

Inattention blindness for shapes, faces, and words: ERP correlates of attention & awareness

Michael Pitts, Juliet Shafto, & Kathryn Schelonka
Psychology Department
Reed College



CSAIL 2014



Neural signatures of conscious perception

“When the same physical stimulus is processed consciously vs. unconsciously, how does neural activity differ?”

Global Neuronal Workspace Theory

Cell
PRESS

Neuron 70, April 28, 2011 ©2011 Elsevier Inc.

Experimental and Theoretical Approaches to Conscious Processing

Stanislas Dehaene^{1,2,3,4,*} and Jean-Pierre Changeux^{4,5,*}

¹INSERM, Cognitive Neuroimaging Unit, Gif sur Yvette, 91191 France

²CEA, DSV, I2BM, Neurospin center, Gif sur Yvette, 91191 France

³University Paris 11, Orsay 91401, France

⁴Collège de France, 11 Place Marcelin Berthelot, 75005 Paris, France

⁵Institut Pasteur CNRS URA 2182, Institut Pasteur, 75015 Paris, France

Consciousness
and the Brain

Deciphering
How the
Brain Codes
Our Thoughts



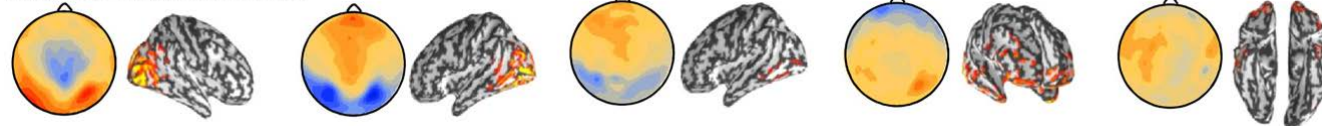
Stanislas Dehaene

author of
READING IN THE BRAIN

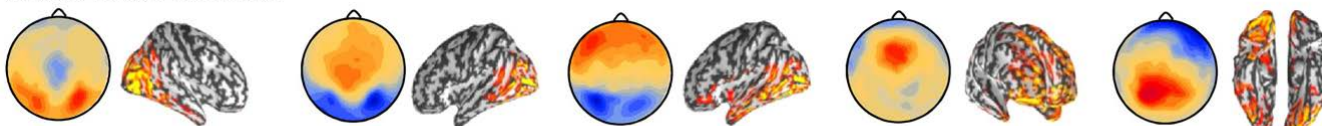
Evidence of Global Neuronal Workspace Activity

1. Wide-spread fronto-parietal activity
2. P3 wave (specifically P3b)
3. High-frequency (gamma) oscillations
4. Long-range synchrony

invisible visual stimulus



visible visual stimulus



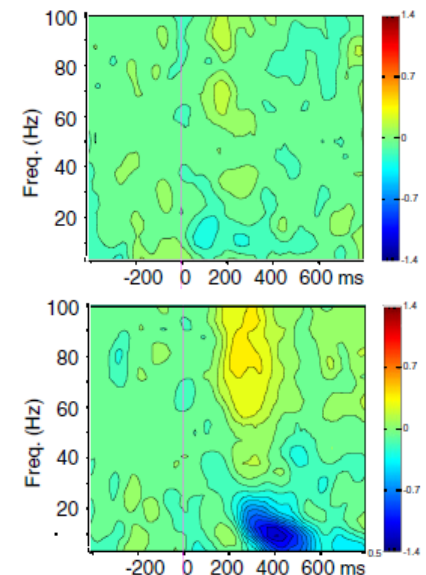
P1 : 96 ms

N1 : 180 ms

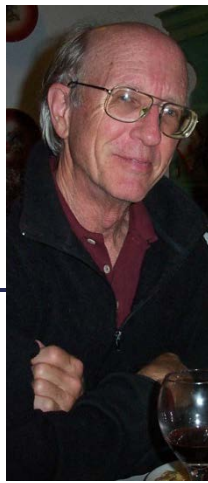
N2 : 276 ms

P3a : 436 ms

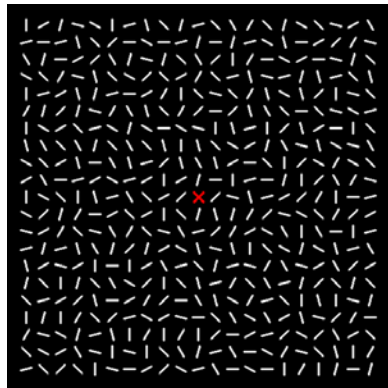
P3b : 576 ms



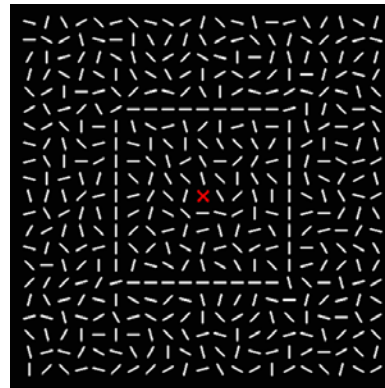
Stimuli



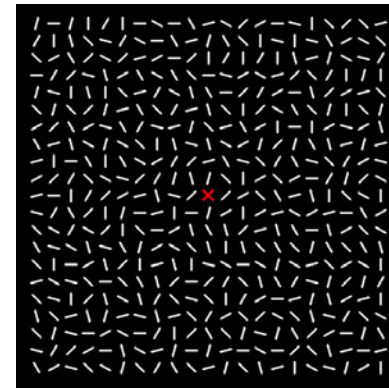
Square or Random



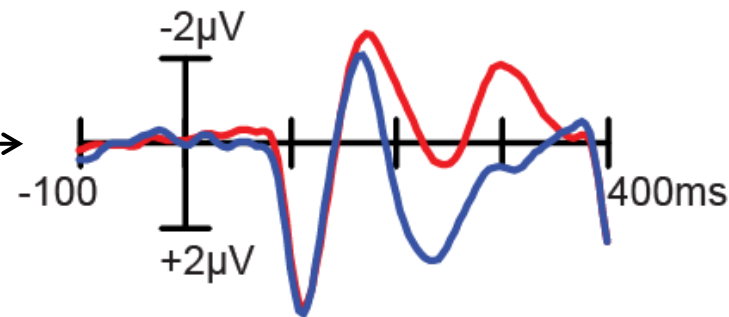
600-800ms



300ms



600-800ms

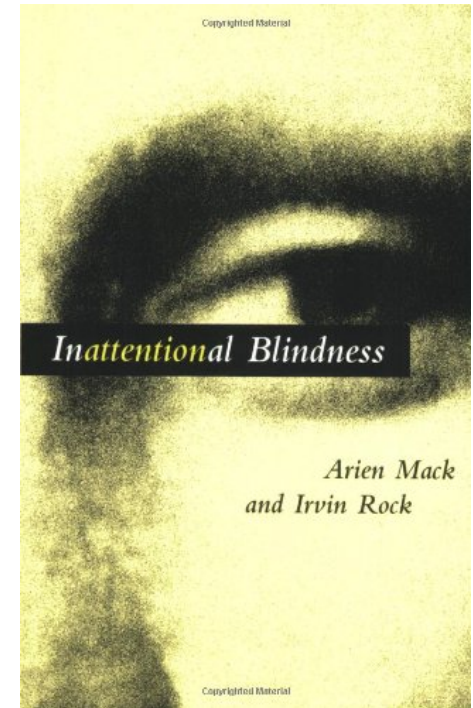
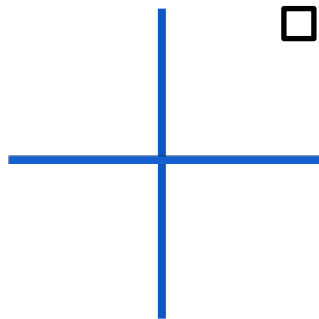


— Square Pattern
— Random Array

Inattentional Blindness

“Failure to perceive unexpected objects or events because attention is focused on another task”

Mack & Rock (1998); Simons & Chabris (1999)



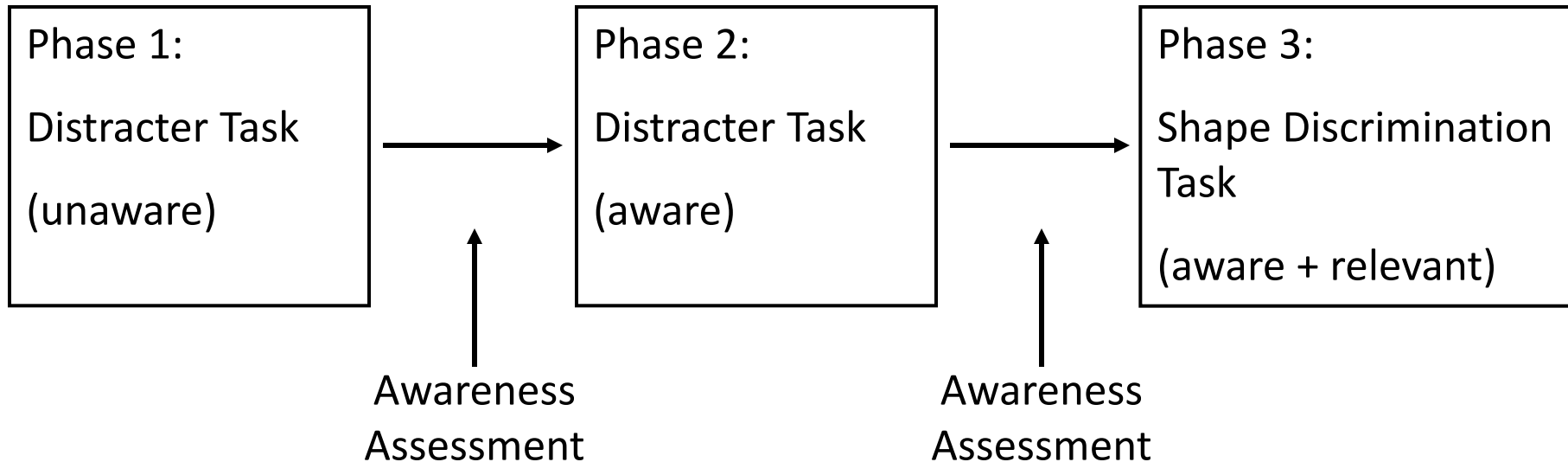
- attentional blink
- backward masking
- bistable figures / binocular rivalry
- interocular suppression

Inattention paradigm adapted for EEG/ERP

- Video Example of Stimuli:

http://www.youtube.com/watch?v=8-9NAFUUn_CI

Experiment 1: Procedure



of Stimuli per phase:

Random: 300

Square: 240

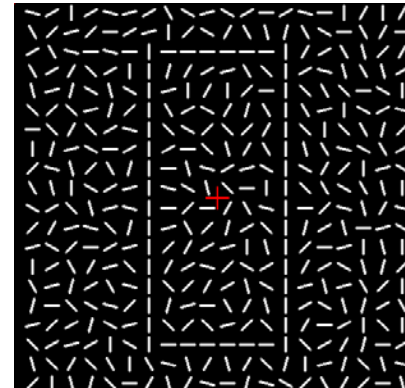
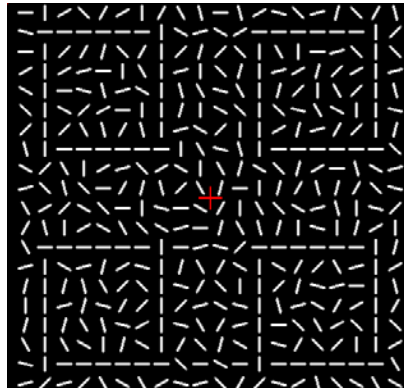
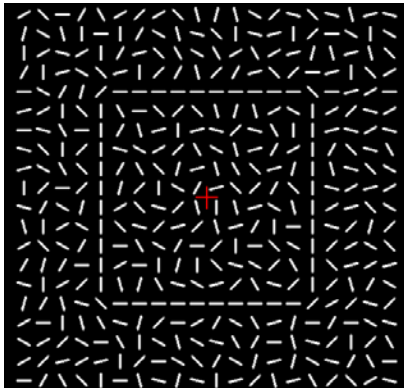
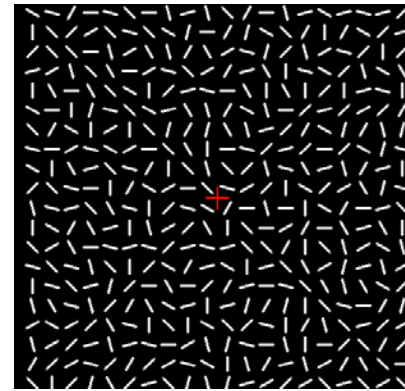
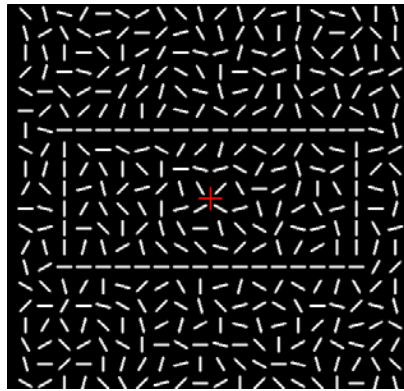
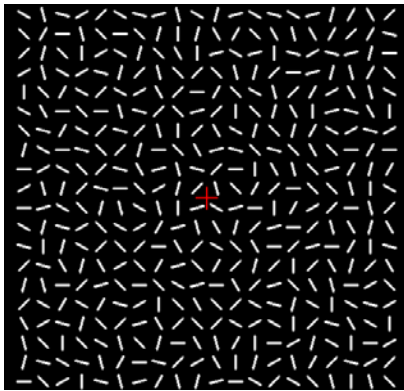
Diamond: 60

Awareness assessment

1) During the experiment, did you notice any patterns within the little white lines?

<input type="checkbox"/> Yes	<input type="checkbox"/> No
------------------------------	-----------------------------

2) If you did see any patterns, please describe (or draw) what you saw in as much detail as possible:



3) Rate how confident you are that you saw each pattern during the experiment.

Please use the following scale:

1 = very confident I *did not* see it

2 = confident I *did not* see it

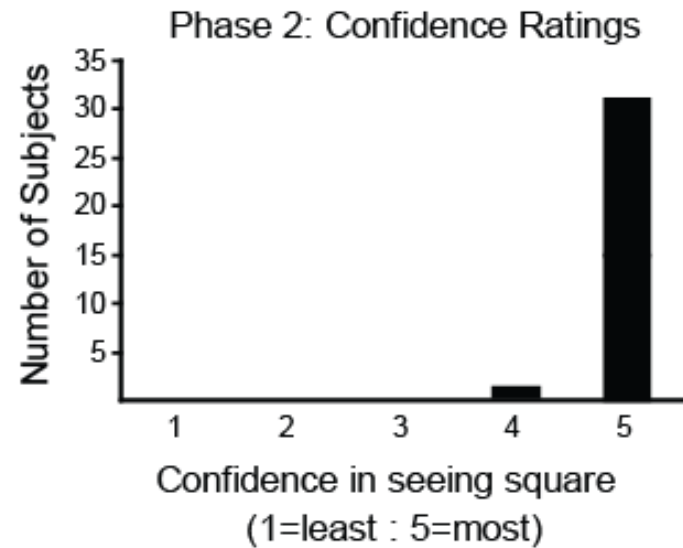
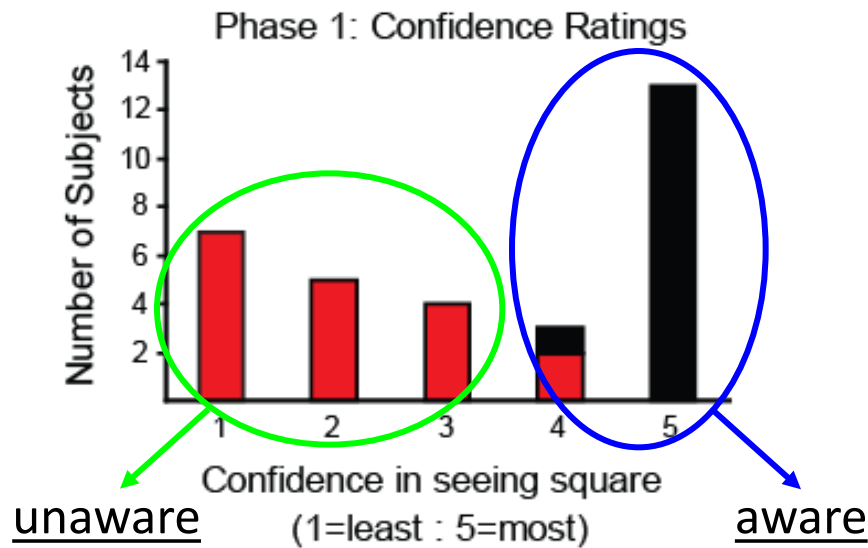
3 = uncertain

4 = confident I saw it

5 = very confident I saw it

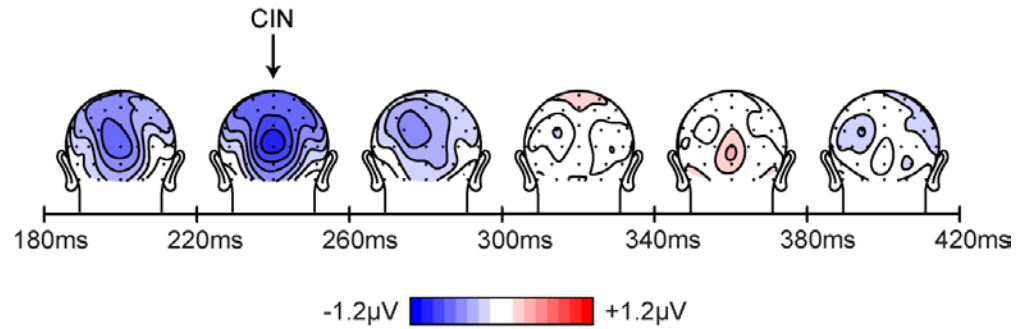
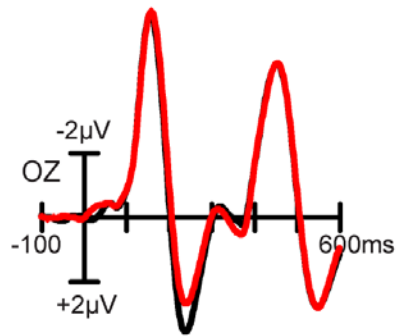
Diamond	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
Horizontal Rectangle	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
X Pattern	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
One Big Square	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
Four Small Squares	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
Vertical Rectangle	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Behavioral results (awareness assessments)

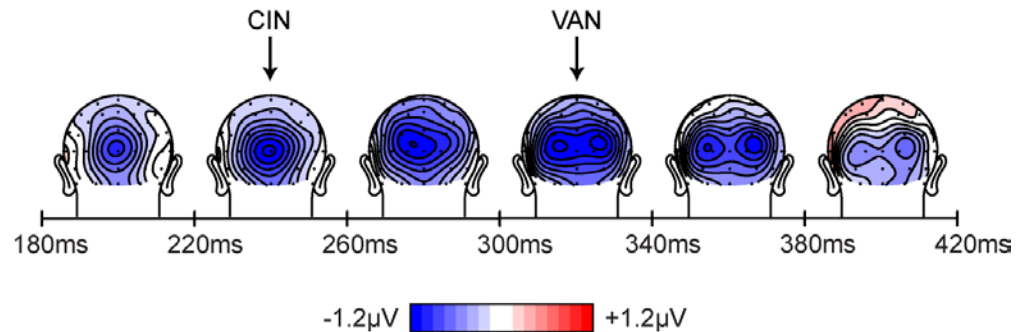
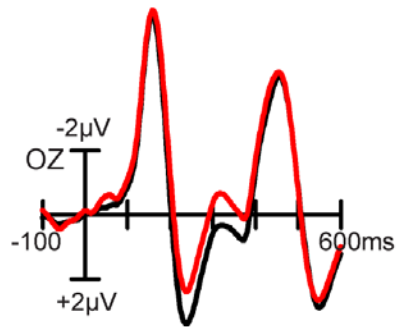


- Did not report square
- Reported seeing square

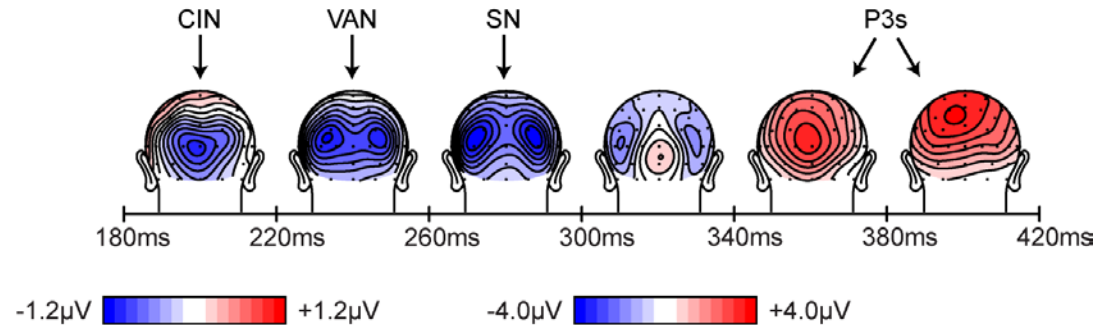
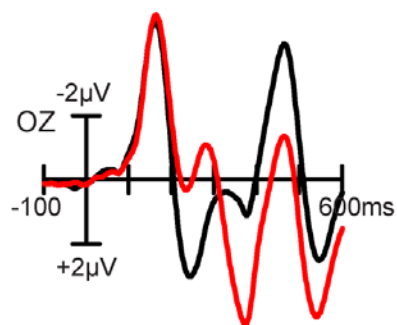
Phase 1: unaware



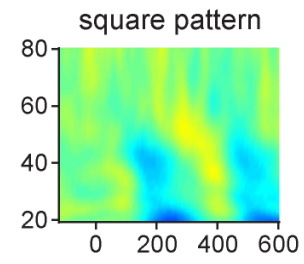
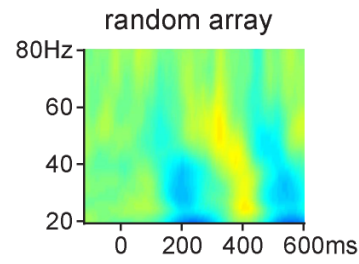
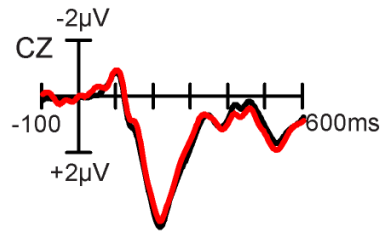
Phase 2: aware



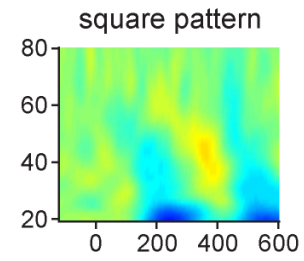
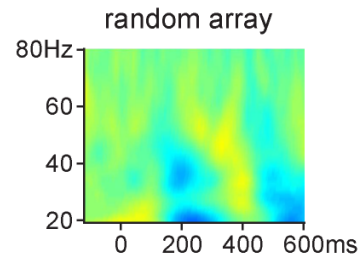
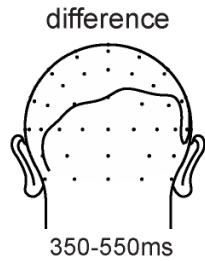
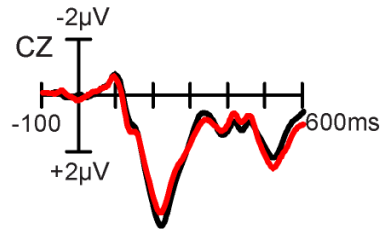
Phase 3: aware + task-relevant



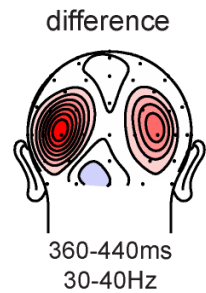
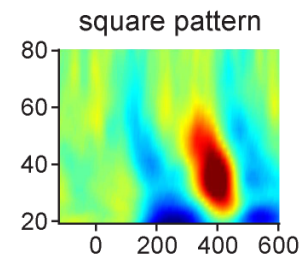
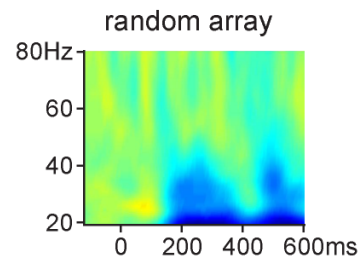
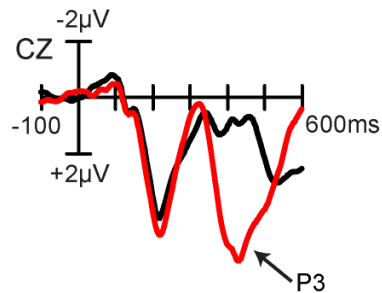
phase 1: unaware



phase 2: aware



phase 3: aware, task-relevant



— random array
— square pattern

-4 +4µV

-0.5 +0.5µV

-0.5 +0.5µV

Summary

- Early (~180ms) ERP negativity *regardless* of whether subjects are aware of the shapes.

- Phase 1 (unaware)



preconscious processing

- Subsequent (~260ms) ERP negativity *only when* subjects are aware of the shapes.

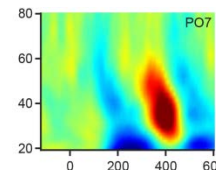
- Phase 2 (aware)



signature of conscious perception?

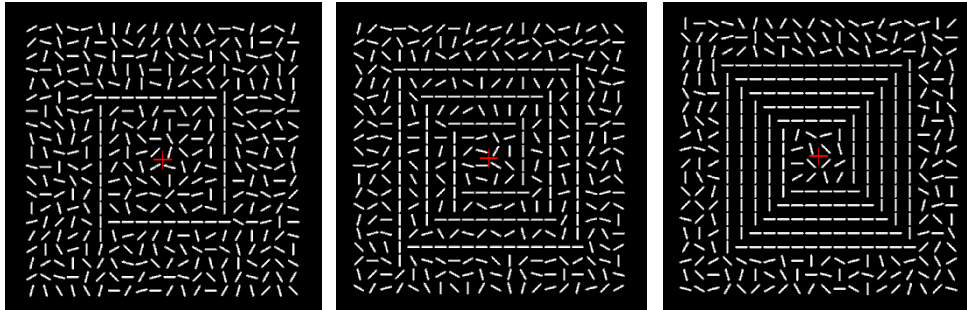
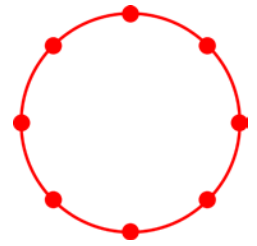
- P3 and gamma (>300ms) *only when* shapes are task relevant.

- Phase 3 (aware + task relevant)



postperceptual processing

Experiment 2: preconscious processing

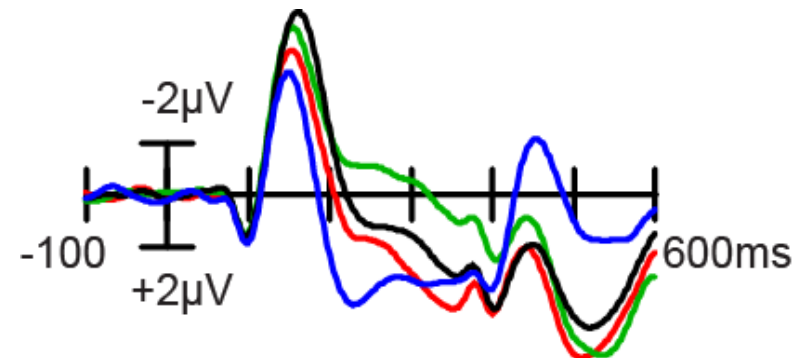
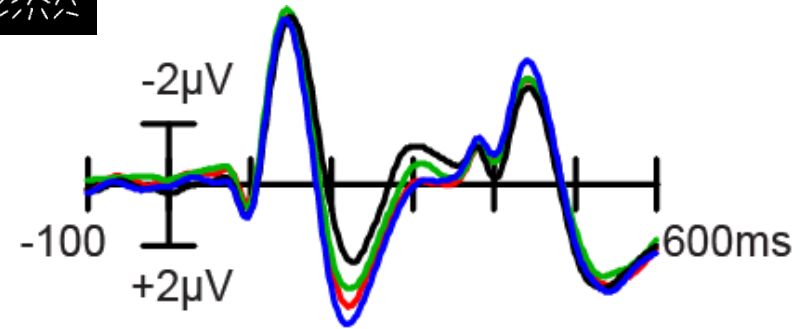


- 5 Contours
- 3 Contours
- 1 Contour
- Random

Contours task irrelevant:



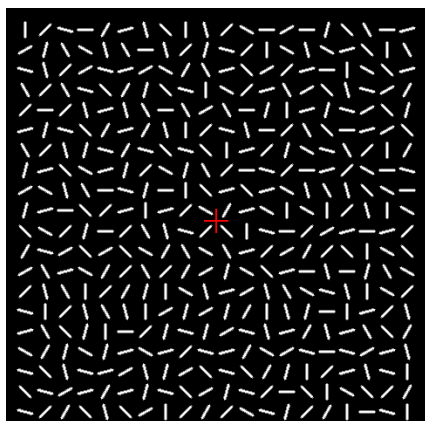
Contours task relevant:



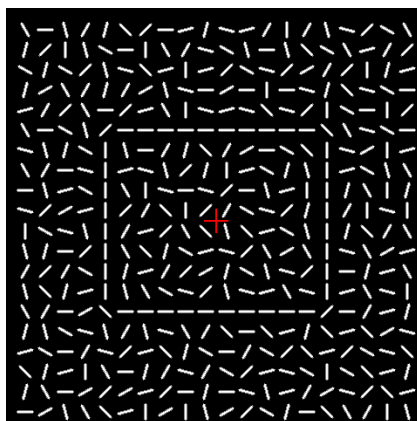
Experiment 3: postperceptual processing



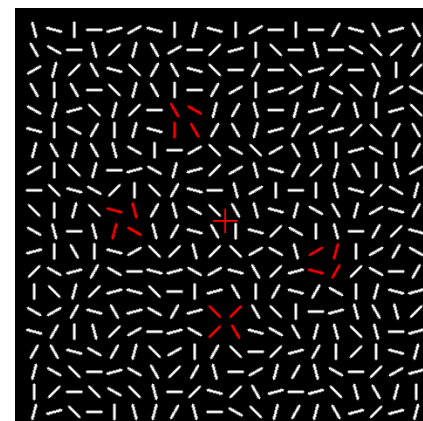
Random Array:



Shape Pattern:



Color Patches:



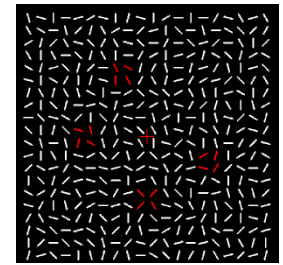
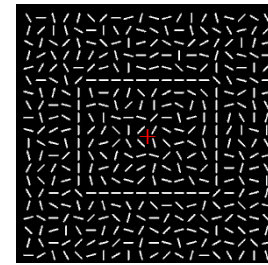
- Shape or color task (counterbalanced blocks)
- P3 & Gamma for consciously perceived, but irrelevant shapes?

Experiment 3: postperceptual processing

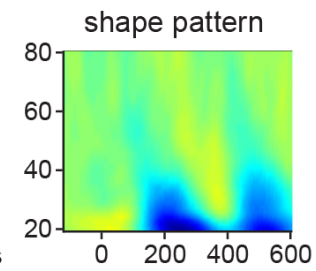
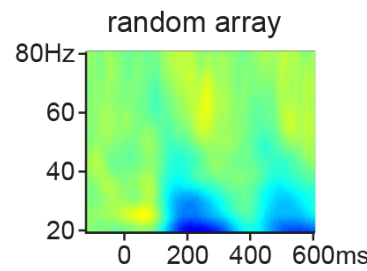
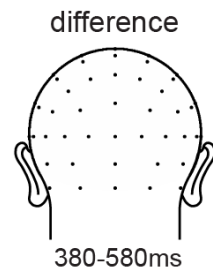
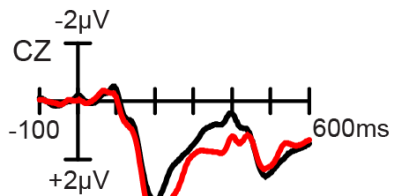
- Video Example of Stimuli:

https://www.youtube.com/watch?v=RpcEWi7iB_4&index=1&list=PLKnEQ1Aool-wtcb6Hh5QRxFiRZqLH79Ca

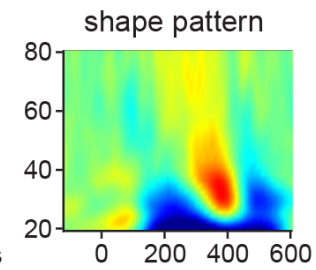
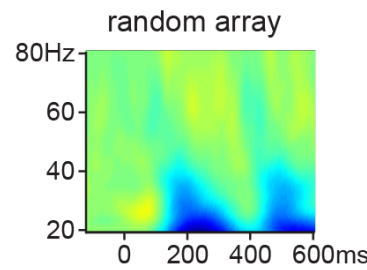
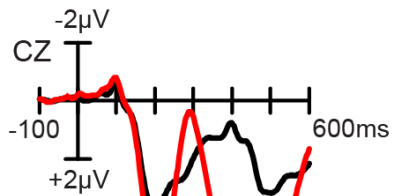
Experiment 3



shapes task-irrelevant



shapes task-relevant



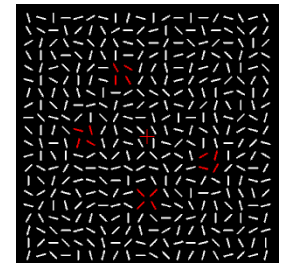
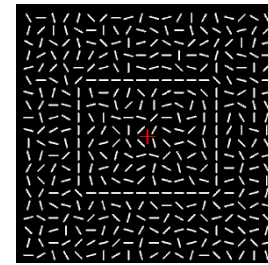
— random array
— shape pattern

-6 +6μV

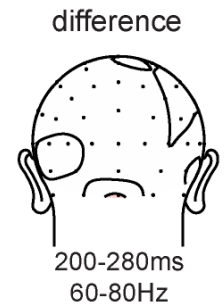
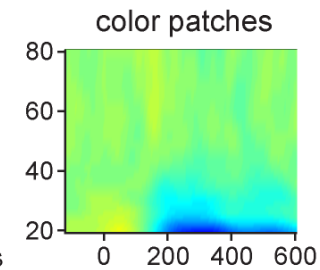
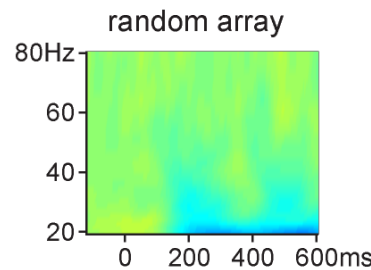
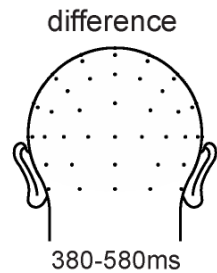
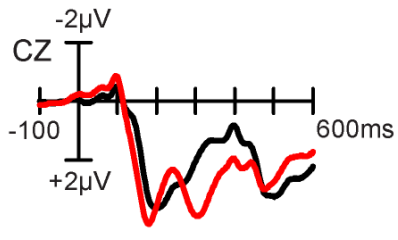
-0.5 +0.5μV

-0.5 +0.5μV

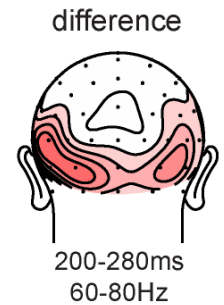
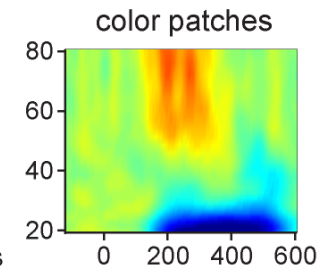
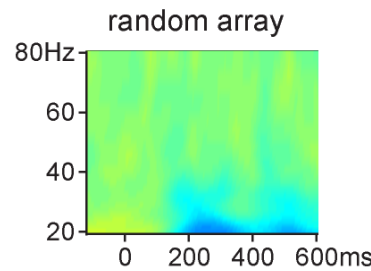
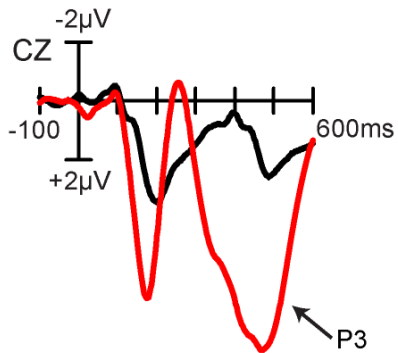
Experiment 3



color task-irrelevant



color task-relevant



— random array
— color patches

-7 +7µV

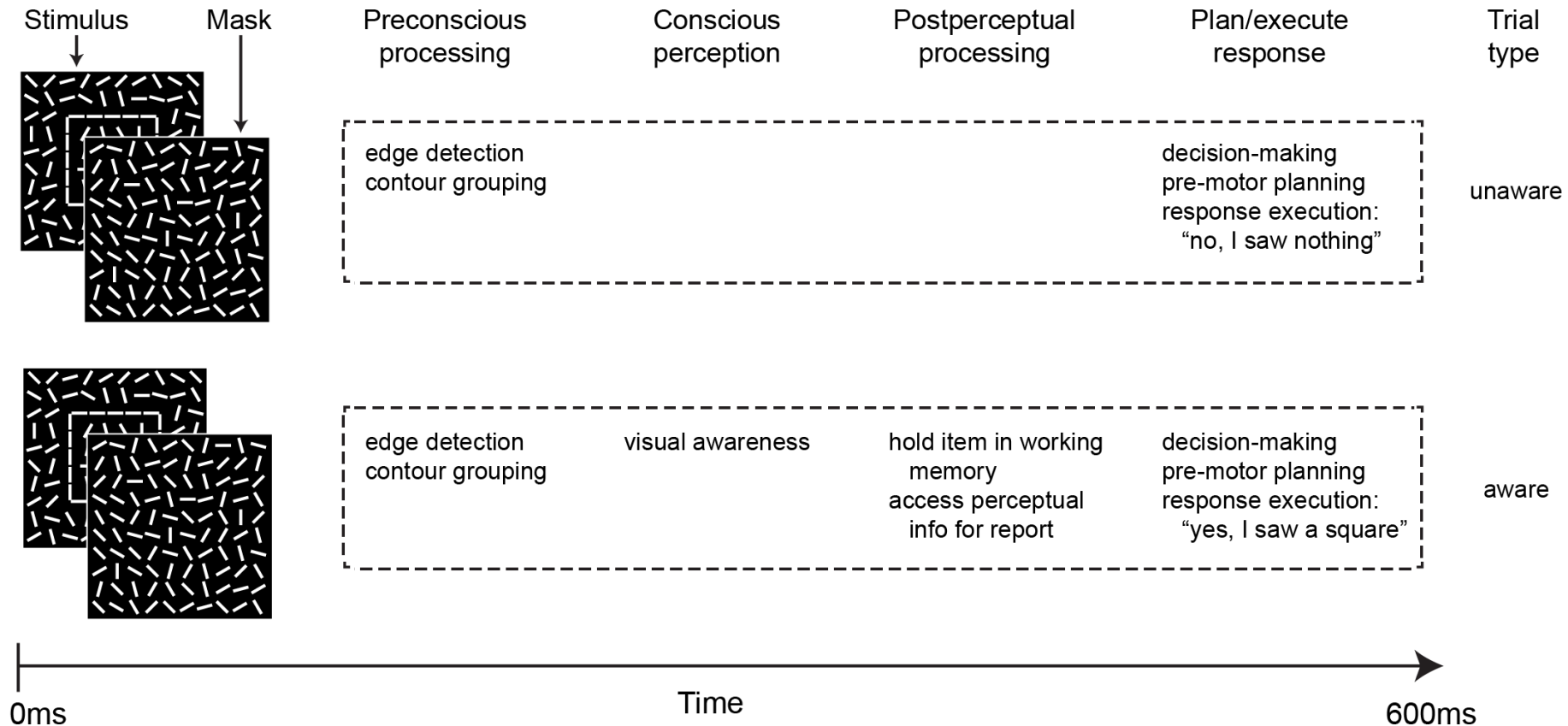
-0.4 +0.4µV

-0.3 +0.3µV

Paradigm comparisons

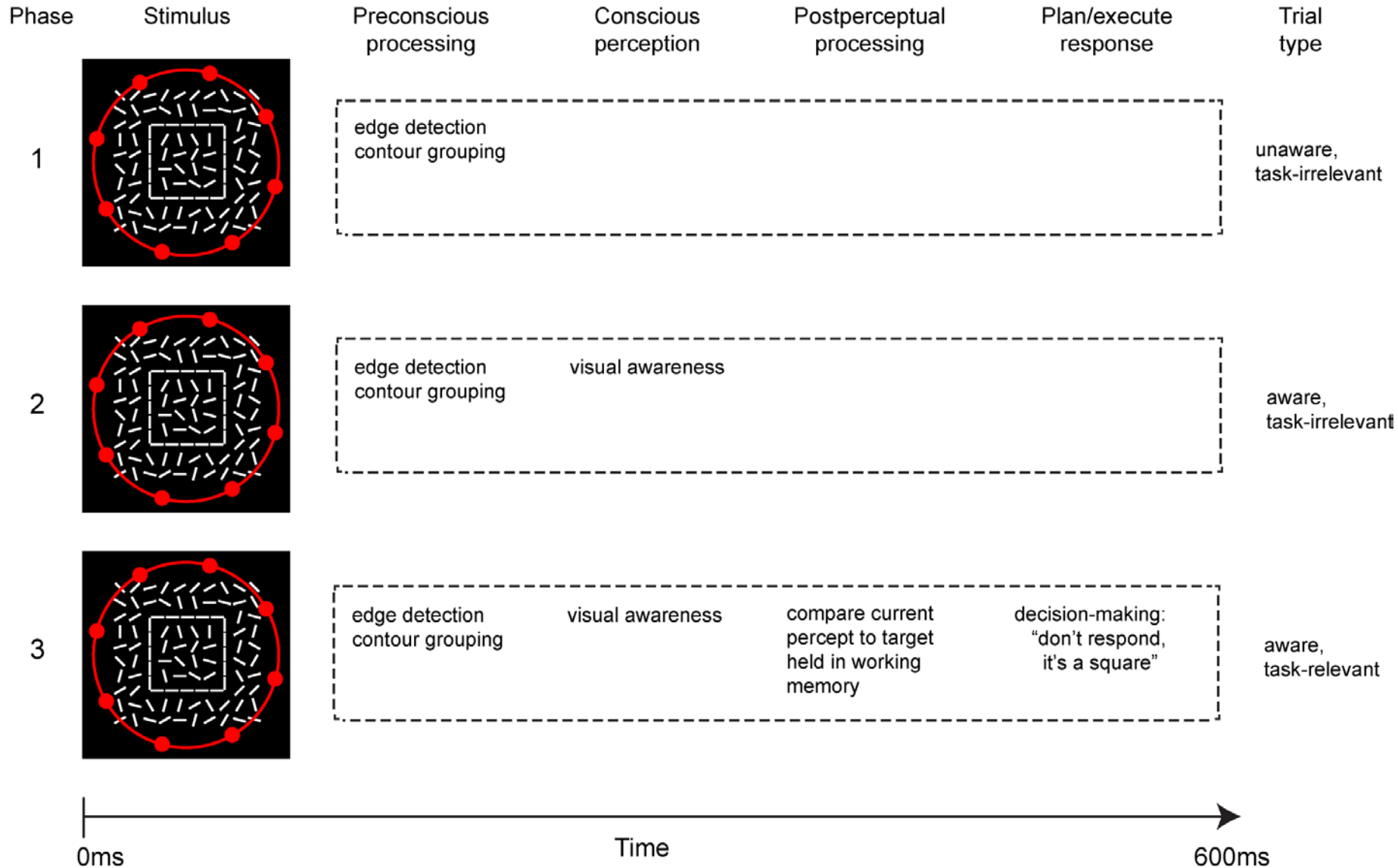
Backward masking paradigm (at threshold)

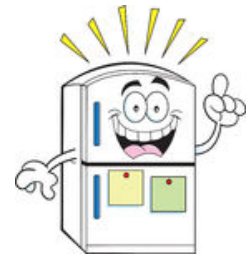
Task = after each trial report percept, e.g. did you see a shape (Y/N)? can you identify the shape?



Inattention blindness paradigm

Tasks: phase 1 & 2 = detect dim-red-disc targets; phase 3 = detect diamond-shaped targets





Refrigerator door problem

- Goal: determine if the light inside the fridge is on
- Light on = neural signature of conscious perception
- Opening door = asking subject to report their perception

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journal homepage: www.elsevier.com/locate/neubiorev



Review

Distilling the neural correlates of consciousness

Jaan Aru^{a,b,*}, Talis Bachmann^c, Wolf Singer^{a,b,d}, Lucia Melloni^{a,d,*}

^a Max-Planck Institute for Brain Research, Deuschordnerstr. 46, 60528 Frankfurt am Main, Germany

^b Frankfurt Institute for Advanced Studies, Max-von-Laue-Str. 1, 60438 Frankfurt am Main, Germany

^c University of Tartu, Kaarli puutestee 3, 10119 Tallinn, Estonia

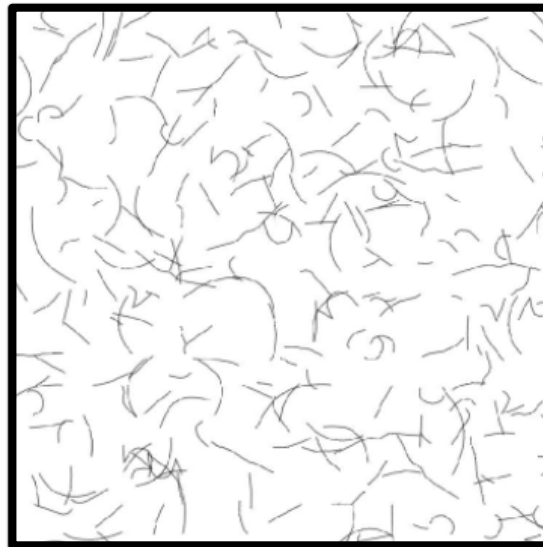
^d Ernst Strüngmann Institute in Cooperation with Max Planck Society, Deuschordnerstr. 46, 60528 Frankfurt am Main, Germany

Experiment 4: inattention blindness to faces

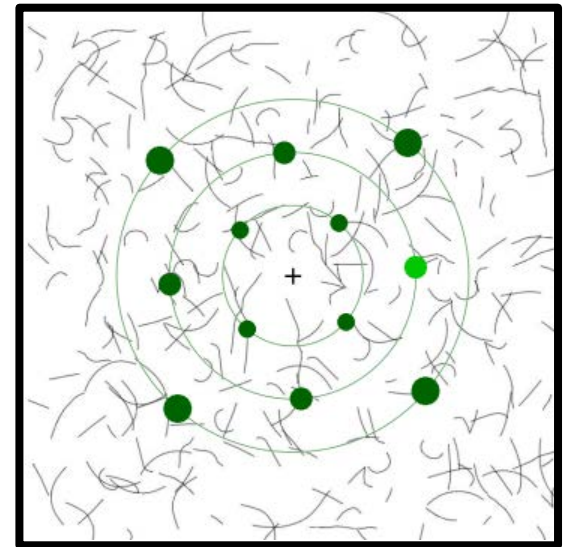
Face Pattern



Random Array



Distracter Task

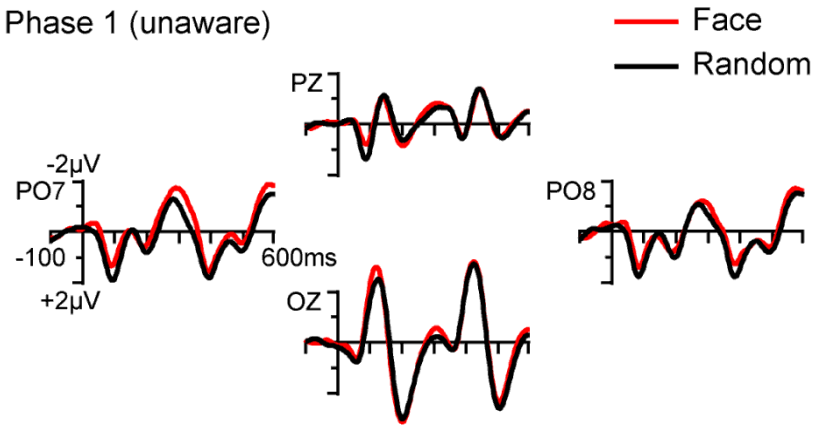


Experiment 4: inattention blindness to faces

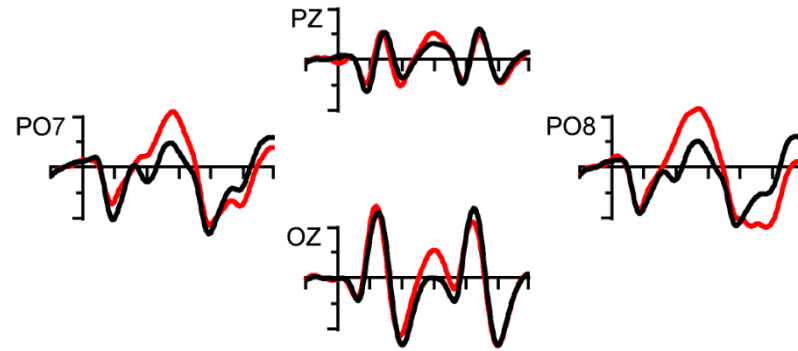
- Video Example of Stimuli:

<https://www.youtube.com/watch?v=aWsfO2FNlp0&list=PLKnEQ1Aool-wtcb6Hh5QRxFiRZqLH79Ca&index=3>

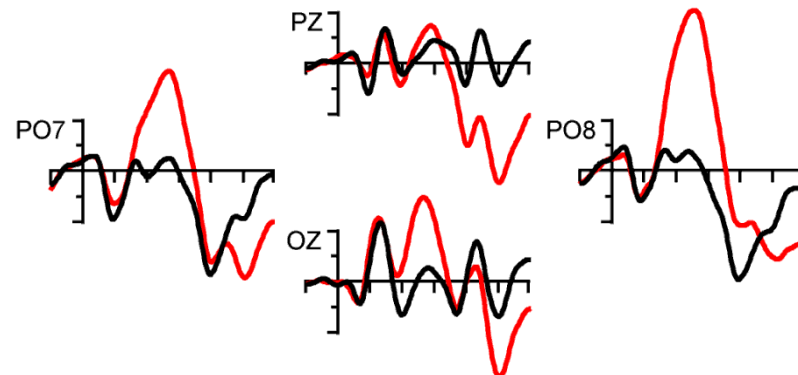
Phase 1 (unaware)



Phase 2 (aware)

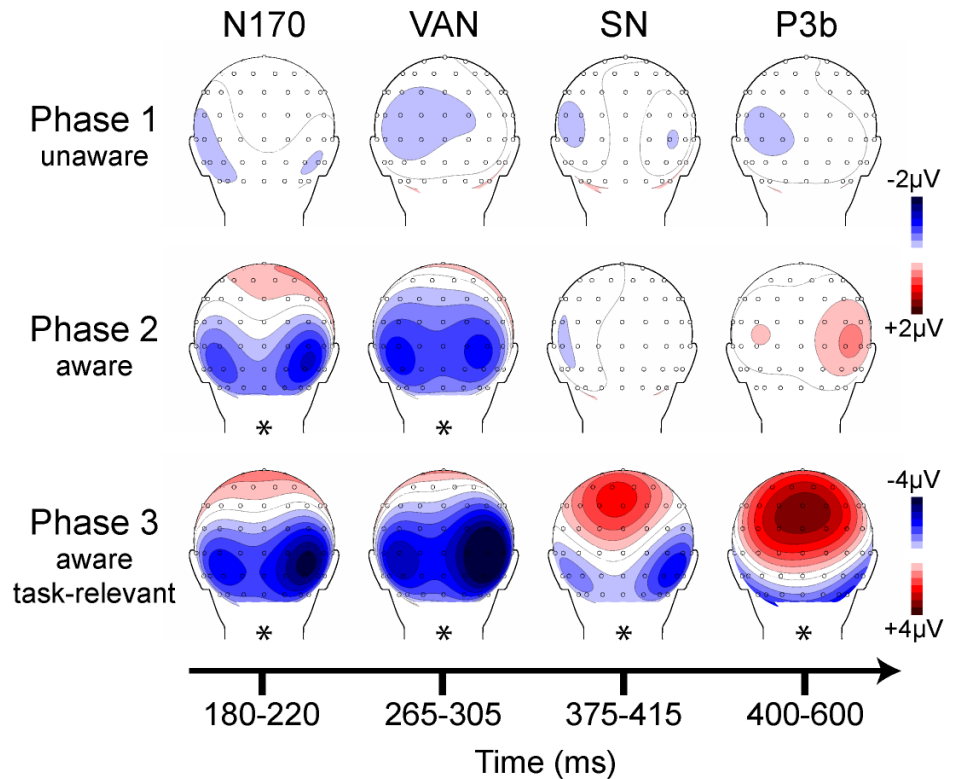
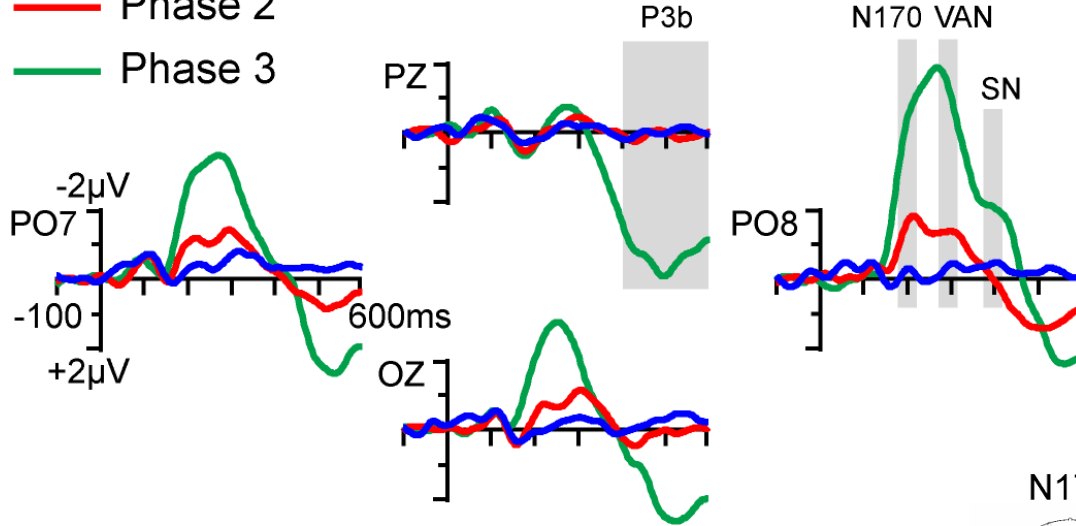


Phase 3 (aware + task-relevant)

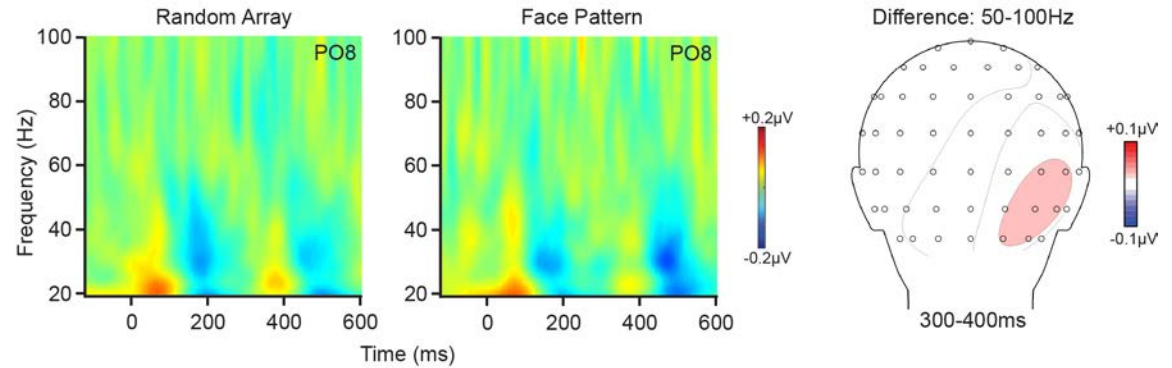


Difference Waves (face – random)

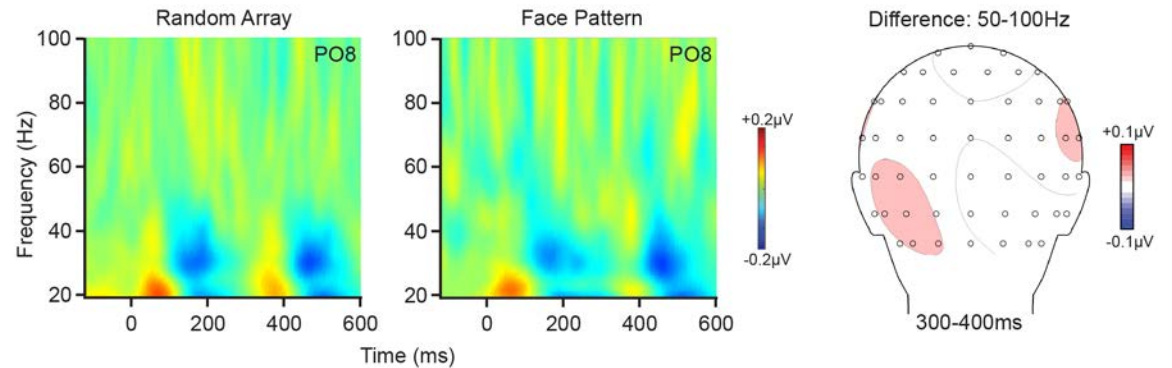
- Phase 1
- Phase 2
- Phase 3



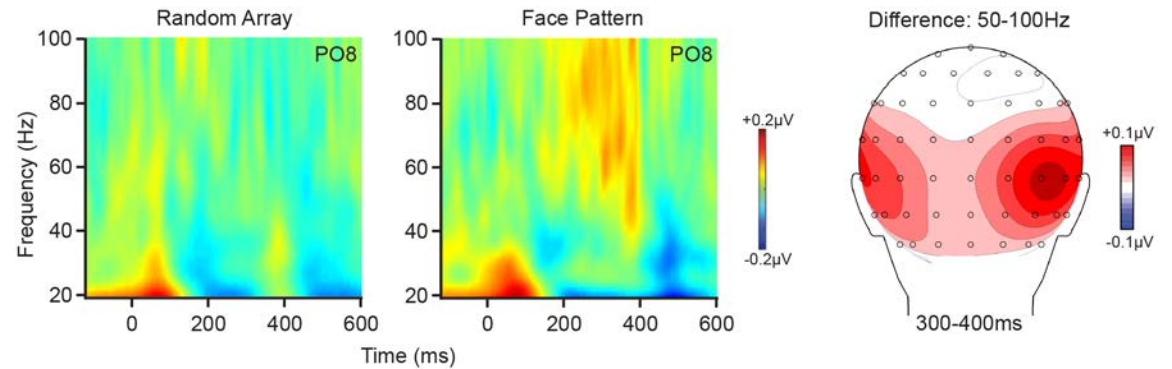
Phase 1
(unaware)



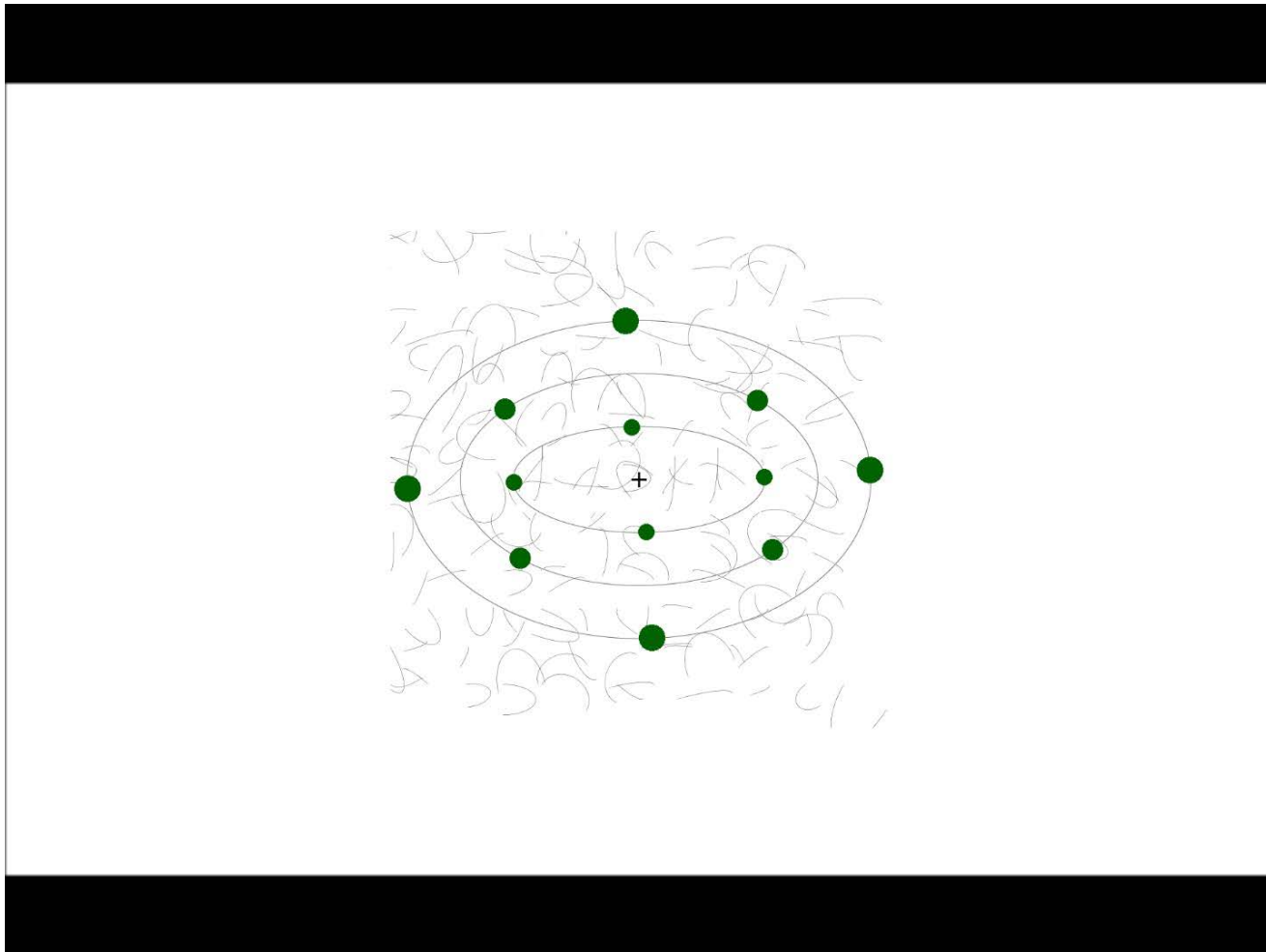
Phase 2
(aware)



Phase 3
(aware + task relevant)



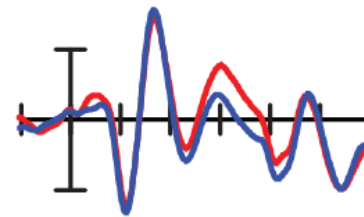
Experiment 5: inattention blindness to words



Conclusions

□ VAN: candidate neural signature of conscious perception

- Does VAN index attention or awareness?
- Neural sources of VAN?
- Auditory analog of VAN?



□ P3 & Gamma: postperceptual processing related to carrying-out discrimination or reporting task (opening refrigerator door)

□ **Global Neuronal Workspace Theory?**

- discounting evidence \neq disproving theory
- VAN might = GNW activity
- VAN, P3, gamma might \neq GNW activity, but signature X might
- or... GNW theory could be wrong

Thank you for your attention and awareness!



Collaborators:

- Steve Hillyard
- Antígona Martínez
- Juliet Shafto
- Jennifer Padwal
- Dan Fennelly
- Kathryn Schelonka
- Enriqueta Canseco-Gonzalez

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- KIBM
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- Reed College

SCALPLAB

Sensation Cognition Attention Language Perception

www.reed.edu/psychology/scalp

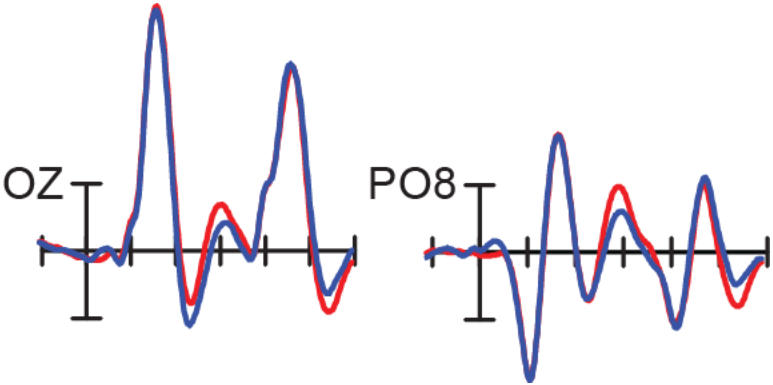
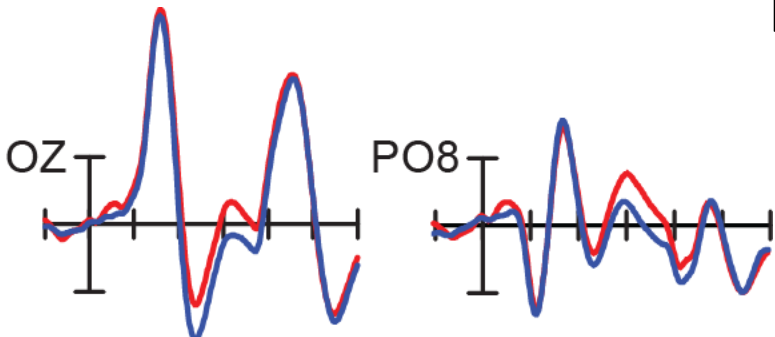
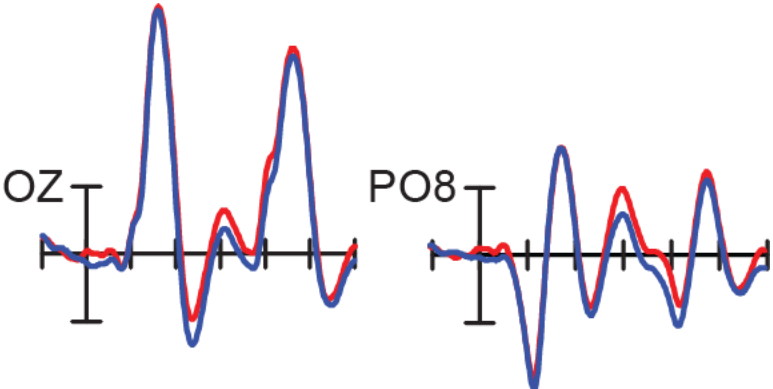
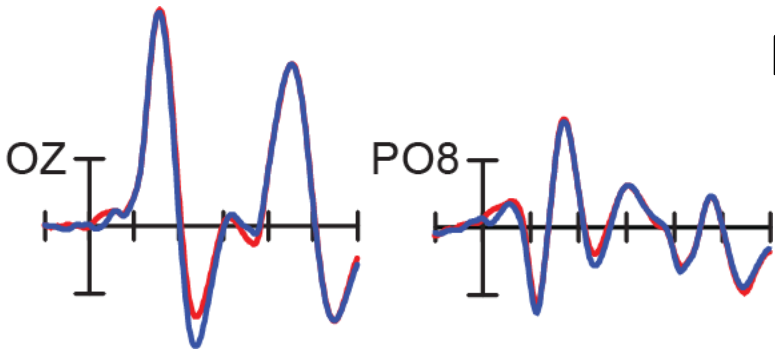
Exp 1: Between Subjects

IB subjects

Noticer subjects

Phase 1

Phase 2



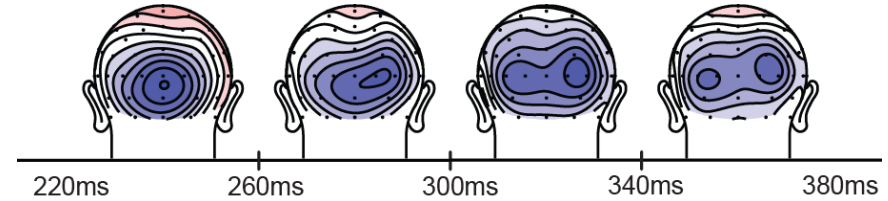
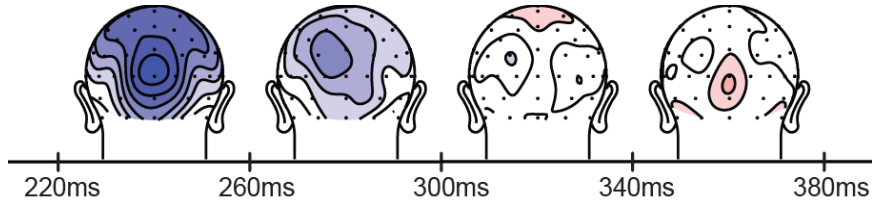
— Square Pattern
— Random Array

Exp 1: Between Subjects

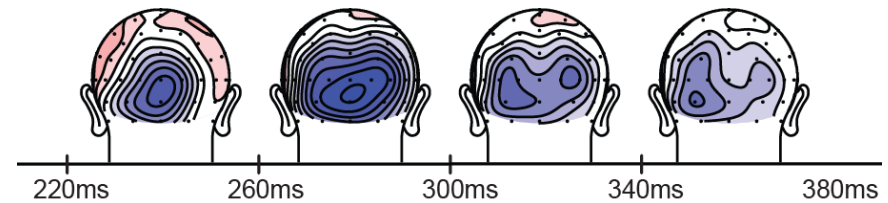
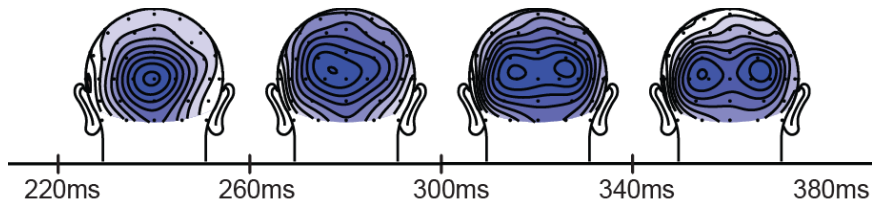
IB subjects

Noticer subjects

Phase 1



Phase 2

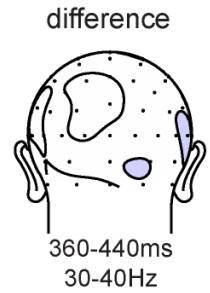
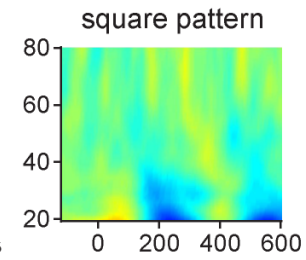
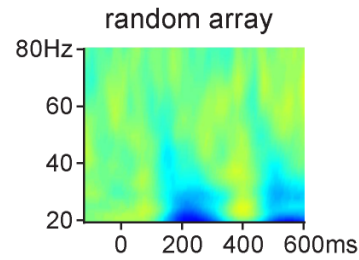
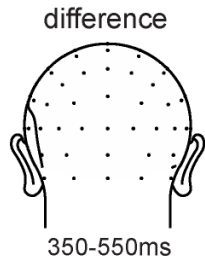
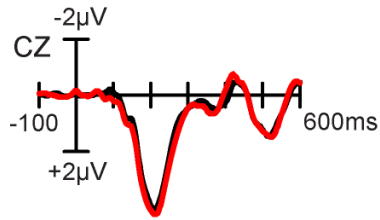


-1.25 μ V  +1.25 μ V

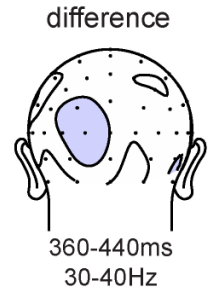
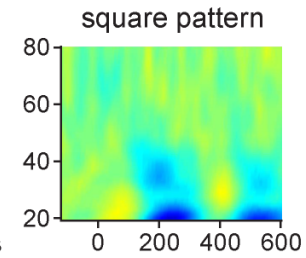
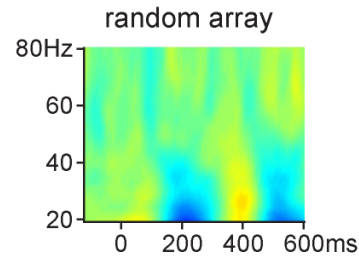
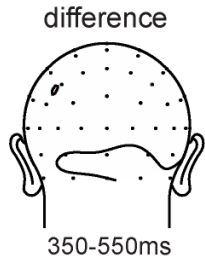
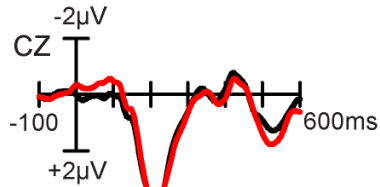
phase 1: aware, task-irrelevant

Noticer subjects

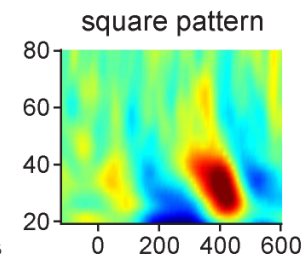
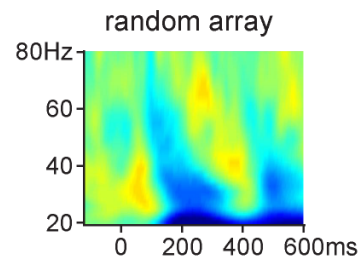
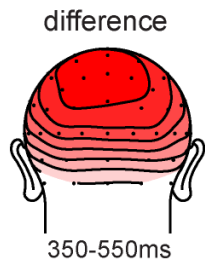
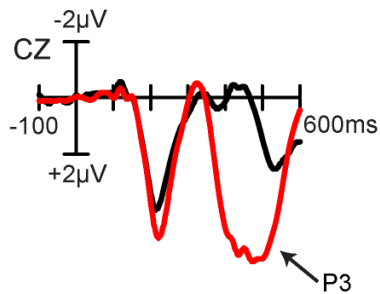
Pitts et al. (in press) *NeuroImage*



phase 2: aware, task-irrelevant



phase 3: aware, task-relevant



— random array
— square pattern

-4.5 +4.5µV

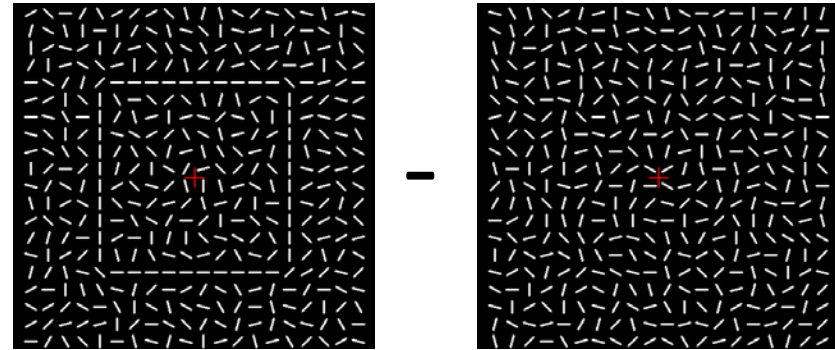
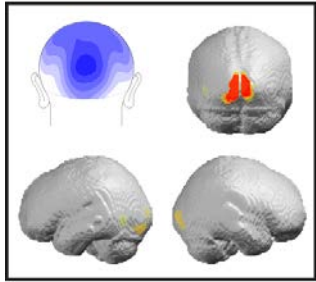
-0.5 +0.5µV

-0.5 +0.5µV

Phase 1: unaware

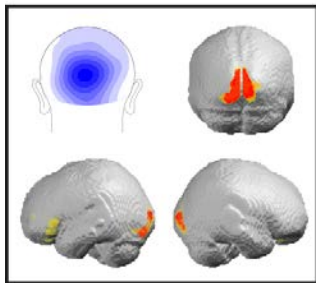
Source Estimates (LORETA)

220ms

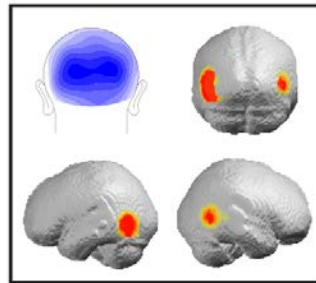


Phase 2: aware

220ms

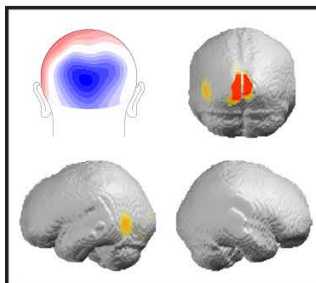


300ms

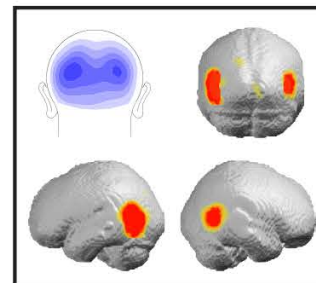


Phase 3: aware + task relevant

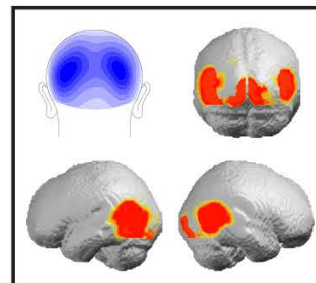
180ms



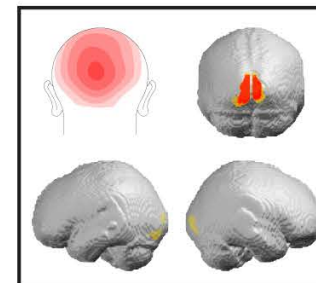
220ms



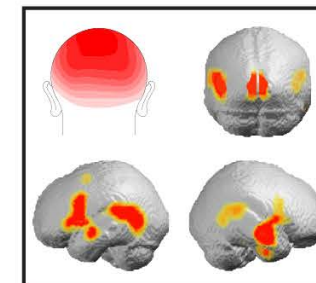
260ms



380ms



420ms



Experiment 4

