual Cue): No cue, Cued, Uncued

ANOVA 2x2x3x(2)

The 4 way interaction is approaching significance: F(2, 36)=2,45, p=,1004).

2 (Alerting: No Auditory Signal vs. Auditory Signal) x
2 (Congruency: Congruent vs. Incongruent) x
3 (Orienting: No Cue, Cued vs. Uncued) x
(2) (Group: Novice vs. Experienced)

2 different ANOVAS are performed:

ORIENTING EFFECT

2x2x2x(2) Only for Valid (Cue) and Invalid (Uncued) trials.

2x2x(2) Only for Neutral (No cued) trials

ORIENTING X ALERTING

ANOVA 2x2x2x(2)

2 (Alerting: No Auditory Signal vs. Auditory Signal) x
2 (Congruency: Congruent vs. Incongruent) x
2 (Orienting: Cued vs. Uncued) x
(2) (Group: Novice vs. Experienced)

ORIENTING

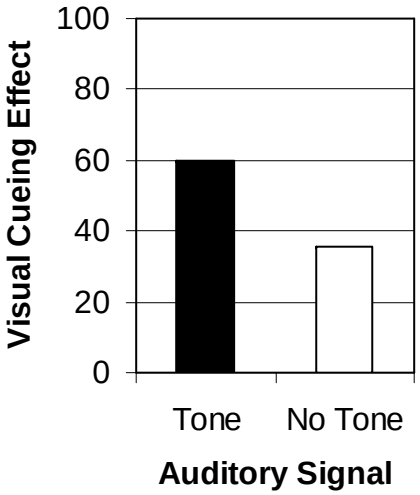
Novice =greater **ORIENTING** effect than **Experienced** F(1,18)=5,49,p=,0308

ORIENTING X ALERTING

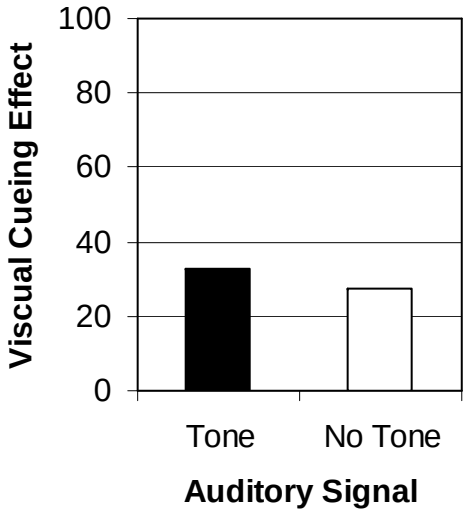
The **Group x Orienting x Alerting** approach * F(1, 18)=3,3970, p=,08185. **Novice** =less interference in valid location trials, as shown in the standard task

Experienced = do not show this reduction (F<1).

NOVICE



EXPERIENCED



Y-Axis represents the **ORIENTING** effect in ms = Uncued - Cued trials

ORIENTING X ALERTING

ANOVA 2x2x2x(2)

NOVICE drivers

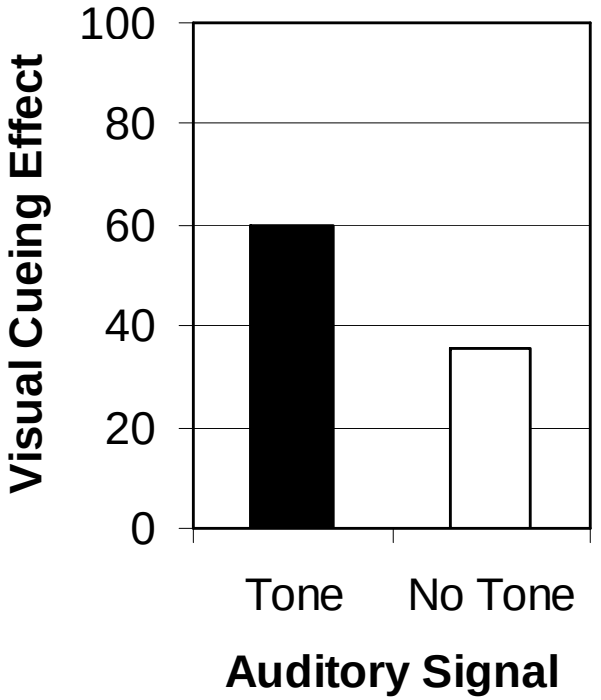
ORIENTING X ALERTING

2 (Alerting: No Auditory Signal vs. Auditory Signal) x
2 (Congruency: Congruent vs. Incongruent) x
2 (Orienting: Cued vs. Uncued)

Alerting X Orienting, (F(2,18)= 2,64, p<0.09
Marginally *

Under Alerting conditions, the effect of an Orienting Cue was larger than in those trials in which no alerting cue was presented.

Therefore the cueing effect (difference between cued and uncued trials) was significantly larger in the trials with an alerting stimulus than in those where the alerting tone was not presented.



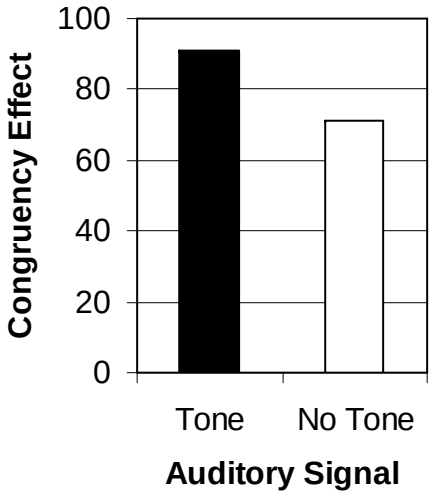
CONGRUENCY X ALERTING

ANOVA 2x2x2x(2)

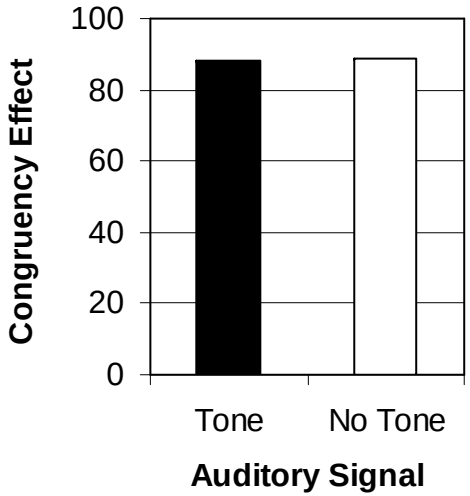
2 (Alerting: No Auditory Signal vs. Auditory Signal) x
2 (Congruency: Congruent vs. Incongruent) x
2 (Orienting: Cued vs. Uncued) x
(2) (Group: Novice vs. Experienced)

The Group x CONGRUENCY X ALERTING *, F(1, 18)=5,04, p=,0375.
Novice = expected interaction: Congruency and Alerting (p=.006)
Experienced do not show this (F<1) = the same amount of interference
in the absence of the tone (i.e., without alerting)
as in its presence (i.e., under alerting).

NOVICE



EXPERIENCED



Y-Axis represents the CONGRUENCY effect in ms = incongruent - congruent trials

CONGRUENCY X ALERTING

ANOVA 2x2x2x(2)

NOVICE

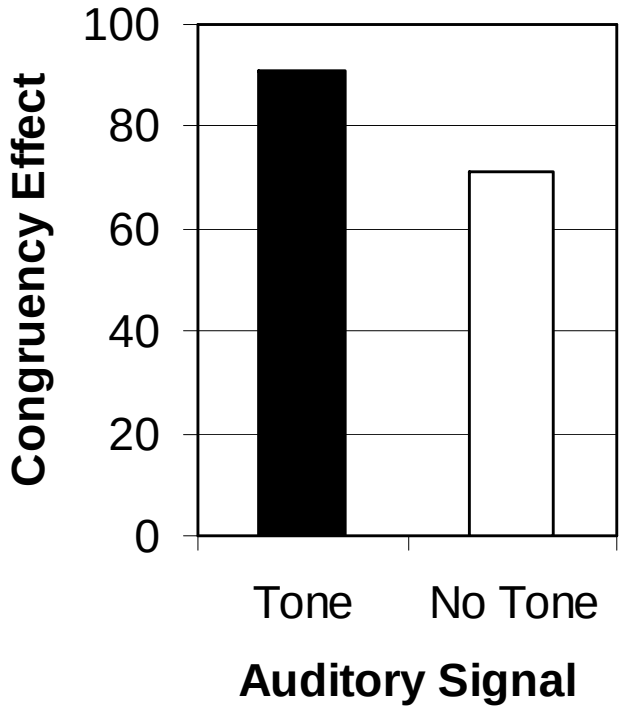
2 (Alerting) x 2 (Congruency) x 2 (Orienting)

Alerting Network produces an inhibitory effect on the Executive Function Network:
To enhance fast responses to sensory input in order to detect an infrequent target and prevent the system from focusing on feelings or thoughts or on further processing of the stimulus

The CONGRUENCY X ALERTING
*** F(1,9)= 13,69, p<0.004**

Greater congruency effect - difference between congruent and incongruent trials- ´
- when an alerting sound was present
- compared with those trials when it was absent

= An increase in the RT for incongruent trials
Those in which the flankers pointed in the opposite direction to that of the target



CONGRUENCY X ORIENTING

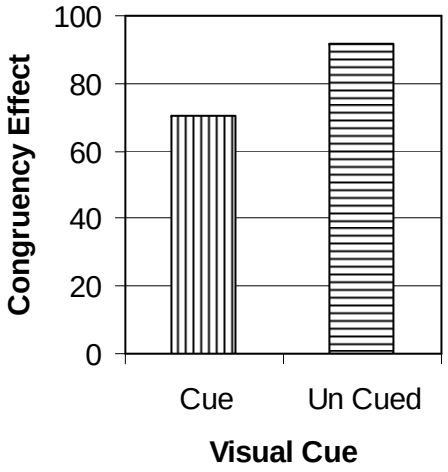
ANOVA 2x2x2x(2)

2 (Alerting: No Auditory Signal vs. Auditory Signal) x
2 (Congruency: Congruent vs. Incongruent) x
2 (Orienting: Cued vs. Uncued) x
(2) (Group: Novice vs. Experienced)

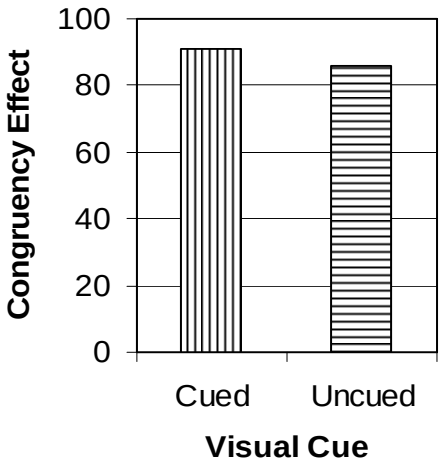
CONGRUENCY X ORIENTING *, F(2,18)=3,71, p<0.04.

Greater Congruency effect when the participant viewed a cue in the location opposite to that of the target than in conditions where the cue was either absent or present in the same location as the target *

NOVICE



EXPERIENCED



Y-Axis represents the CONGRUENCY effect in ms = incongruent - congruent trials

CONGRUENCY X ORIENTING

ANOVA 2x2x2x(2)

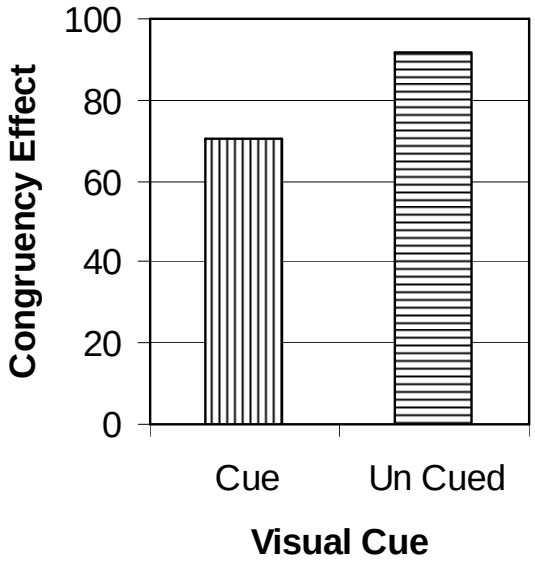
NOVICE

CONGRUENCY X ORIENTING

- **Greater Congruency effect when the participant viewed a cue in the location opposite to that of the target.**

In cued trials the asterisk appeared in exactly the same position as the target arrow

Thus helping focus attention and making it easier for the participant to ignore the incongruent flankers.



Results: RT

ALERTNESS

2x2x(2) mixed ANOVA on No-Cue trials.

2 (Alerting: No Auditory Signal vs. Auditory Signal) x
2 (Congruency: Congruent vs. Incongruent) x
2 (Group: Novice vs. Experienced),

Here the expected main effect of each variable is significant:

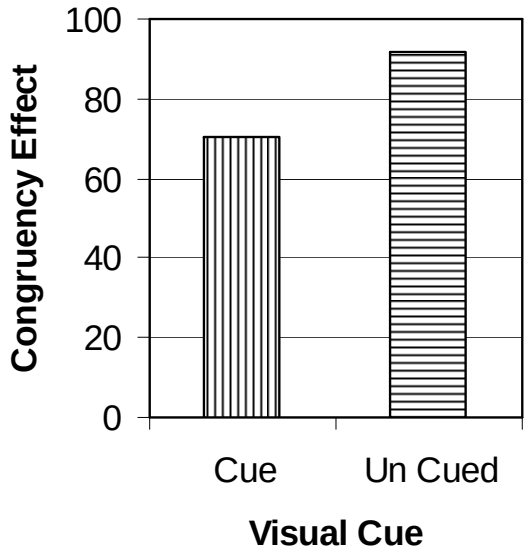
Alerting, F(1, 18)=90.99, p=,0001;
Congruency F(1, 18)=36,73, p=,0001
Group F(1, 18)=7,61, p=,012.

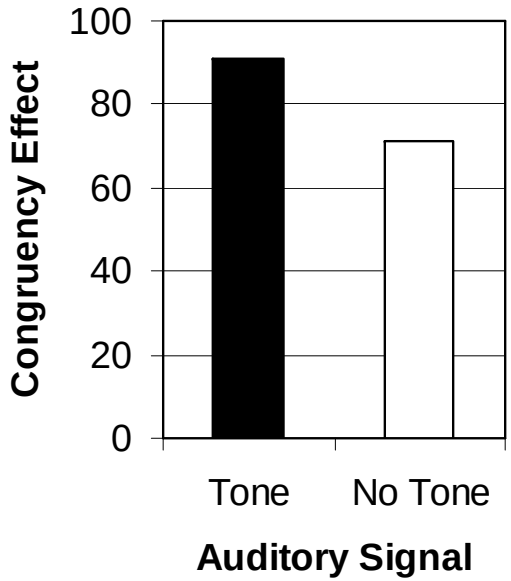
In addition, the CONGRUENCY X ALERTING interaction was significant, F(1, 18)=, 23,30, p=,0001.

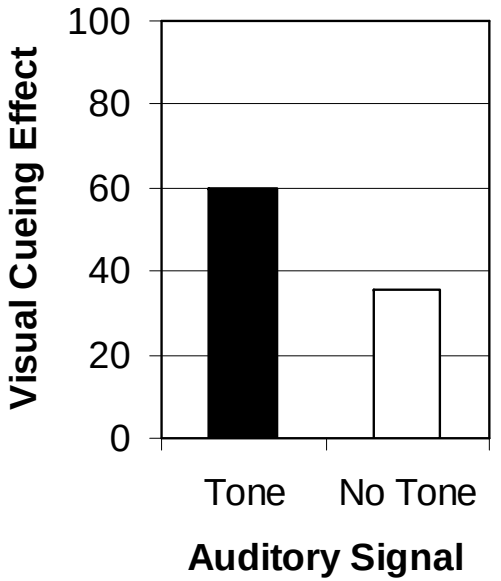
No other effects of interaction differ between one experience group and the other.

Novice Drivers

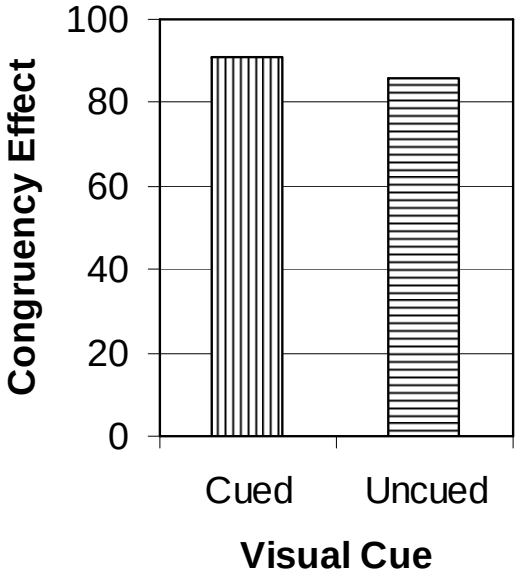
In NOVICE DRIVERS **Callejas *et al* (2004) replication of results.**

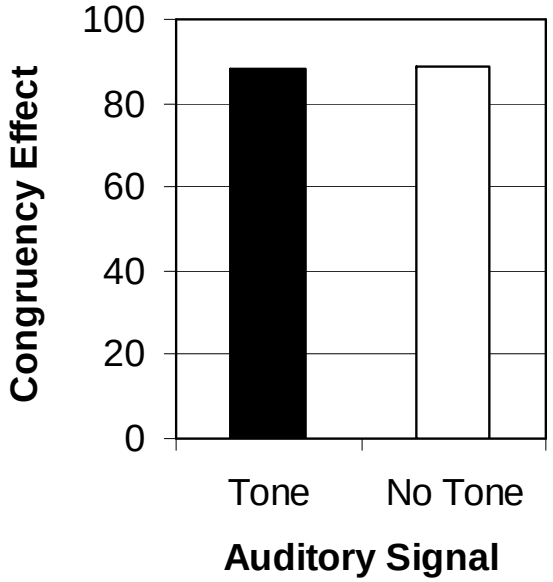


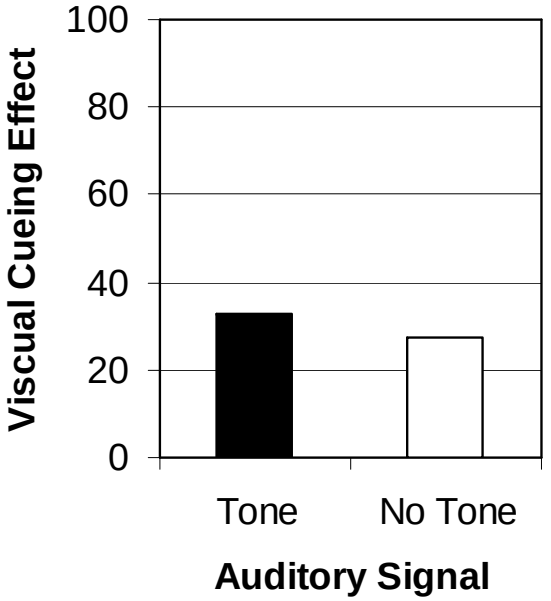




Experienced Drivers





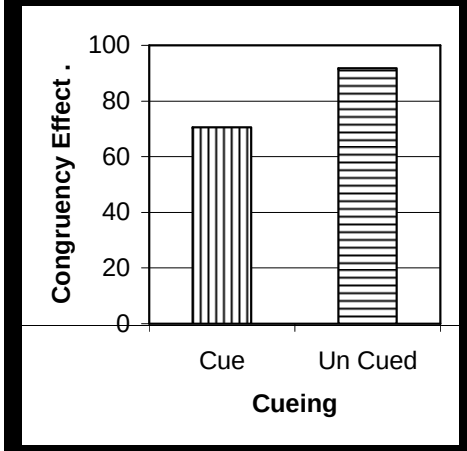


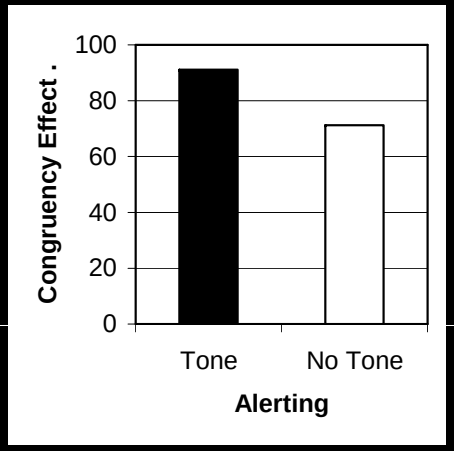
In EXPERIENCED DRIVER

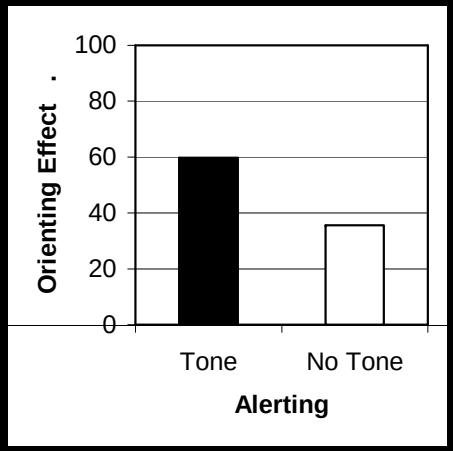
Smoother patterns of interaction between the 3 Attentional Networks.

Novice vs Experienced Drivers

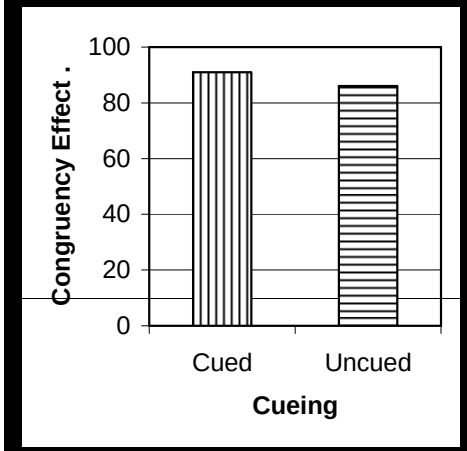
NOVICE DRIVERS

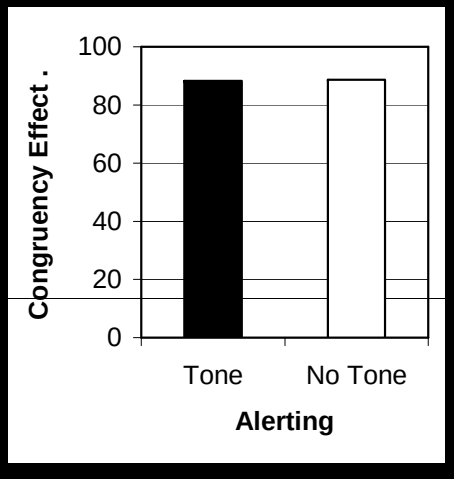


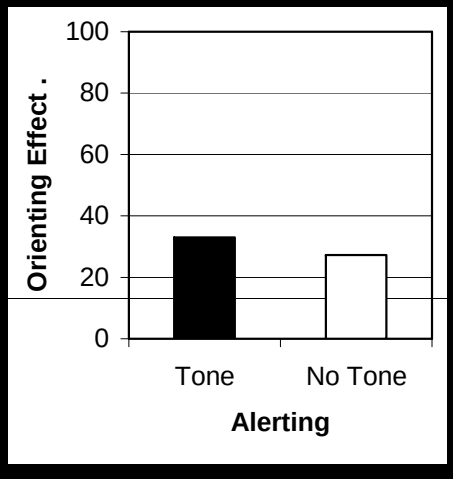




EXPERIENCED DRIVERS







Discussion

NOVICE DRIVERS Callejas *et al* (2004) replication of results :

ORIENTING X ALERTING ***Tone enhancing effect….***

The effect of an Orienting Cue was larger under Alerting conditions than in those trials in which no alerting sound was presented.

CONGRUENCY X ORIENTING

Larger Congruency effect when the participant viewed a cue

in the location opposite to that of the target.

When the asterisk appeared in the same position as the target arrow,

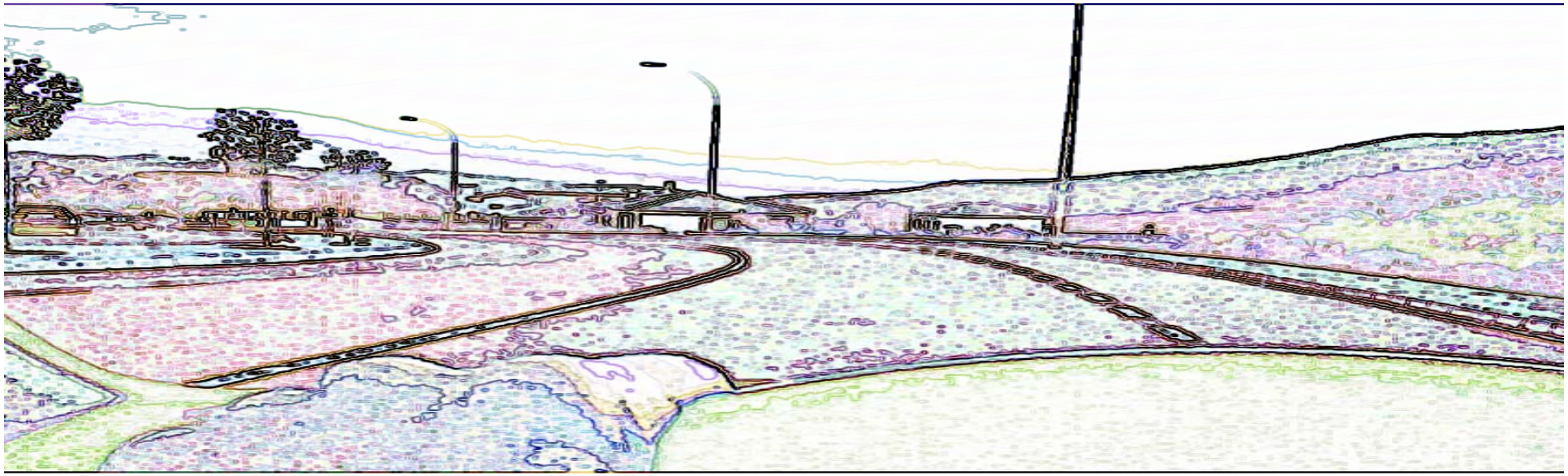
it helped focus the attention.

ALERTNESS x CONGRUENCY

Alerting produces an inhibitory effect on the Executive Function

To enhance fast responses to sensory input in order to detect an infrequent target and prevent the system from focusing on feelings

or thoughts or on further processing of the stimulus.



We should measure the FUNCTIONING of the 3 ATTENTIONAL NETWORKS in other complex tasks, like driving

- **To explore the interesting interactions between them:**
  - **ORIENTING X ALERTING X CONGRUENCY**
  - **These seem to vary according to DRIVING EXPERIENCE…**
- **To confirm the pattern found in the lab task….**
  - **The stronger interactions for Novice Drivers**
- **To clarify that the difference found is not only a function of age…**

Promising research issue that deserves

Continue...