

Isolating NCCs that are necessary and sufficient for visual awareness

Michael Pitts

Psychology Department

Reed College



ASSC 17 July 15, 2013



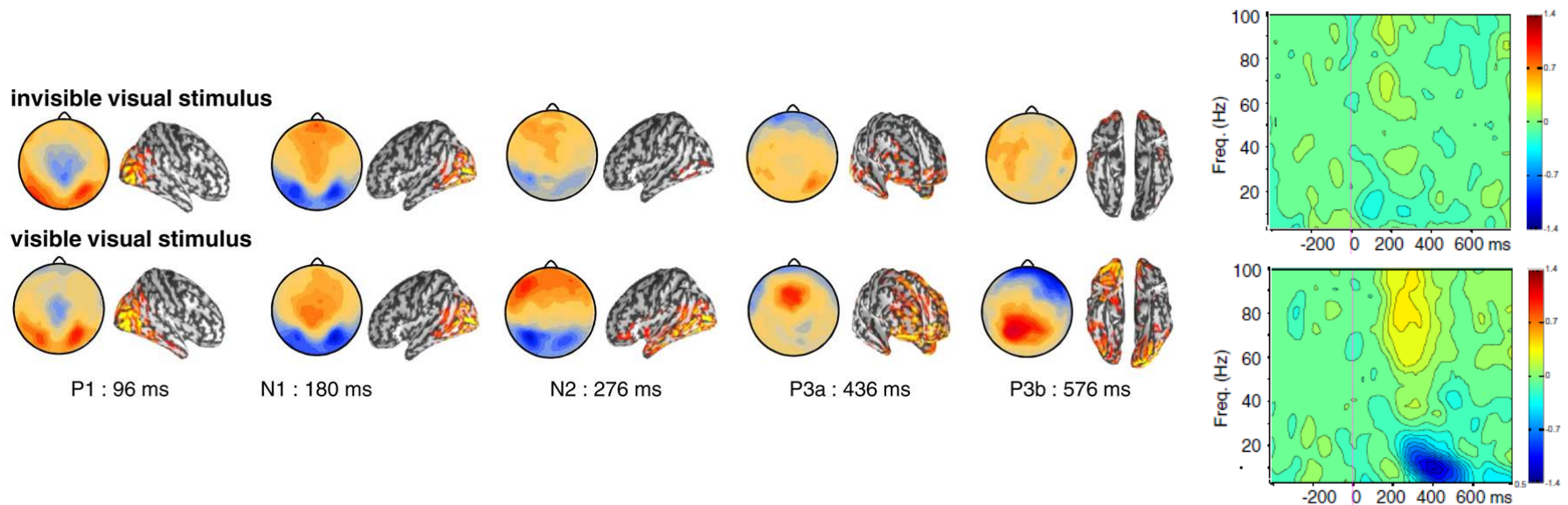
Necessity & Sufficiency

Goal: distinguish neural correlates of...

- 1) Preconscious processing (necessary but not sufficient)
- 2) Conscious perception (necessary *and* sufficient)
- 3) Postperceptual processing (sufficient but not necessary)

Previous Paradigms & Findings

- Masking, Attentional Blink: aware vs. unaware contrasts
- Awareness = widespread “**ignition**” of cortical activity

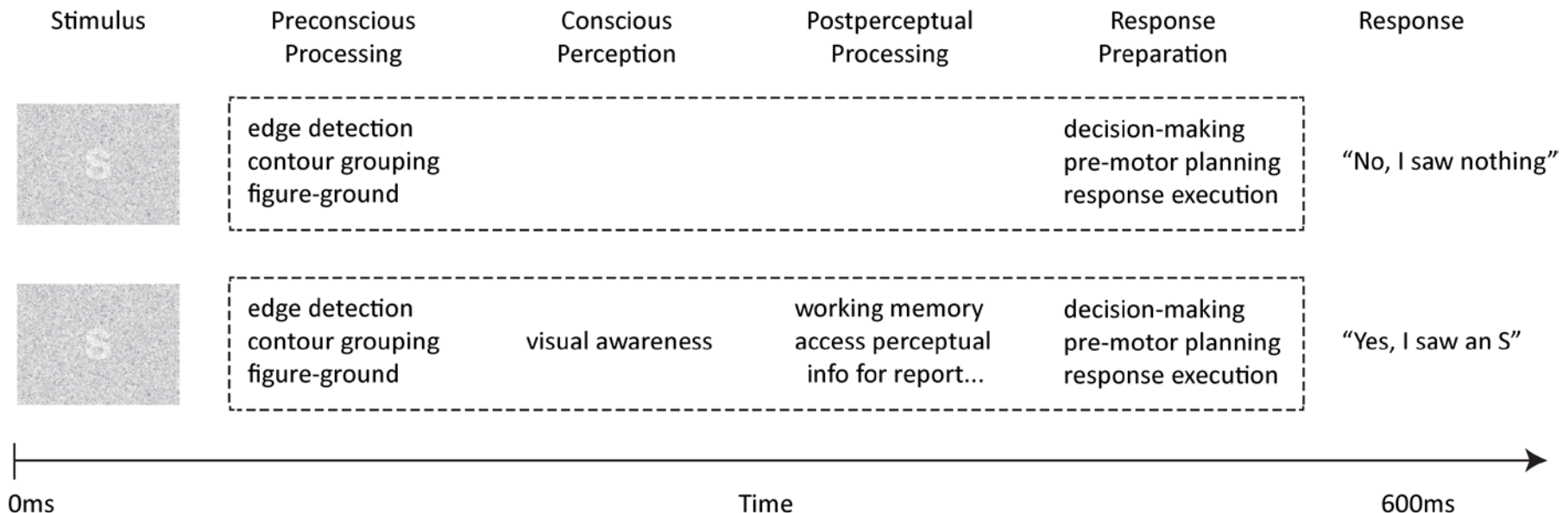


- EEG signatures of awareness = P3 & Gamma Oscillations

Problem with Previous Paradigms?

Masking, Attentional Blink:

- Unaware = no PPP; Aware = PPP

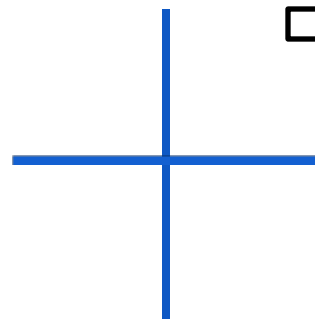


- Different paradigms needed to address this problem...

The Inattention Paradigm

□ Inattention Blindness (IB)

- “Failure to perceive unexpected objects or events because attention is focused on another task”
- Simons & Chabris (1999); Mack & Rock (1998)



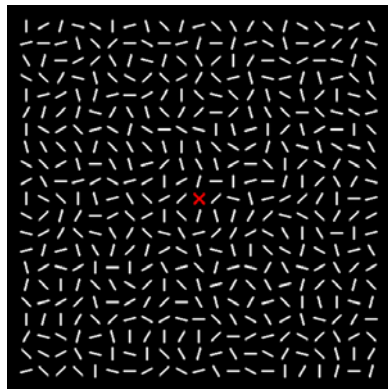
Inattention Paradigm adapted for EEG/ERP

- Video Example of Stimuli:

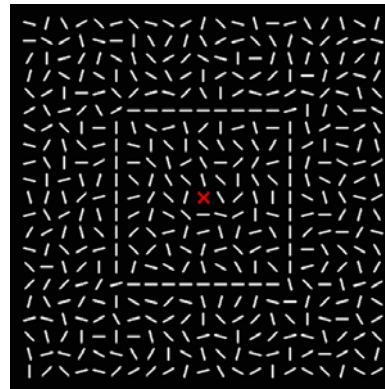
http://www.youtube.com/watch?v=8-9NAFUn_CI

Stimuli

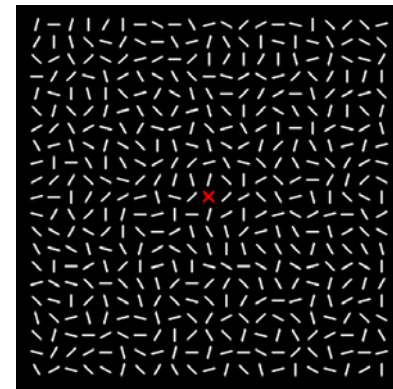
Square or Random



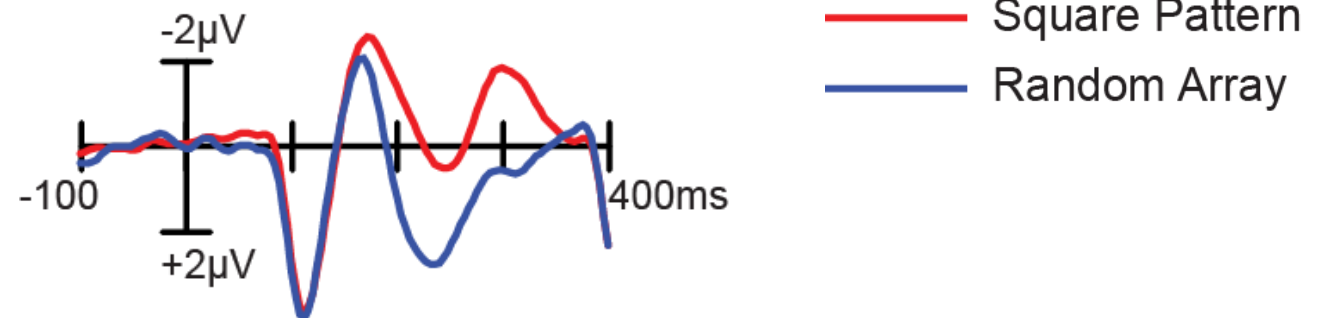
600-800ms



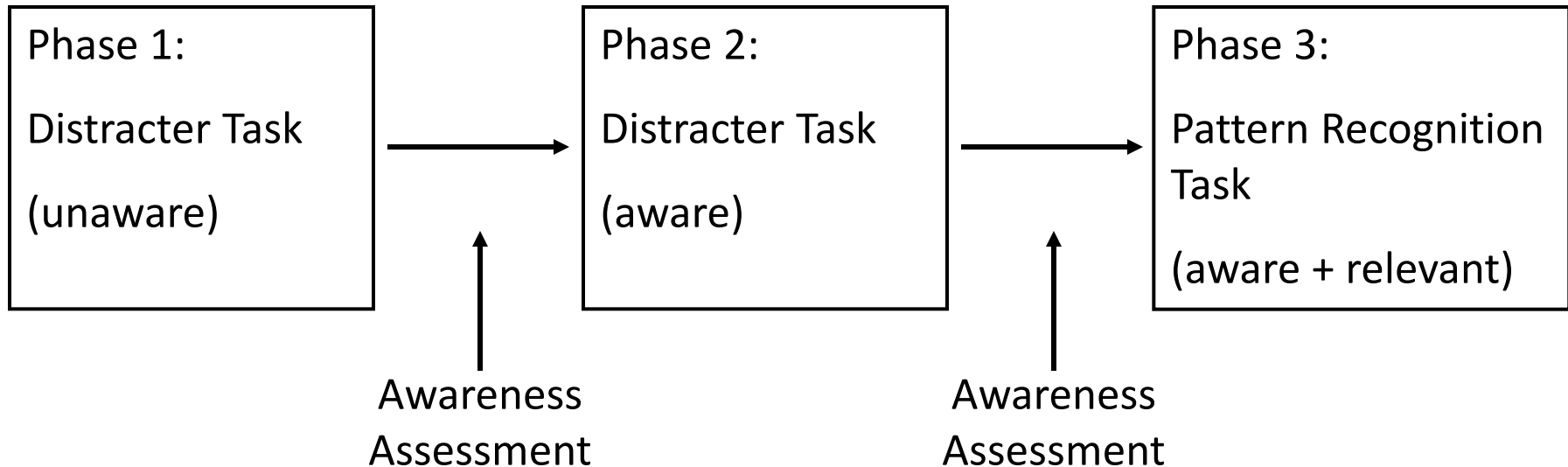
300ms



600-800ms



Procedure

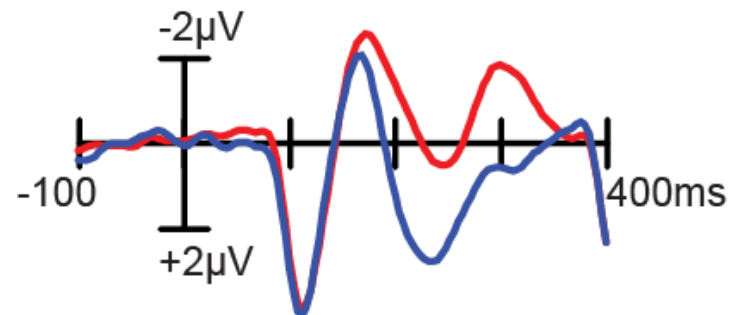


of Stimuli:

Random: 300

Square: 240

Diamond: 60



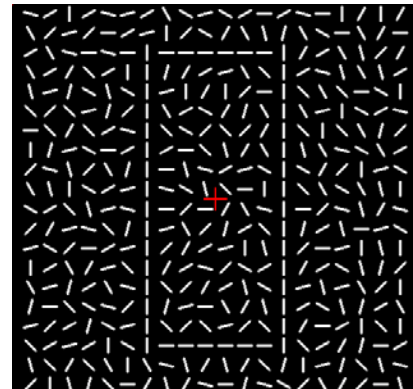
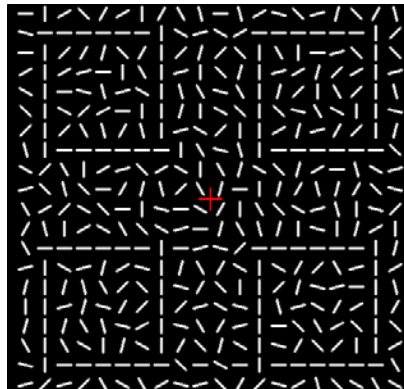
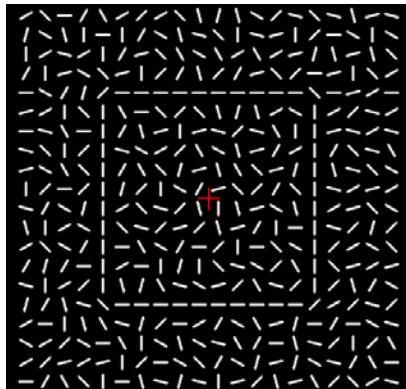
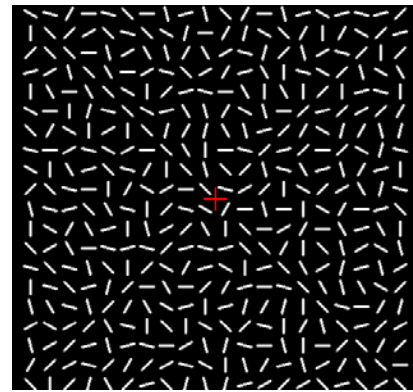
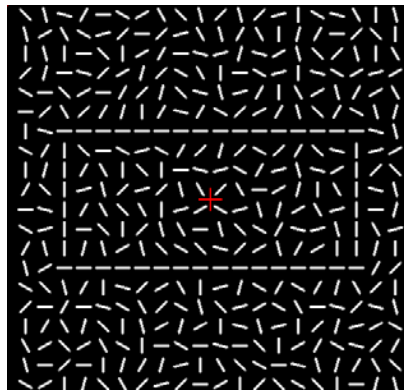
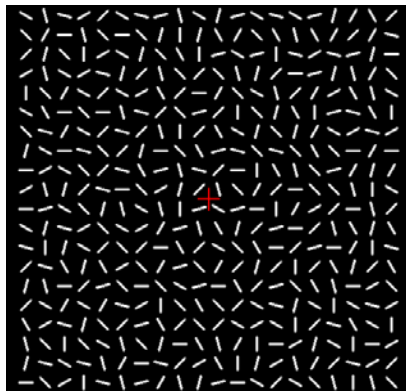
— Square Pattern
— Random Array

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:



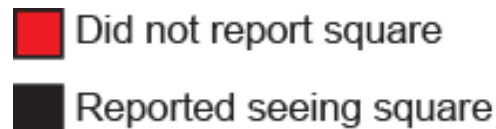
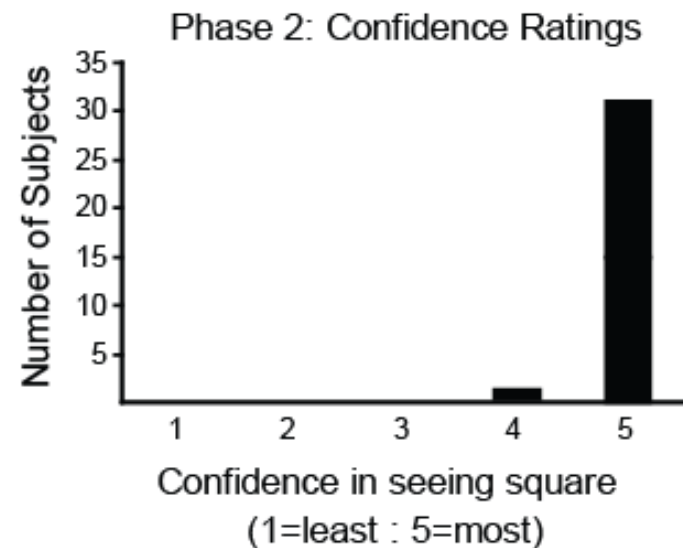
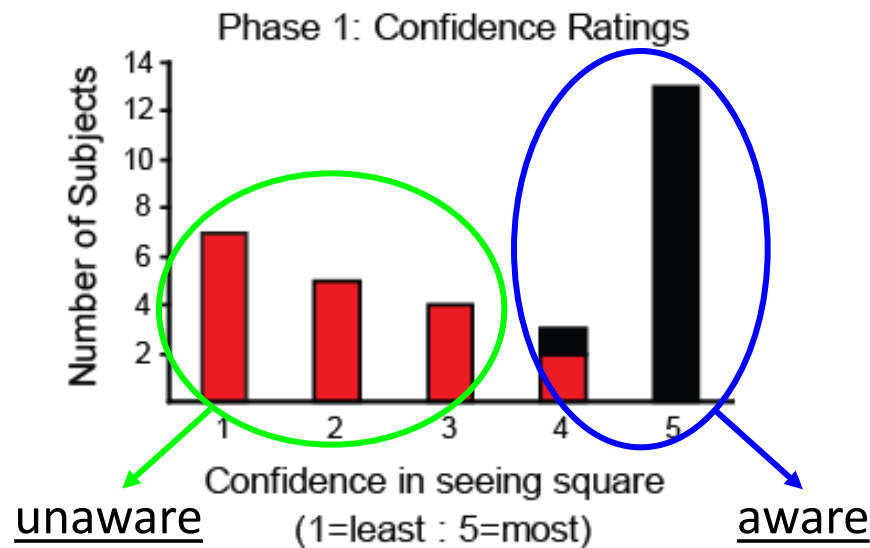
3) Rate how confident you are that you saw each pattern during the experiment.

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

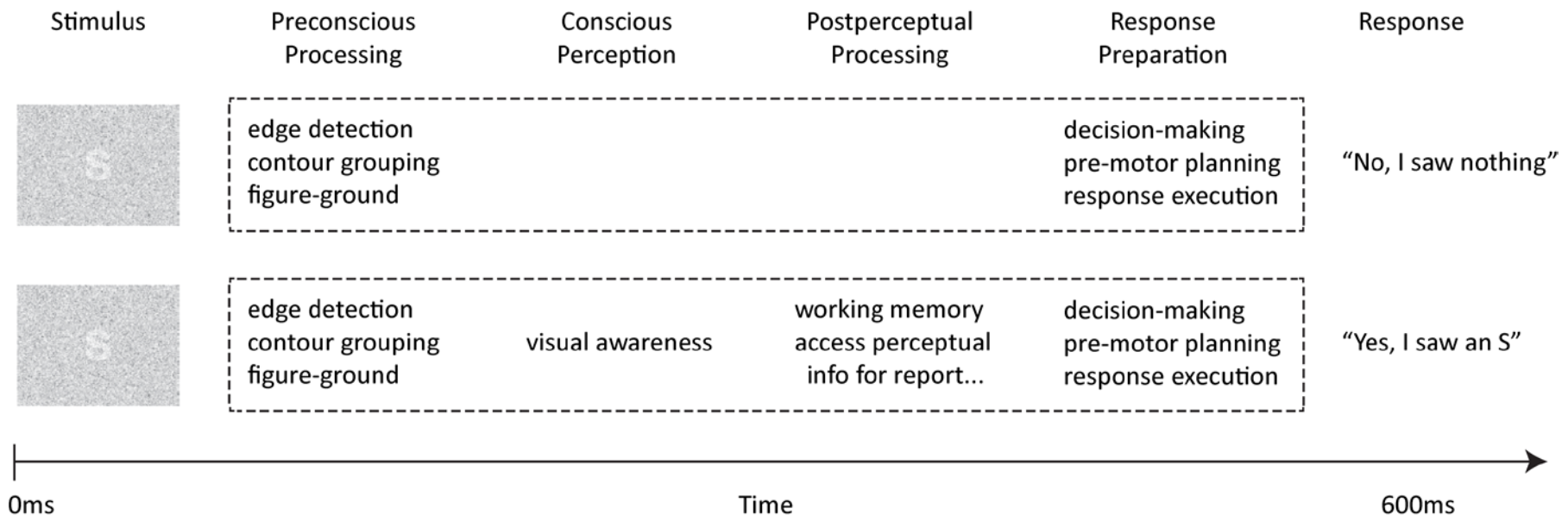
Behavioral results (awareness assessments)



Paradigm comparison

Masking, Attentional Blink:

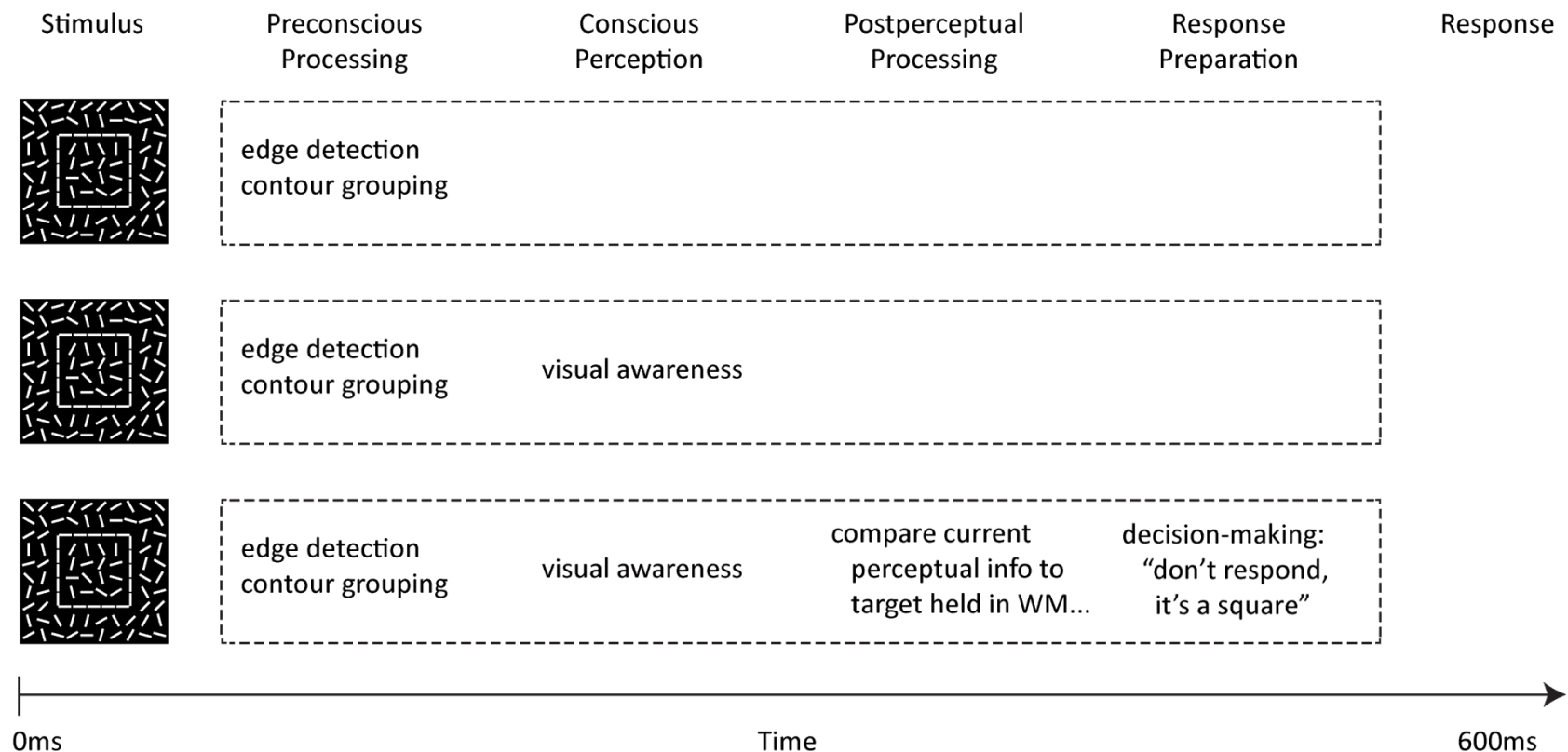
□ Unaware = no PPP; Aware = PPP



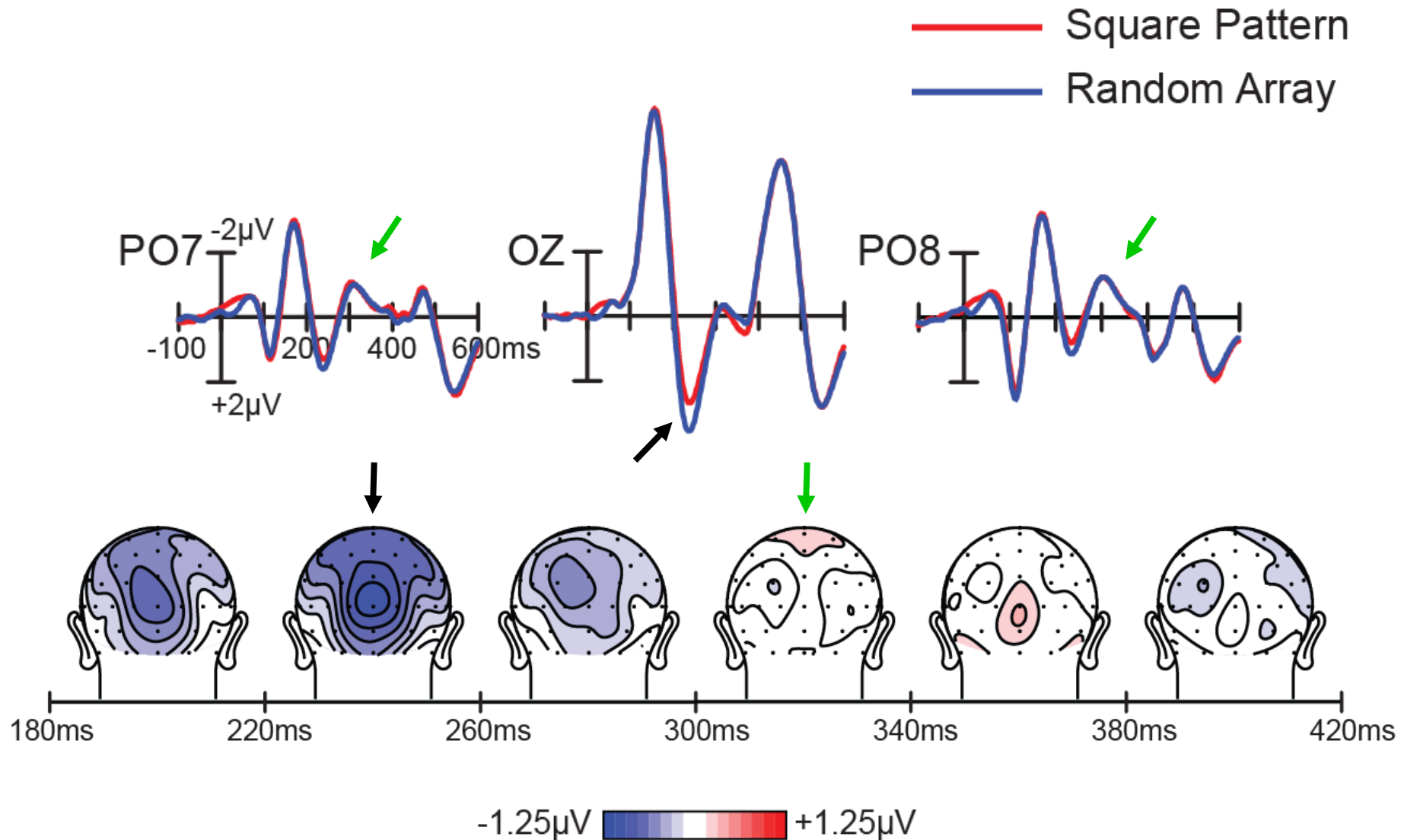
Paradigm comparison

Inattentional Blindness:

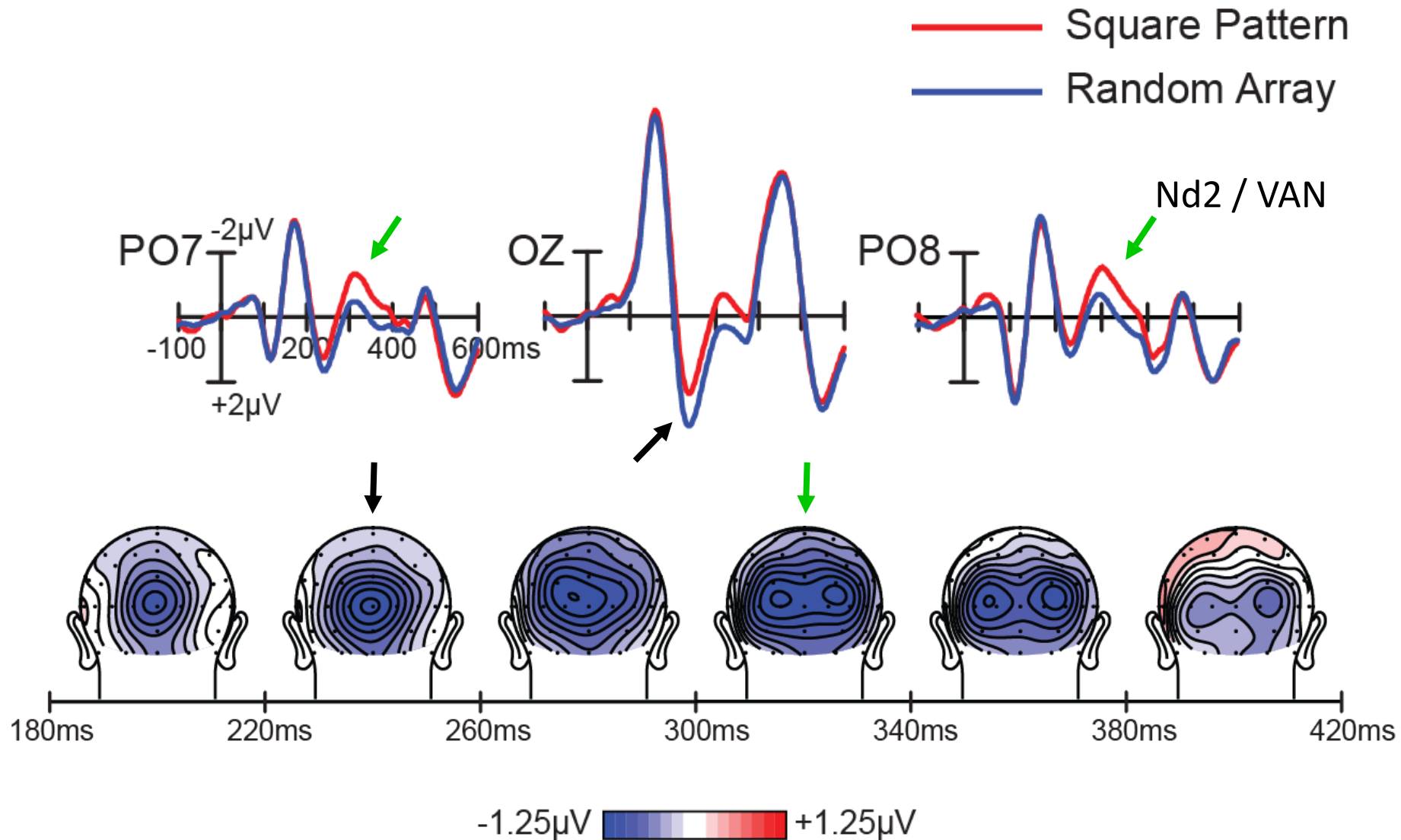
□ Unaware = no PPP; **Aware = no PPP; Aware⁺ = PPP**



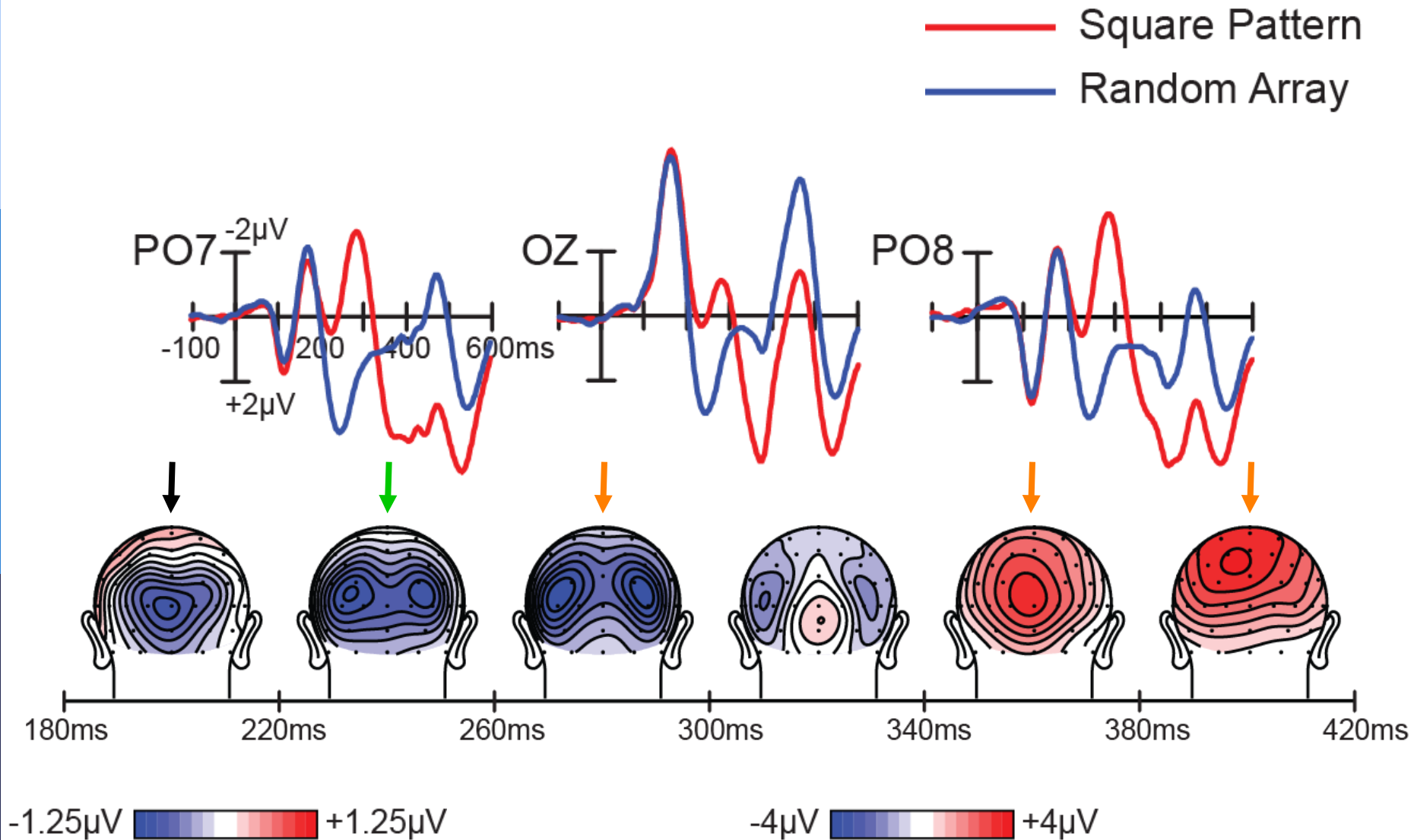
Phase 1 (unaware, task irrelevant)



Phase 2 (aware, task irrelevant)

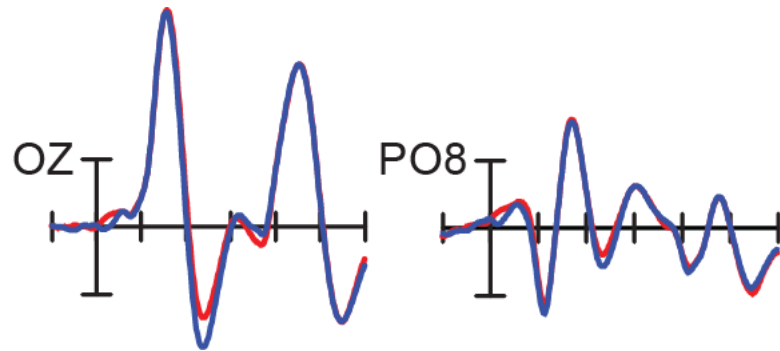


Phase 3 (aware, task relevant)



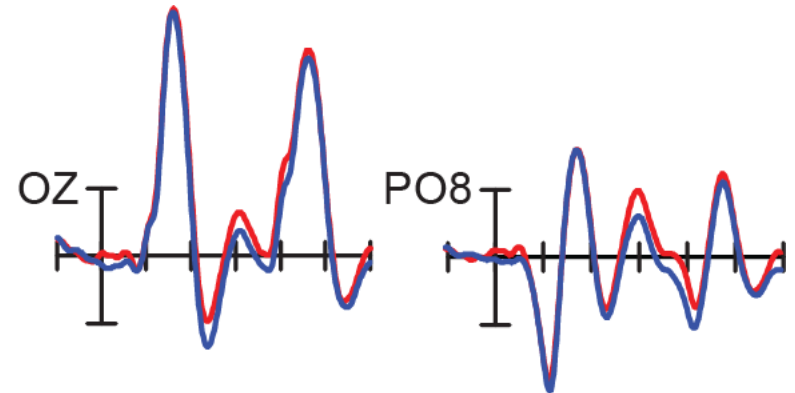
Between Subjects

IB subjects

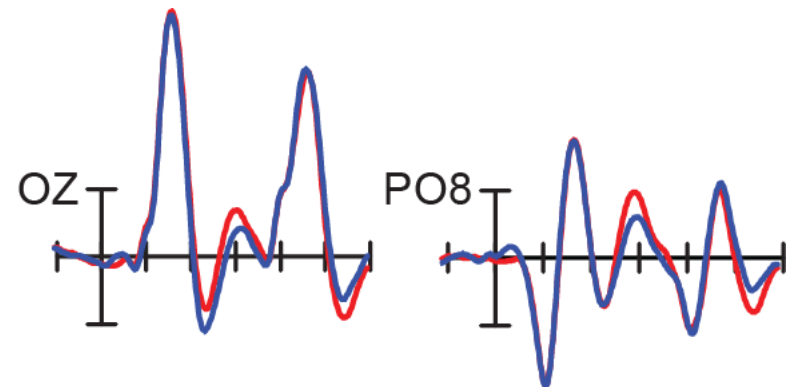
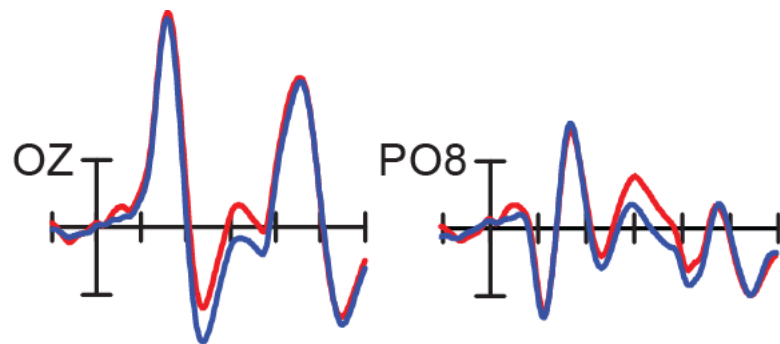


Phase 1

Noticer subjects



Phase 2



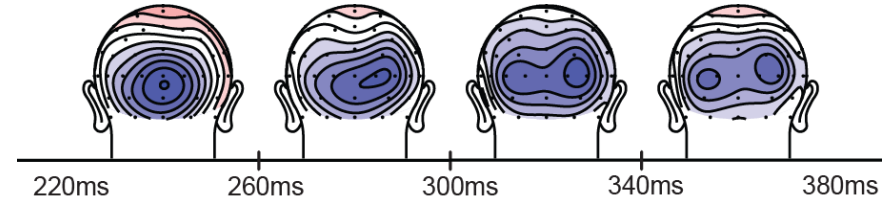
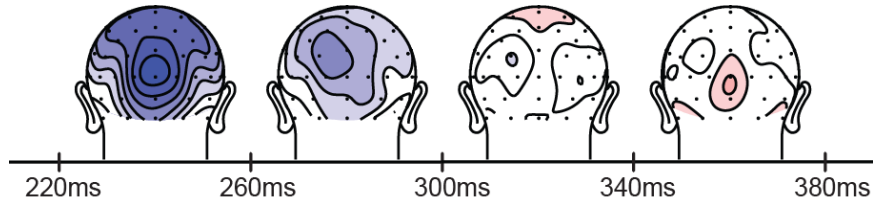
— Square Pattern
— Random Array

Between Subjects

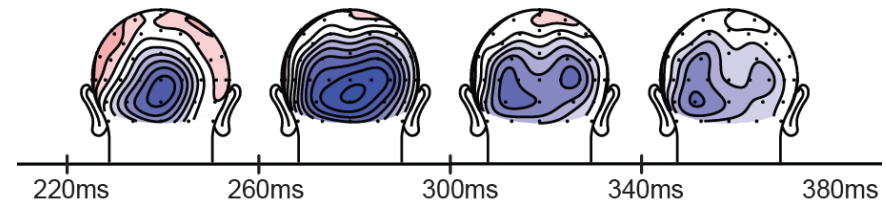
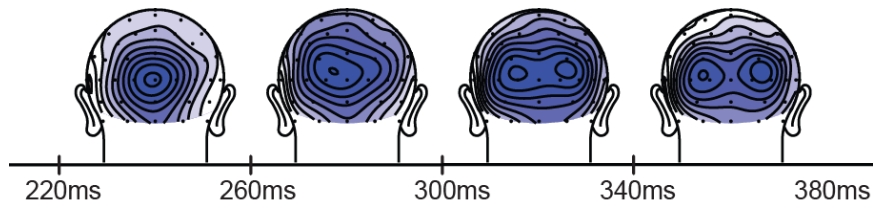
IB subjects

Noticer subjects

Phase 1



Phase 2

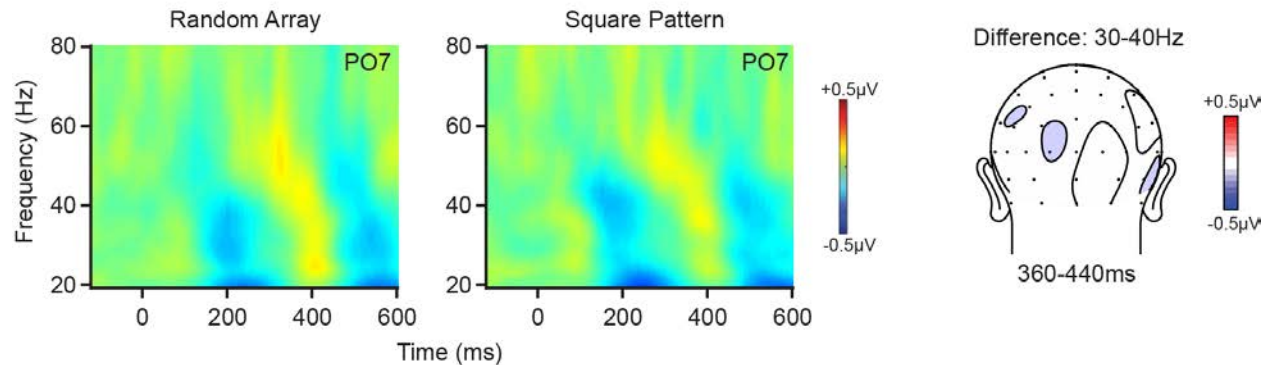


-1.25 μ V  +1.25 μ V

Time-Frequency Results (IB subjects)

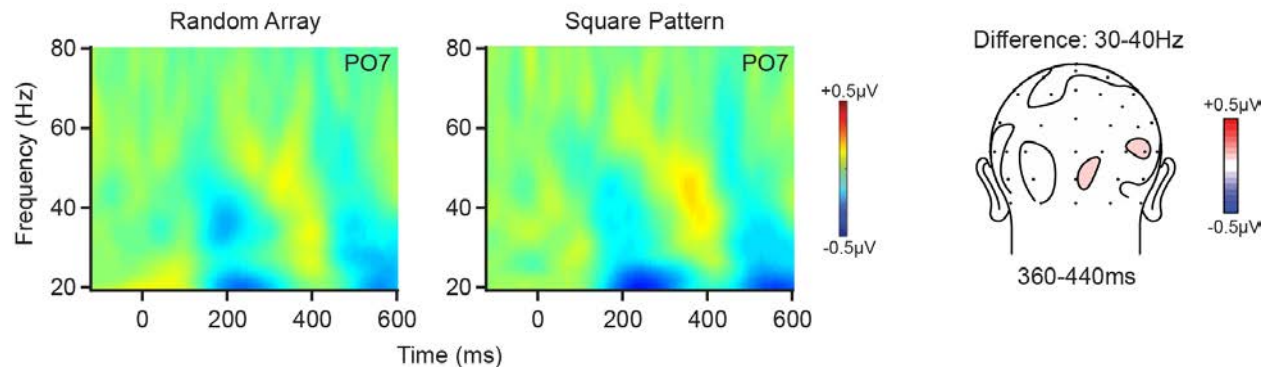
Phase 1

(unaware, task irrelevant)



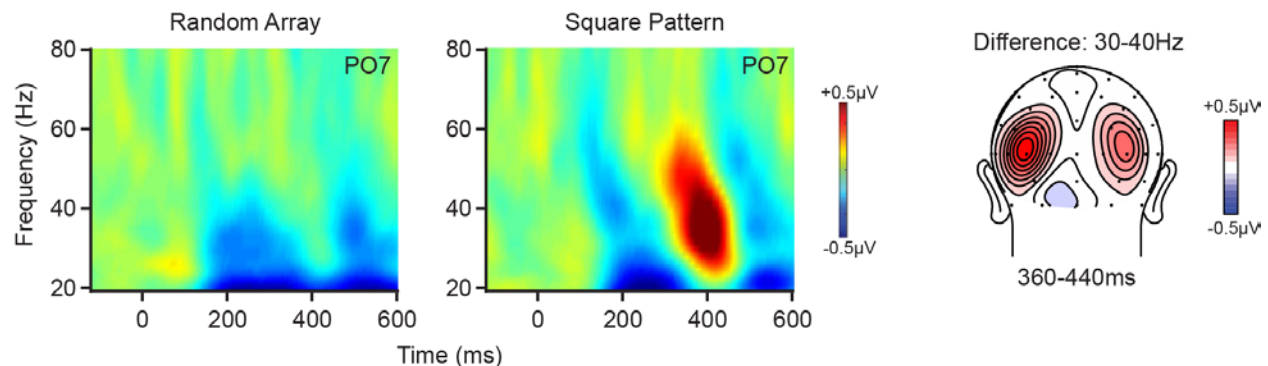
Phase 2

(aware, task irrelevant)



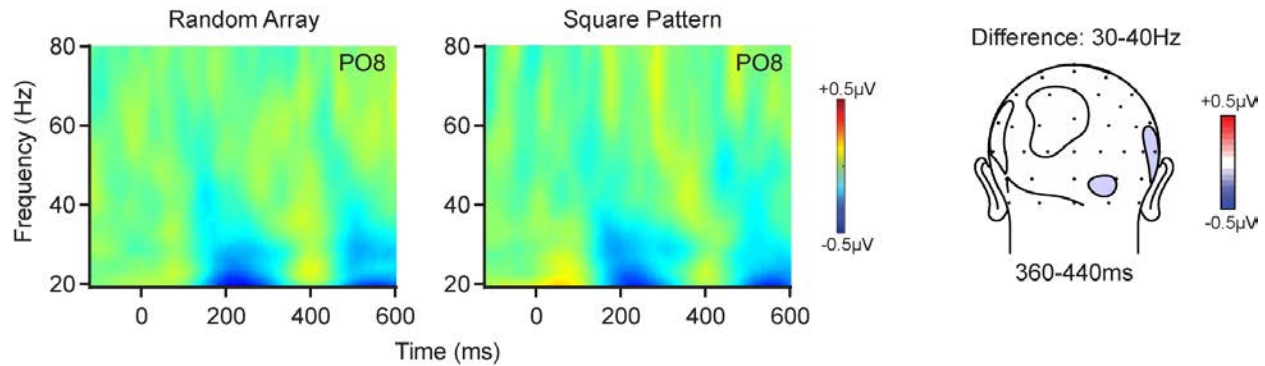
Phase 3

(aware, task relevant)

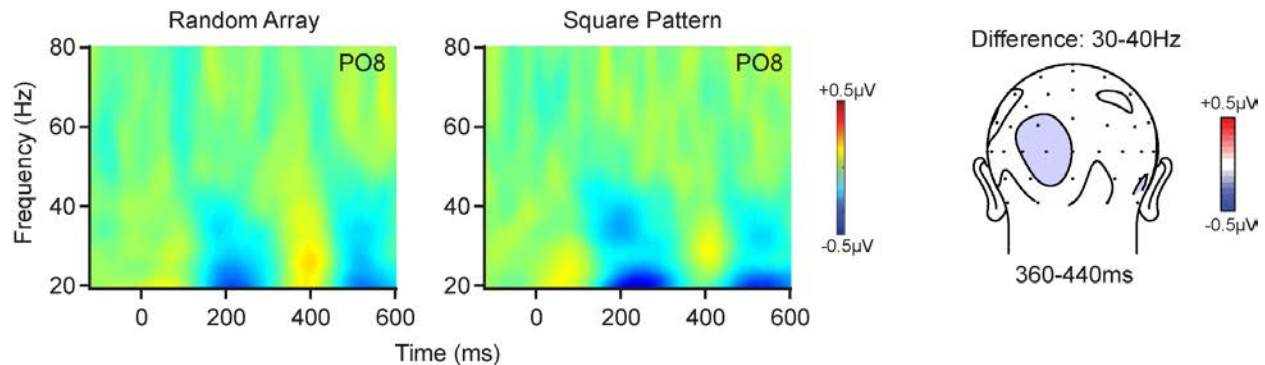


Time-Frequency Results (noticer subjects)

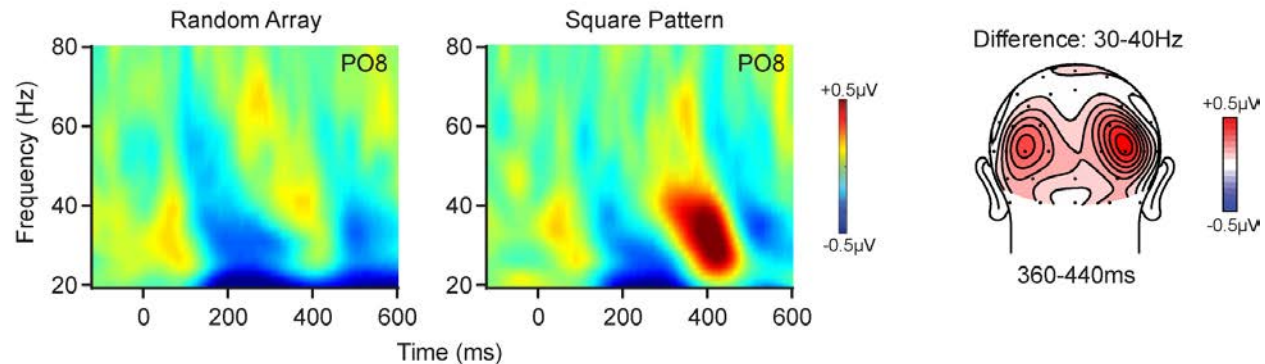
Phase 1
(aware, task irrelevant)



Phase 2
(aware, task irrelevant)



Phase 3
(aware, task relevant)



Interim Summary

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

- Phase 1 (unaware, task irrelevant)



preconscious
processing

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

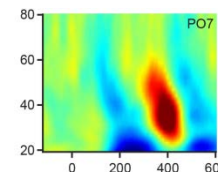
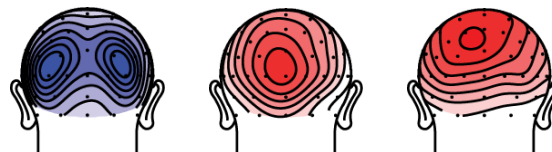
- Phase 2 (aware, task irrelevant)



NCC ?

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

- Phase 3 (aware, task relevant)



postperceptual
processing

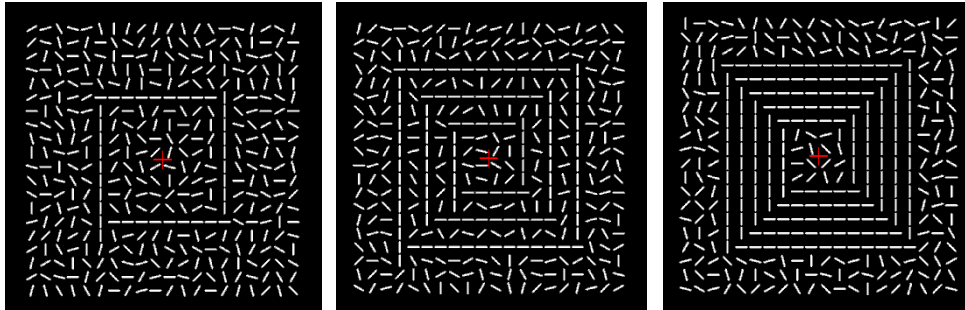
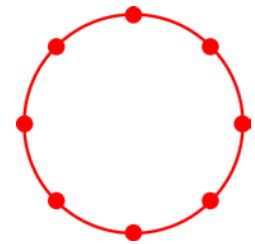
Follow-up Experiments

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



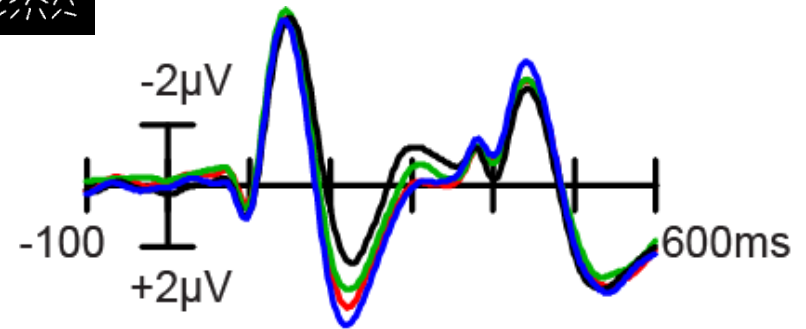
preconscious
processing

Preconscious Processing

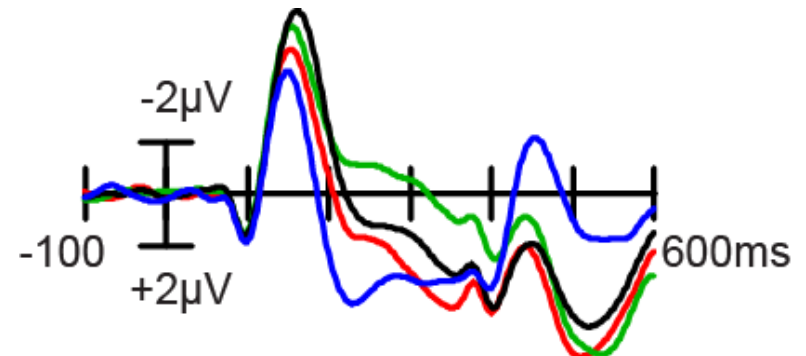


- 5 Contours
- 3 Contours
- 1 Contour
- Random

Contours task irrelevant:

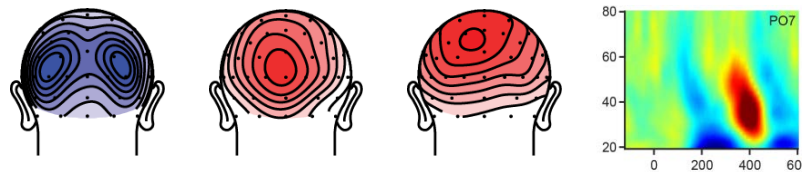


Contours task relevant:



Follow-up Experiments

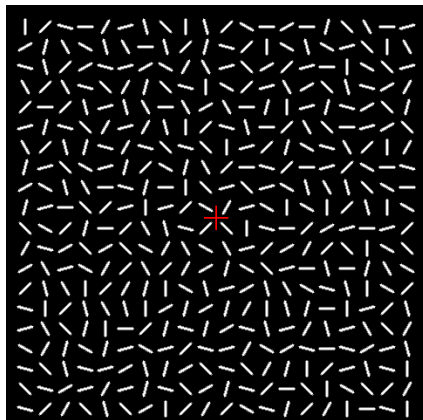
- Widespread activity and gamma ($>300\text{ms}$) *only when* shapes are task relevant.



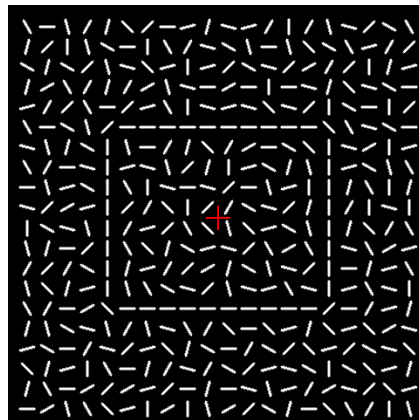
postperceptual
processing

Postperceptual Processing

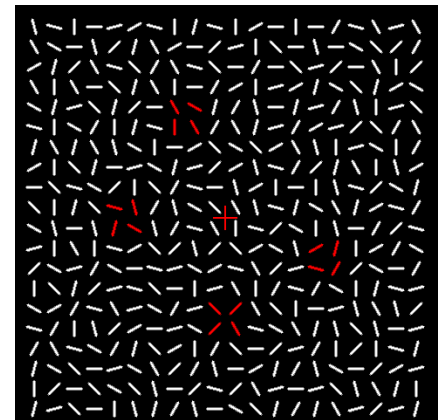
Random Array:



Shape Pattern:

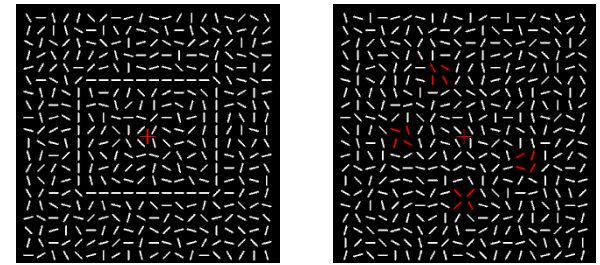


Color Patches:

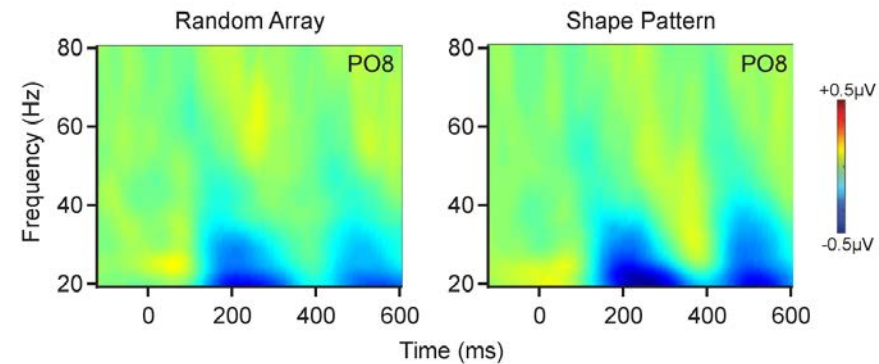
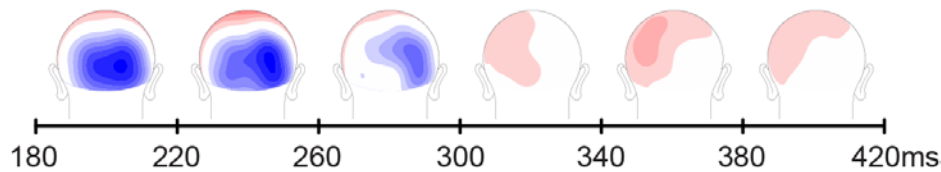


- Attend shape or color (counterbalanced blocks)
- P3 & Gamma for clearly perceived, but irrelevant shapes?

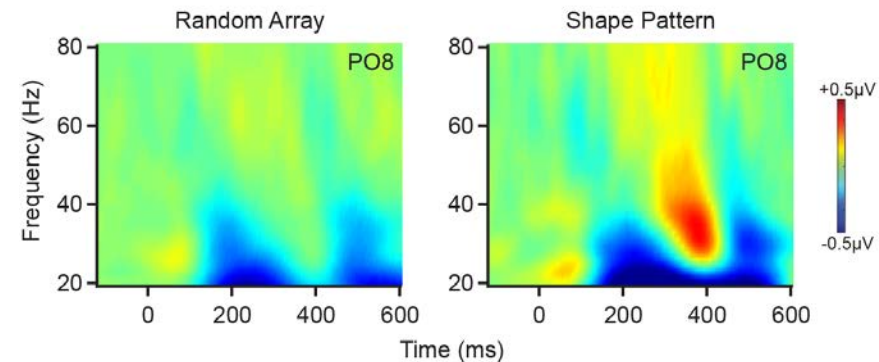
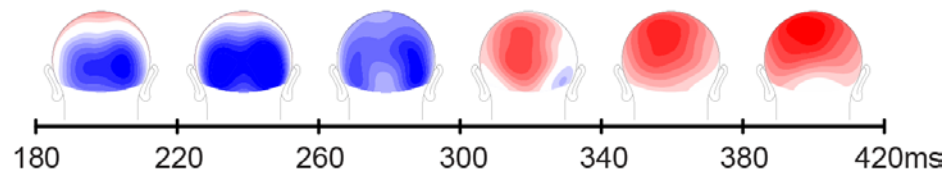
Postperceptual Processing



Shapes task irrelevant:



Shapes task relevant:



Follow-up Experiments

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



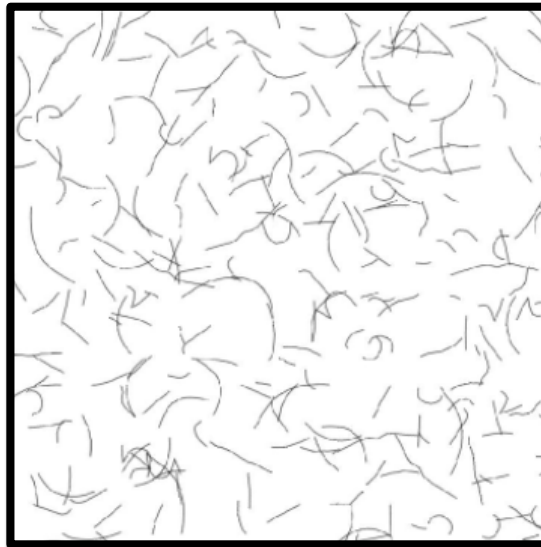
NCC ?

NCC for faces

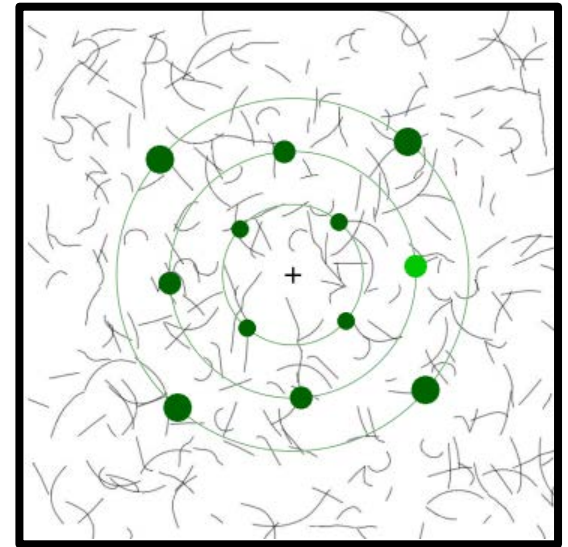
Face Pattern



Random Array



Distracter Task

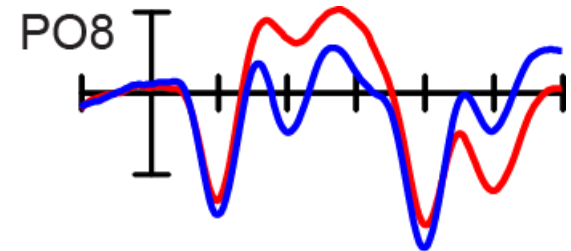
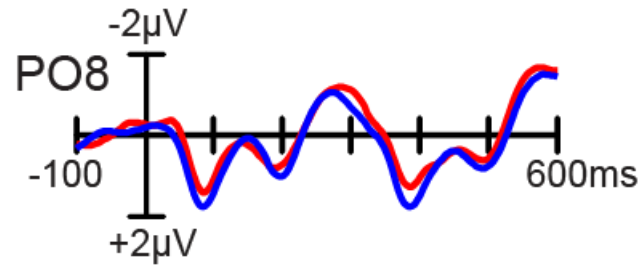


— Face Pattern
— Random Array

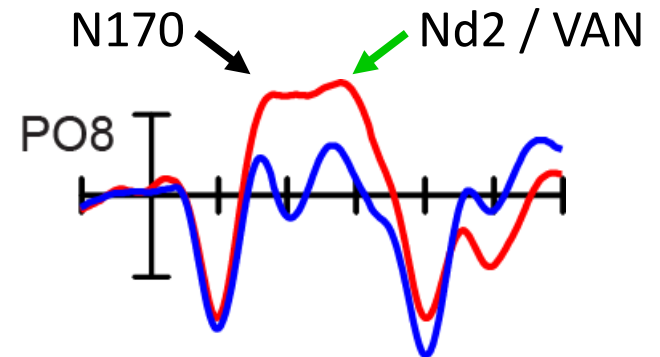
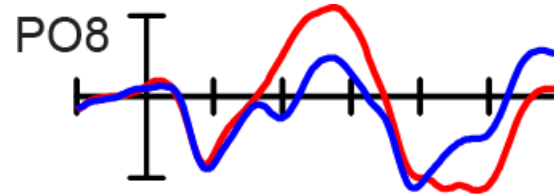
IB subjects

Noticer subjects

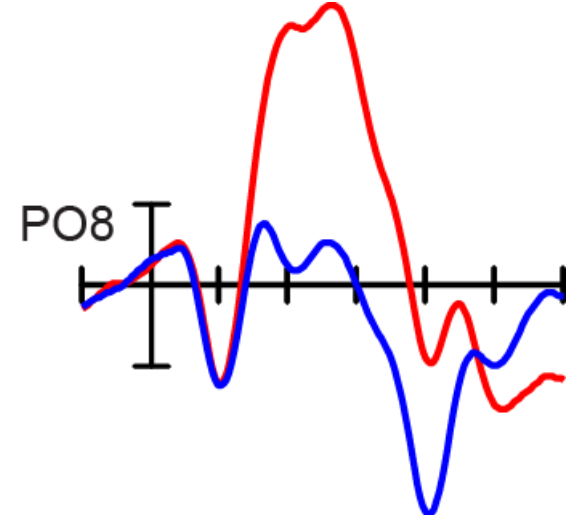
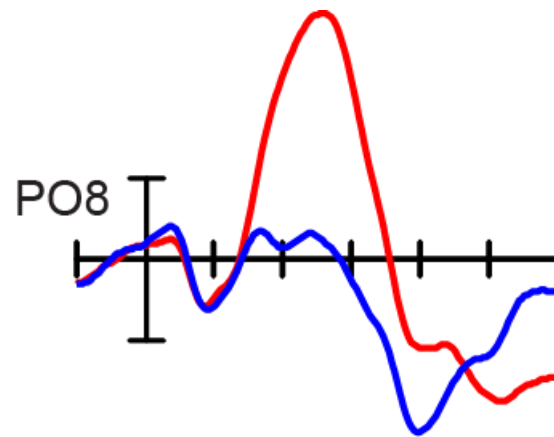
Phase 1



Phase 2



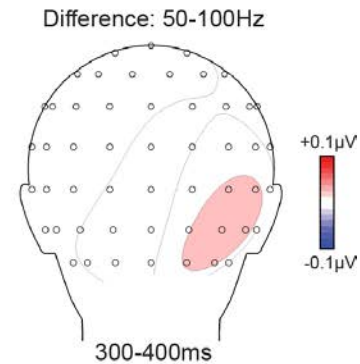
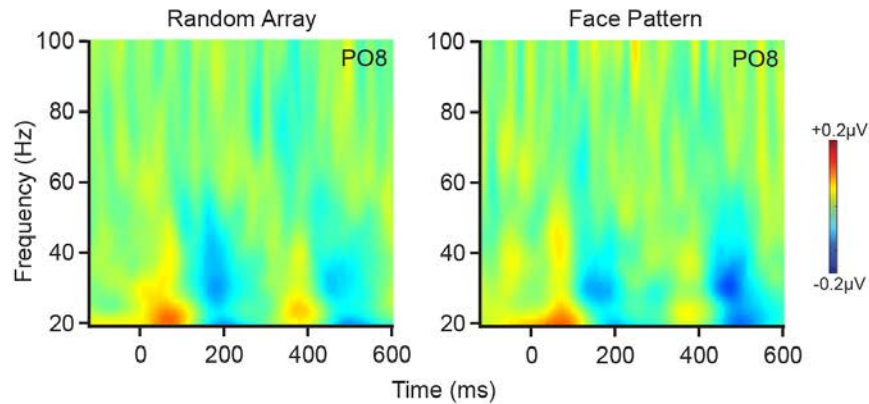
Phase 3



Time-Frequency Results

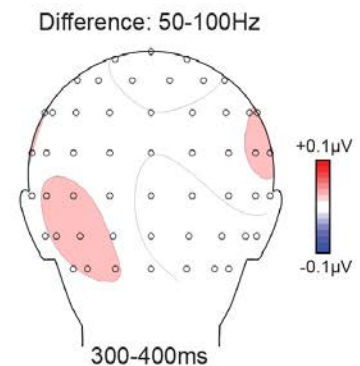
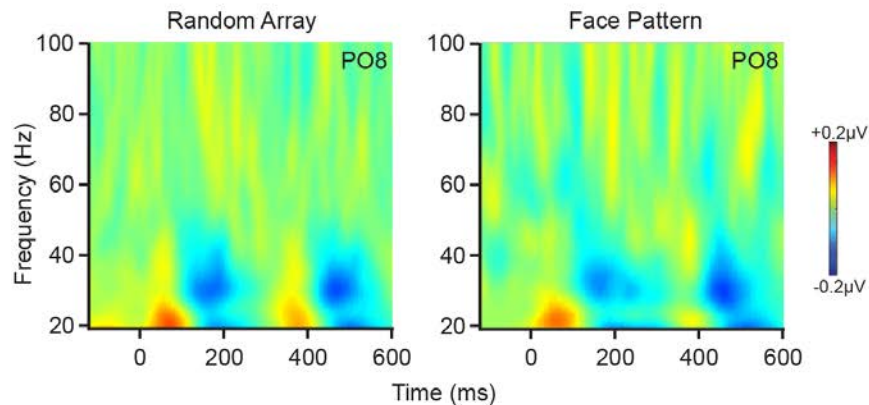
Phase 1

(unaware, task irrelevant)



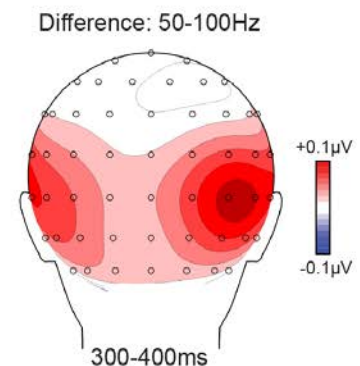
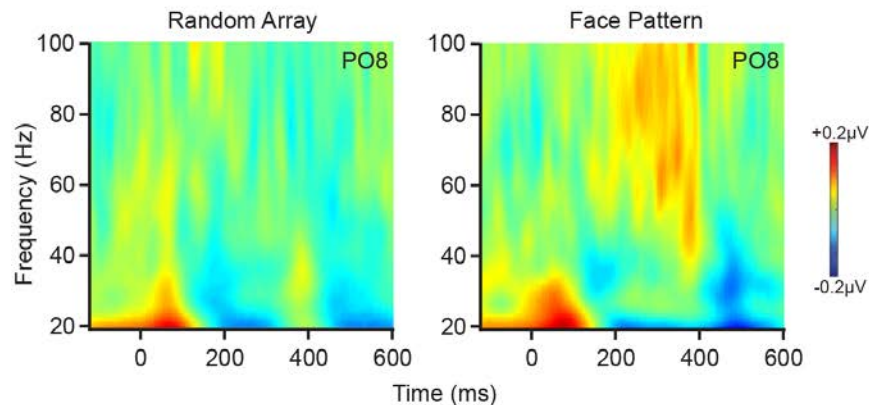
Phase 2

(aware, task irrelevant)



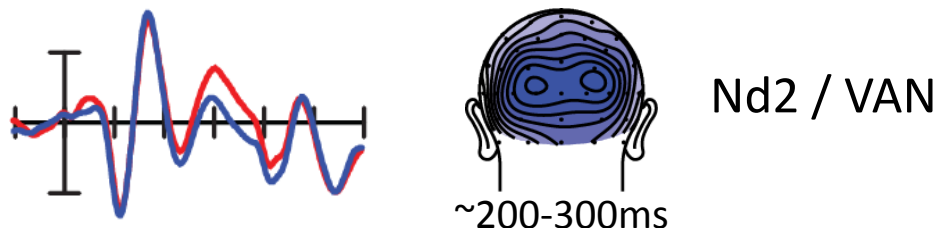
Phase 3

(aware, task relevant)



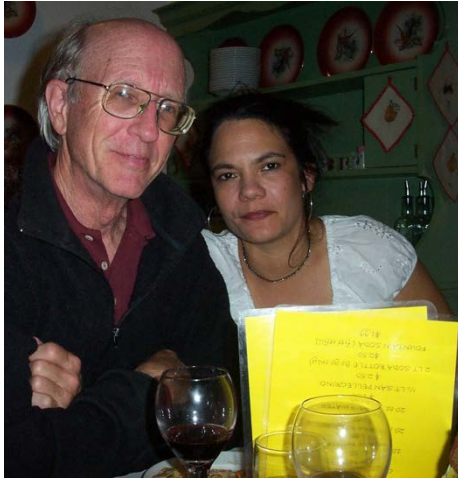
Conclusions

- P3 & Gamma reflect “ignition” of postperceptual processes
- NCC: local “flicker” instead of widespread “ignition”?



- Does this NCC (Nd2/VAN) reflect attention or awareness?
- Important to isolate NCC from pre & postperceptual processes

Thank you for your attention and awareness!



Collaborators:

- Steve Hillyard
- Antígona Martínez
- Juliet Shafto
- Jennifer Padwal
- Daniel Fennelly

Funding:

- KIBM
- NIMH
- NSF
- Reed College

SCALPLAB

Sensation Cognition Attention Language Perception

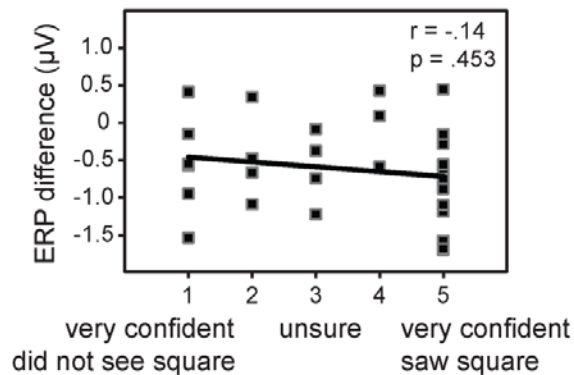
www.reed.edu/psychology/scalp

ERP correlations with awareness reports

Confidence Ratings

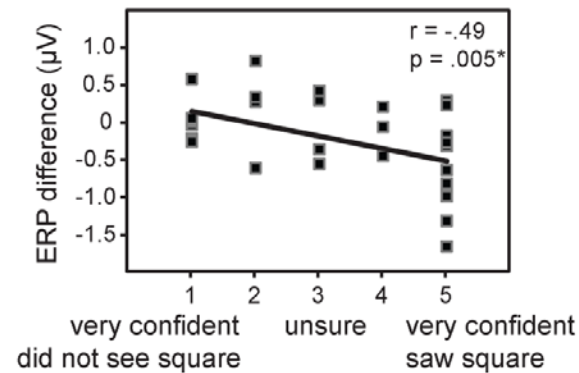
Nd1

220-260ms



Nd2

300-340ms



Nd2



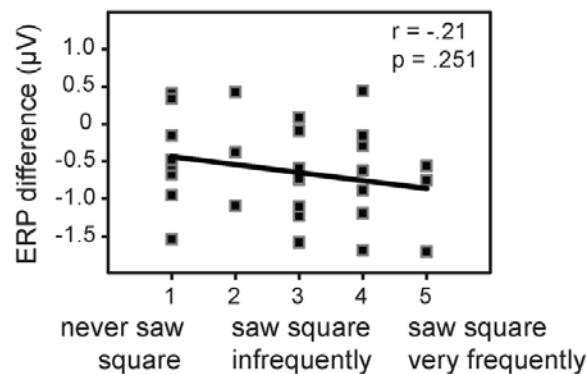
Nd1



Frequency Ratings

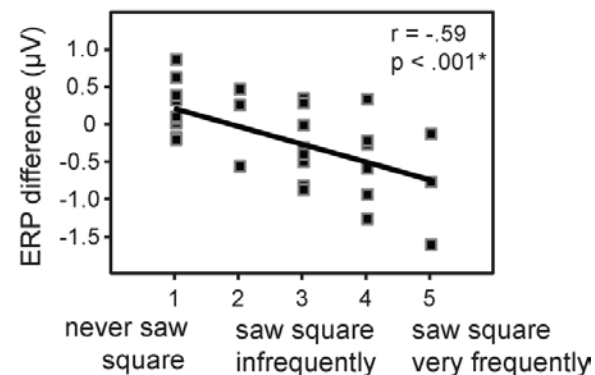
Nd1

220-260ms



Nd2

300-340ms



4) Estimate how often you saw each pattern.

Please use the following scale:

1 = never

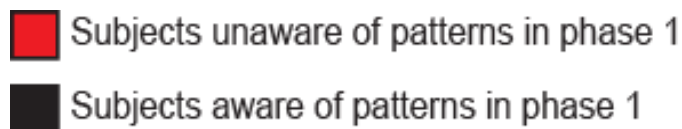
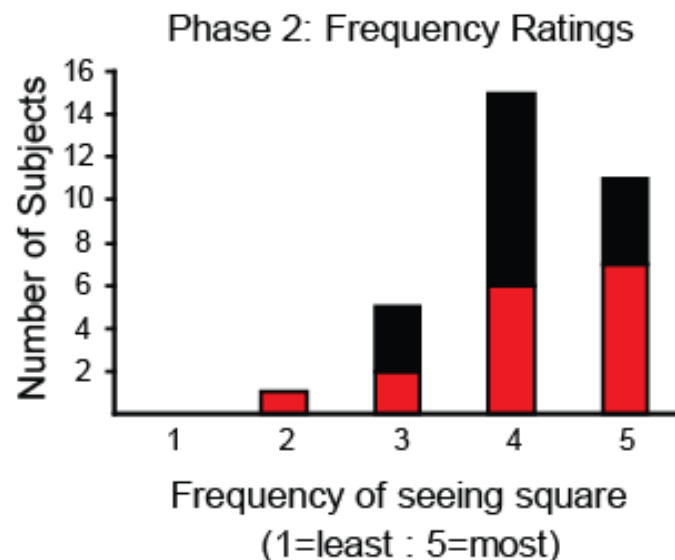
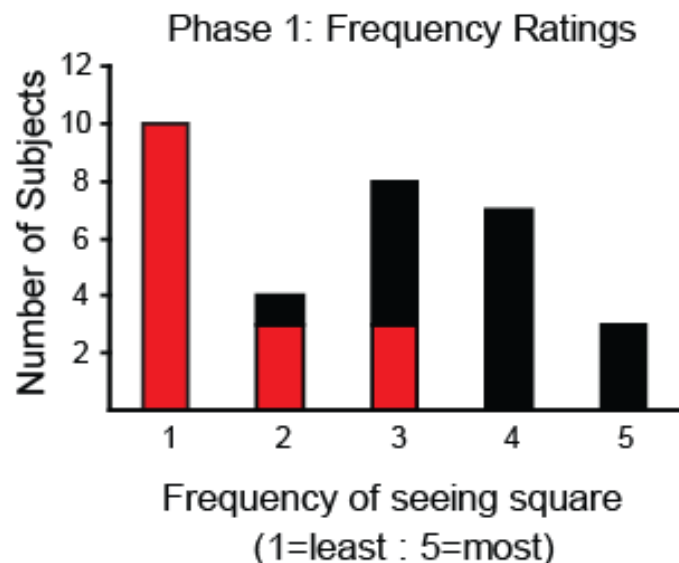
2 = rarely / less than 10 times

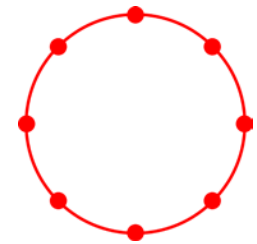
3 = infrequently / 10-50 times

4 = frequently / 50-100 times

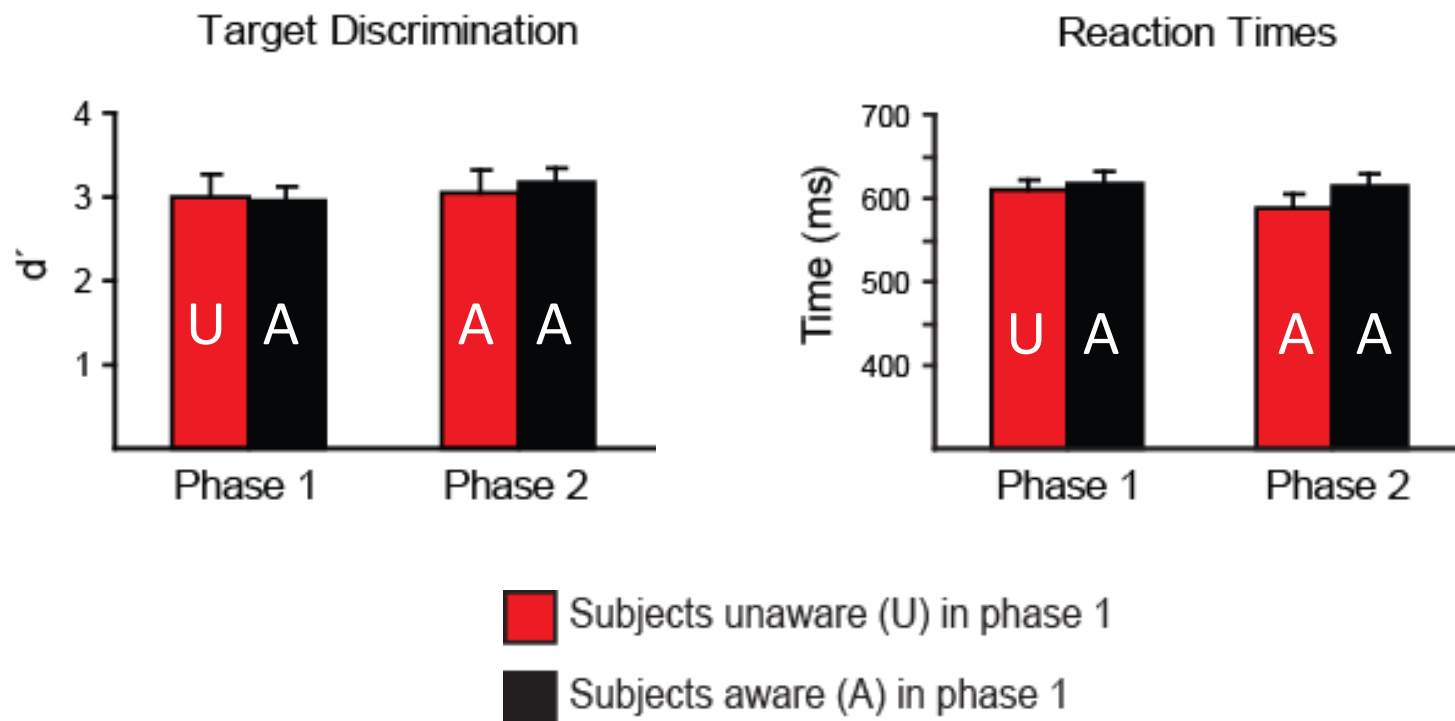
5 = very frequently / more than 100 times

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 (distracter task)

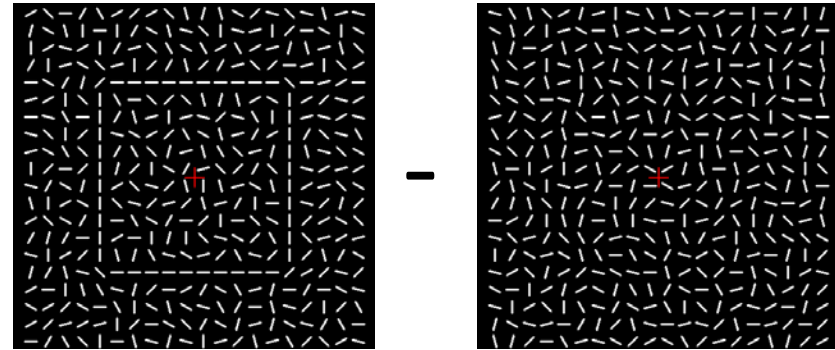
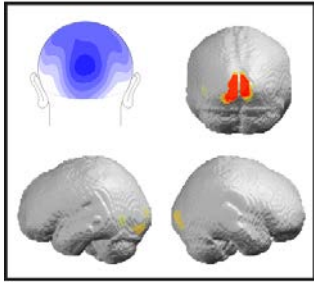


No performance difference for aware vs. unaware (within or between subjects)

Phase 1: unaware

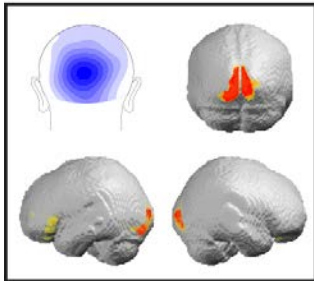
Source Estimates (LORETA)

220ms

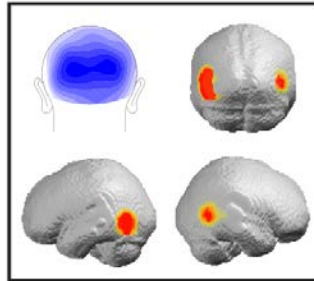


Phase 2: aware

220ms

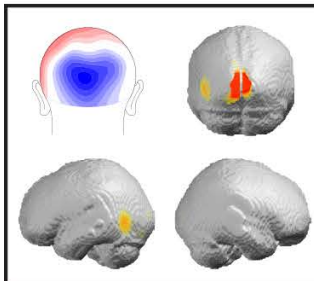


300ms

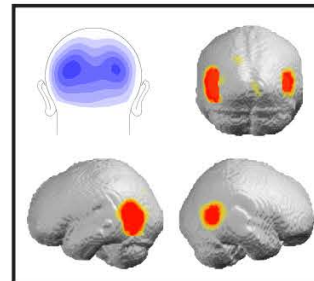


Phase 3: aware + task relevant

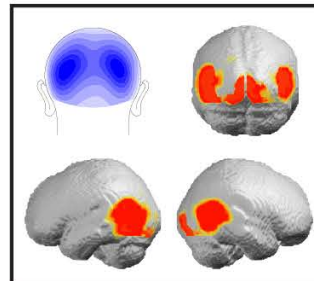
180ms



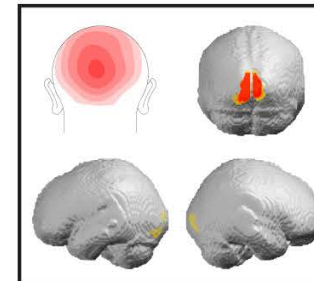
220ms



260ms



380ms



420ms

