Algorithms for cue competition

Suggestions from EEG and eye-tracking data

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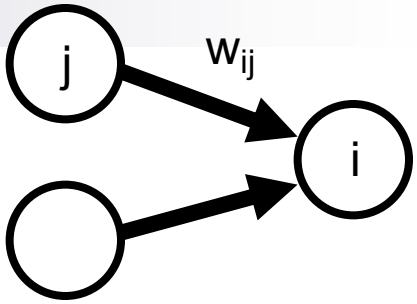
Cue competition



Phase 1	Phase 2	Test
A+	AX+	X?
B-	BY+	Y?

$\Delta w = \alpha (\lambda_i - w_{ij}) a_j$ Linear operator

$\Delta w = \alpha (\lambda_i - \Sigma aw) a_j$ LMS rule

Deductive reasoning

1	2
A+	AX+
B-	BY+

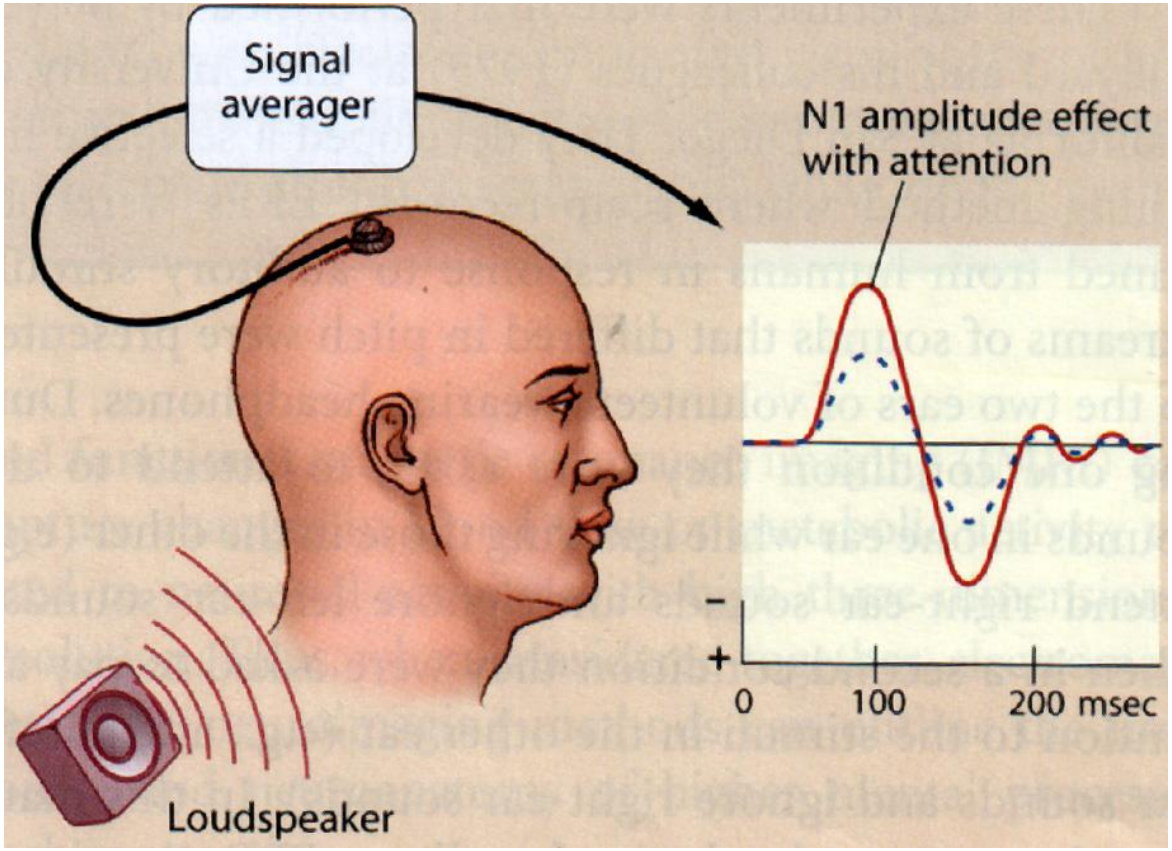
Selective attention

- Mackintosh (1975)
  - α is stimulus-specific
  - α increases when the stimulus predicts a change in reinforcement; decreases when it does not.

$\Delta\alpha_A$ positive if $|\lambda - w_a| < |\lambda - w_x|$

$\Delta\alpha_A$ negative if $|\lambda - w_a| >= |\lambda - w_x|$

Selective attention and ERP



Attentionally differentiated?

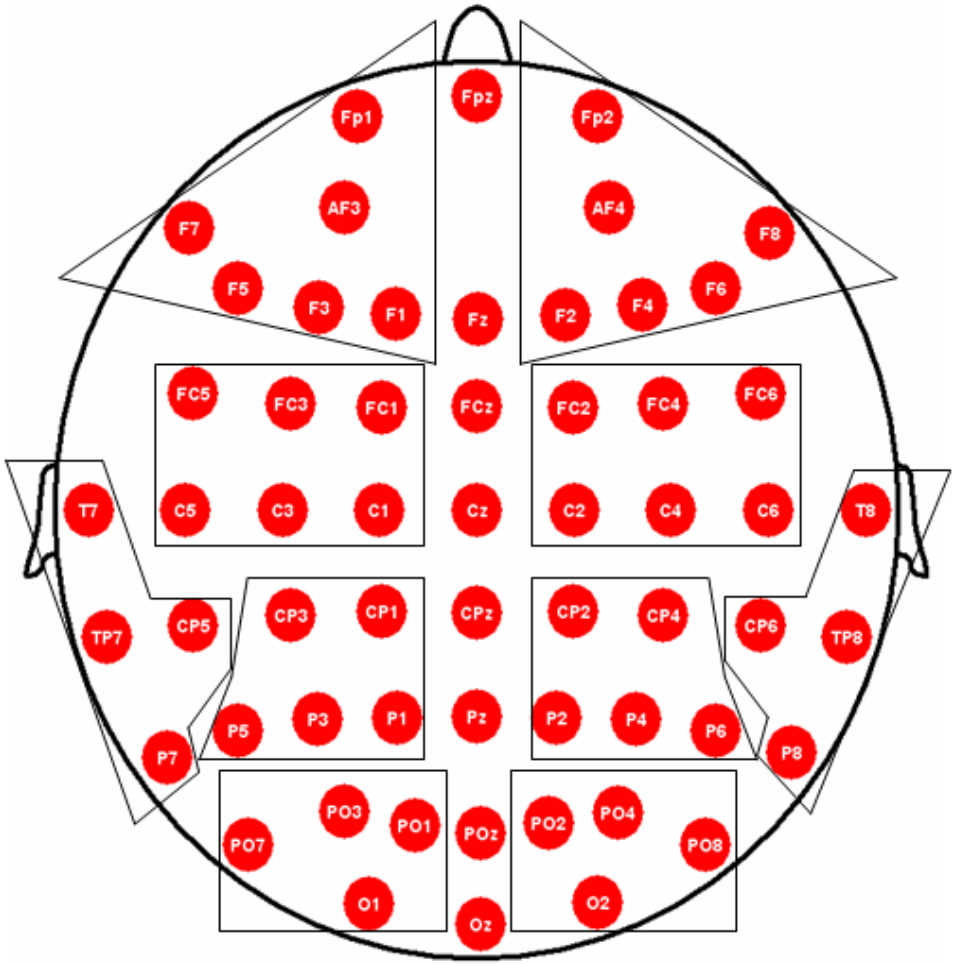
When?

(approximately) where?

1	2	Test
A+	AX+	**X**
B-	BY+	**Y**

- Hillyard et al. (1973) … Luck *et al*. (2000)

- High-density EEG array allows cortical localisation via LORETA.



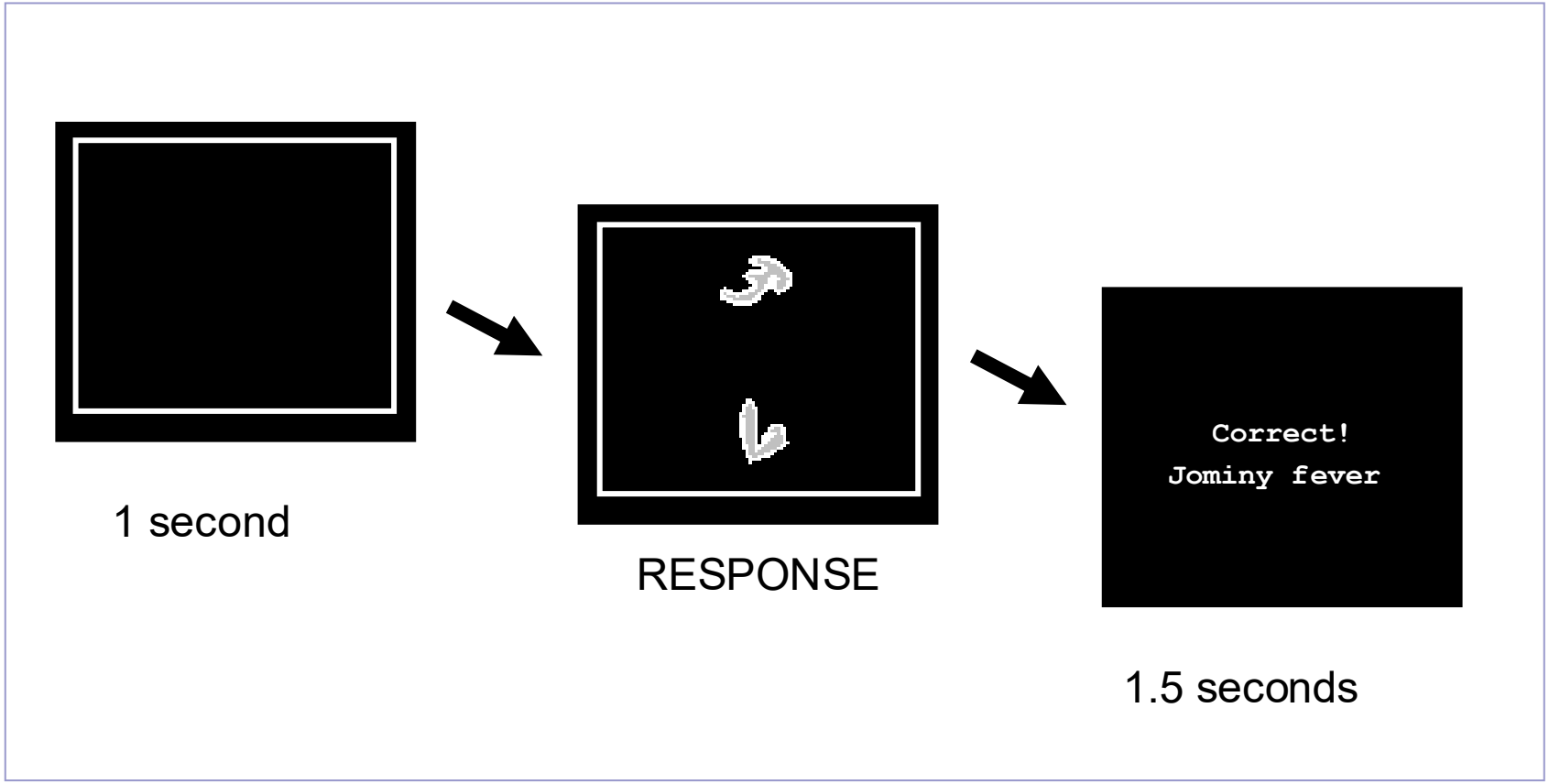
Selective attention and gaze direction

Attentional selection?

1	2	Test
A+	**AX+**	X
B-	**BY+**	Y

- Kaakinen et al., 2002; Rehder & Hoffman, 2003

Trial structure



- 2 second time-out (0.3% trials terminated)

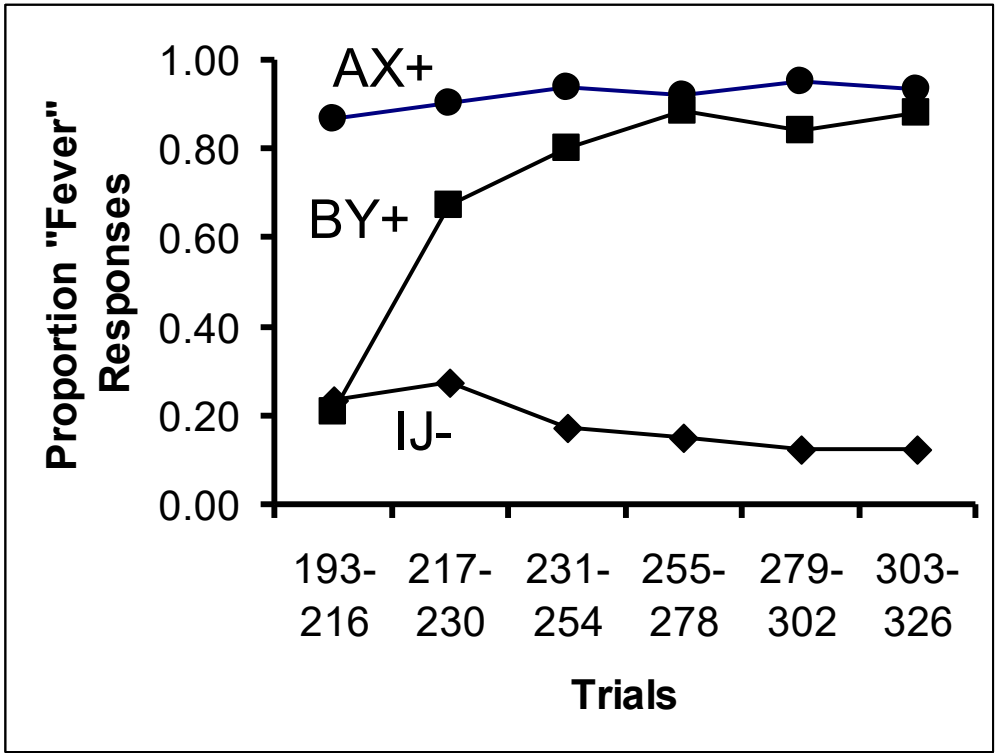
Behavioural results

Phase 1

A+ 0.90

B- 0.03

I- 0.03



Phase 3

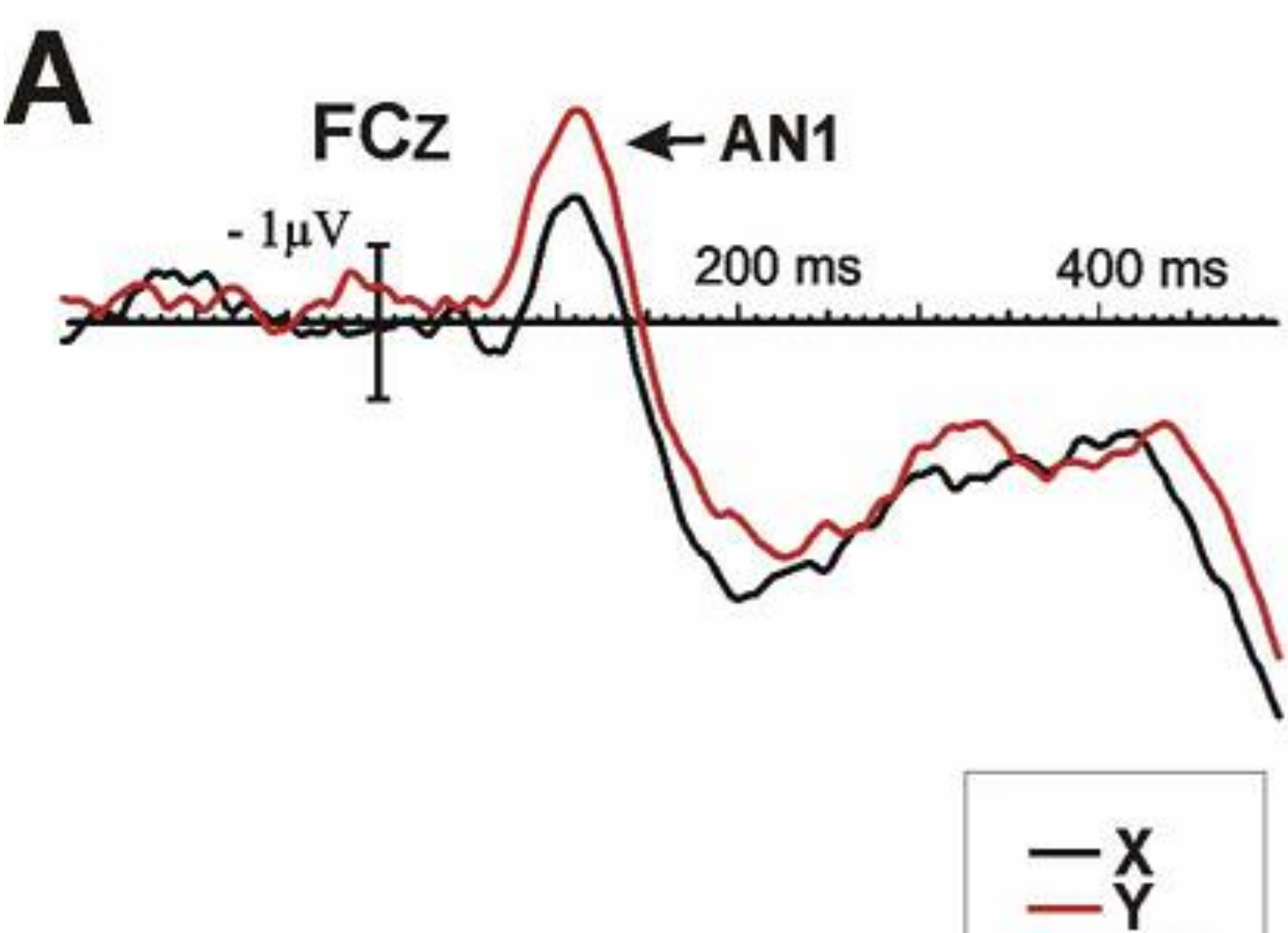
X – 0.45 (807ms)

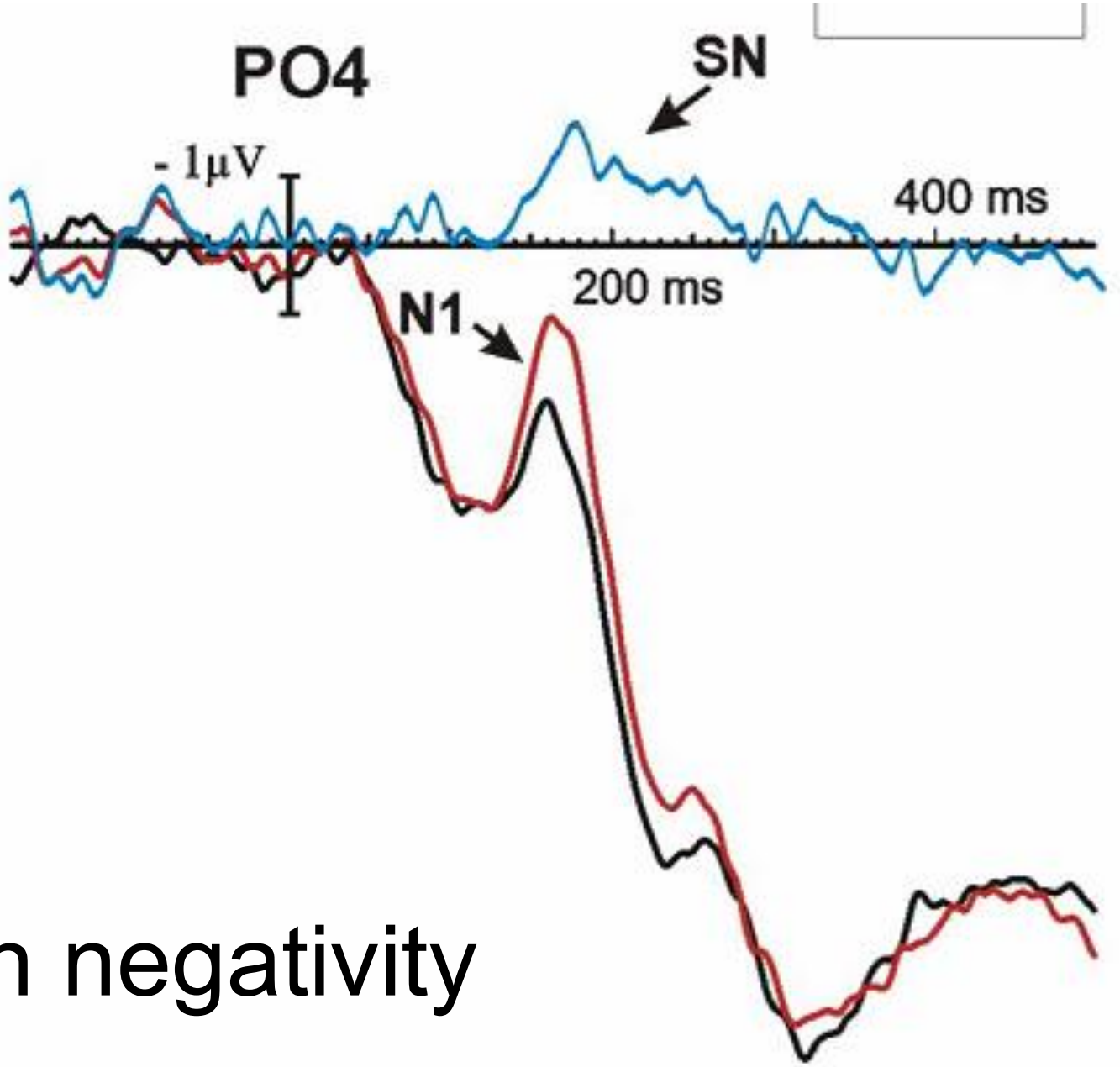
Y – 0.72 (767ms)

- Other phase 3 trial types:
  A:0.96; AX: 0.98; BY: 0.91; B: 0.18

Earliest differences

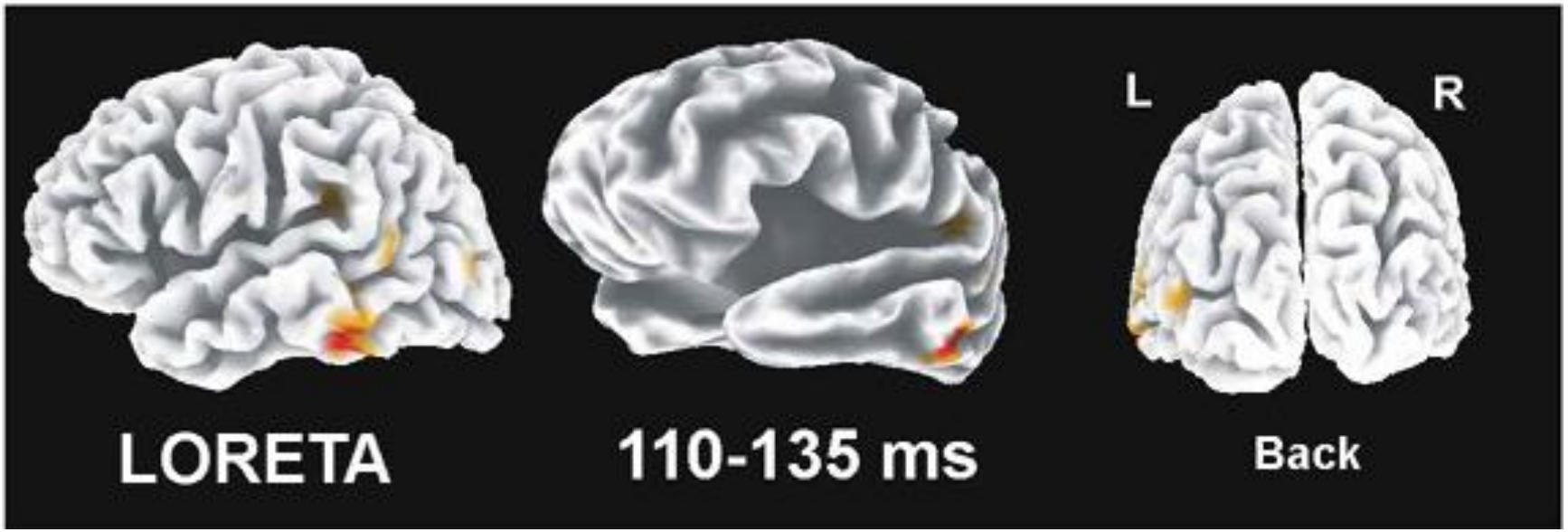
1	2	Test
A+	AX+	**X**
B-	BY+	**Y**





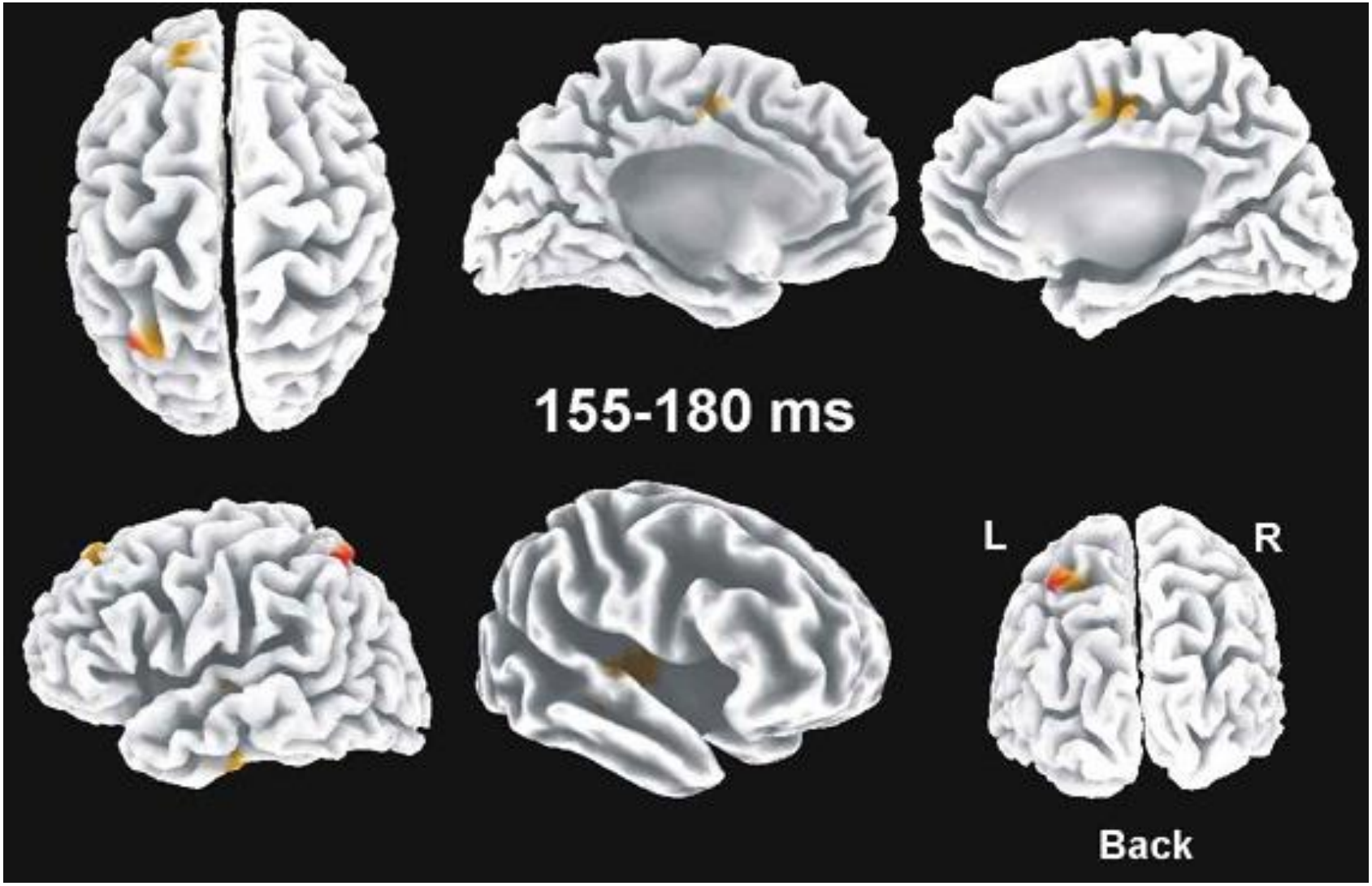
Selection negativity

Earliest differences



lateral occipital, inferior temporal, posterior mid-temporal and posterior insula

Selection negativity

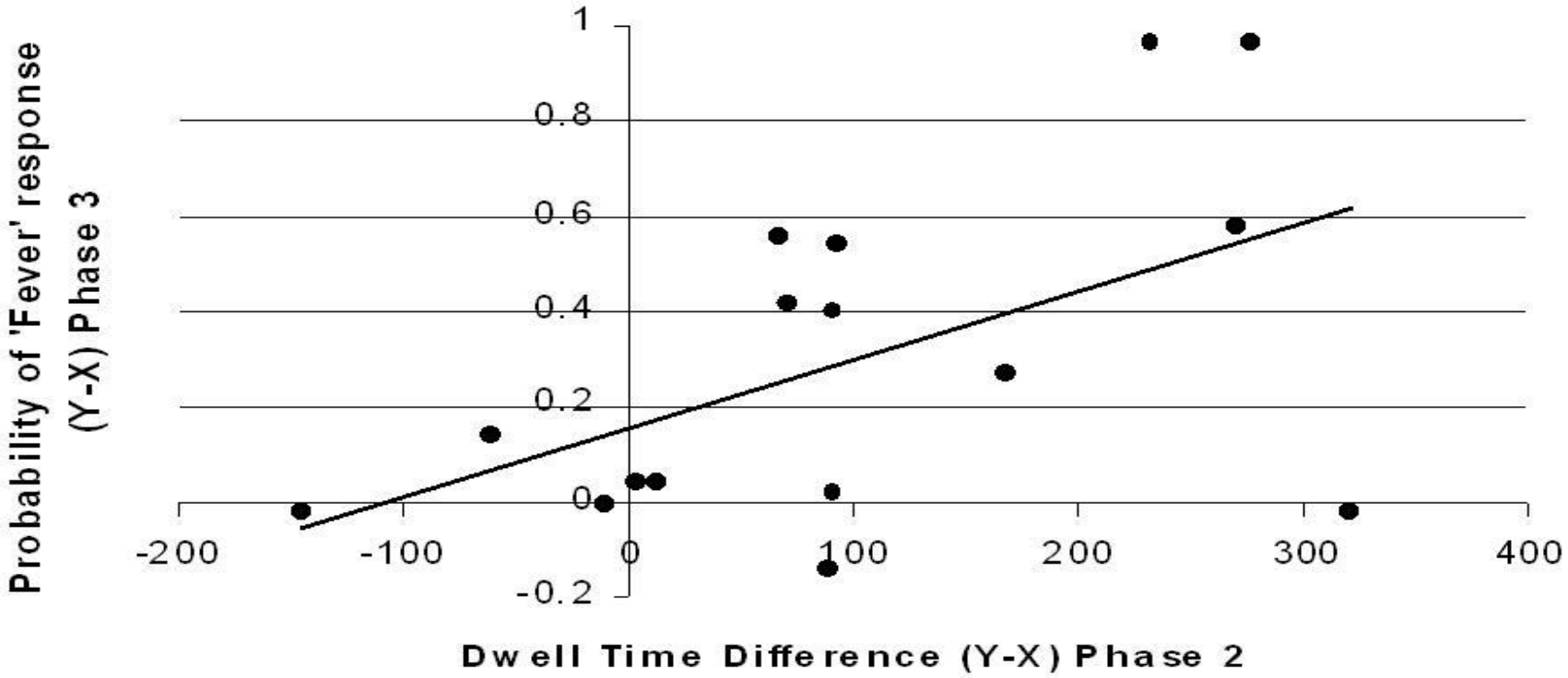


superior parietal, superior medial frontal, inferior temporal, anterior cingulate, insula

Gaze direction

- X / (A+X) 0.37
- Y / (B+Y) 0.46

1	2	Test
A+	**AX+**	X
B-	**BY+**	Y



Summary

- Stimuli that predict a change in reinforcement attract more attention than those that do not.
- Attentional differentiation begins within 120ms of stimulus onset in the dorsal (“what”) pathway of the visual system.
- Findings consistent with the idea that cue competition (at least partly) results from stimulus-specific learning rates modulated by predictive history (e.g. Mackintosh, 1975).