

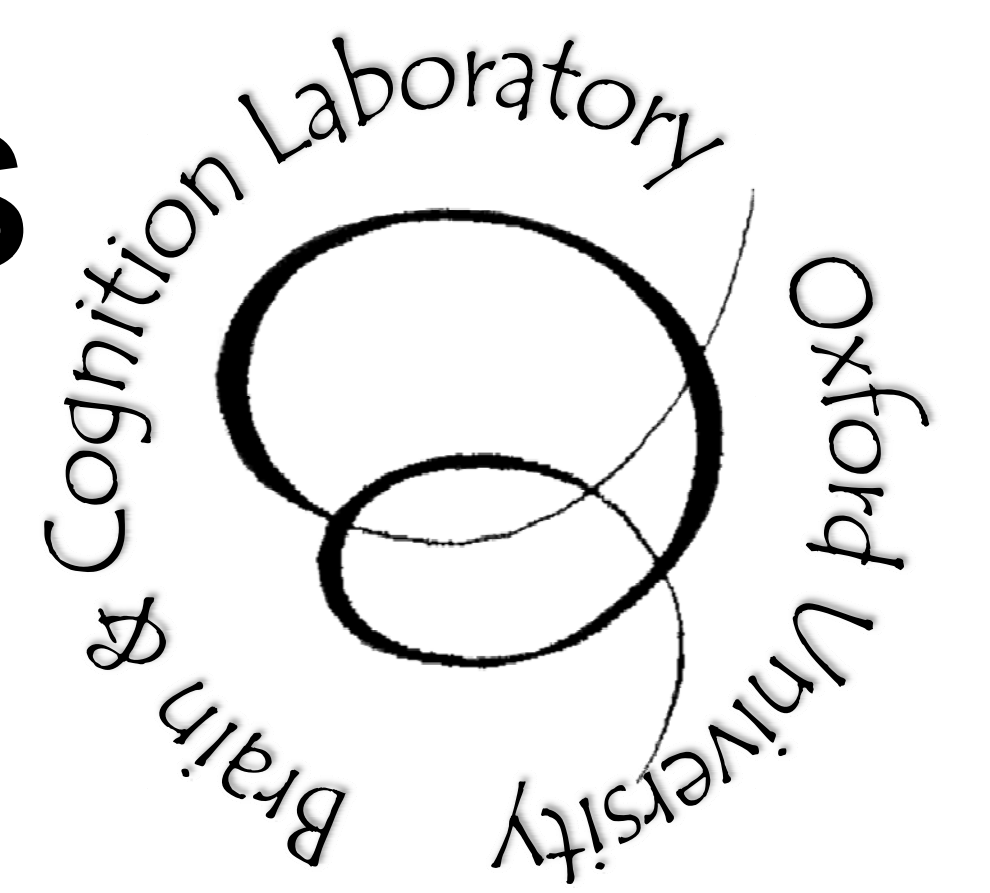
Neural Modulation by Rhythm-Induced Temporal Expectations

Gustavo Rohenkohl, Anna Dal Molin, Anna C. Nobre

Brain & Cognition Laboratory, Department of Experimental Psychology, University of Oxford

http://psyweb.psy.ox.ac.uk/B_&_C/

braincoglab@gmail.com



Experimental Questions:

Previous studies of visual temporal orienting have consistently shown modulation of response-related potentials, but have yielded conflicting results as to whether visual analysis can also be modulated. In previous experiments, temporal expectations induced by regular rhythms significantly enhanced early visual potentials (P1) only when spatial expectation was also available^[1,2]. In this study, we manipulated the presence and validity of temporal expectations, in the presence of spatial expectations, and used a discrimination task to replicate and extend these previous findings.

Specifically, we asked:

1. Are there behavioural benefits and costs for valid and invalid temporal expectations?
2. Are early visual potentials modulated by temporal expectations in the presence of visual expectations?
3. Are lateralised response-related potentials (LRP) modulated by temporal expectations?

Findings & Conclusions:

- Valid temporal expectations significantly speeded responses.
- Effects of temporal expectations in the presence of spatial expectation occurred at multiple stages of analysis, from early perceptual stages to late stages of motor selection and execution.
- P1 was larger; N2 was diminished; P3 occurred earlier and was larger; and LRP was steeper and larger.

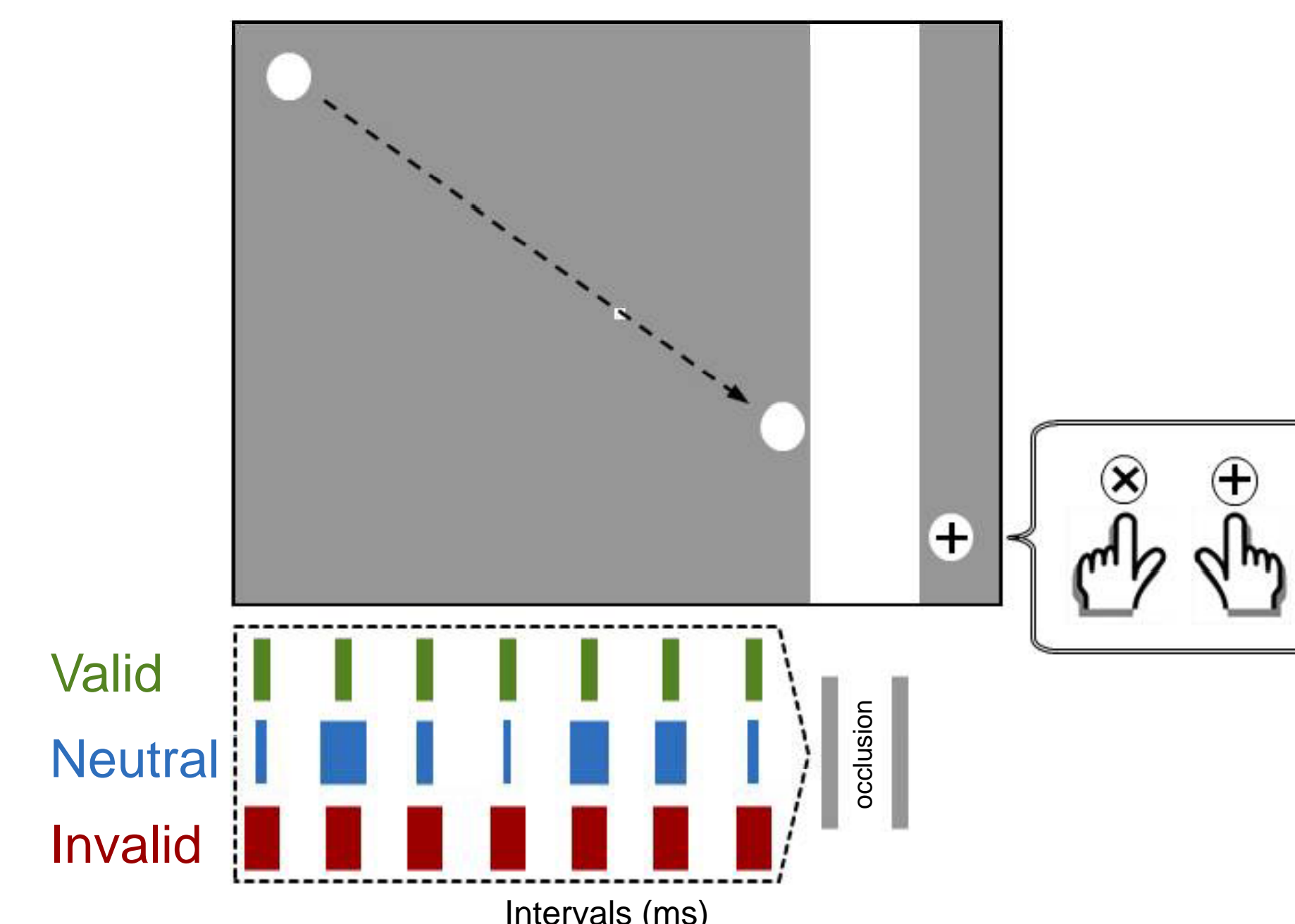
References:

- [1] Doherty JR, Rao A, Mesulam MM, Nobre AC (2005) Synergistic effect of combined temporal and spatial expectations in visual attention. *J Neurosci* 25: 8259-66.
- [2] Correa A, Nobre AC (2008) Neural modulation by regularity and passage of time. *J Neurophysiol* 100:1649-55.

For review see:

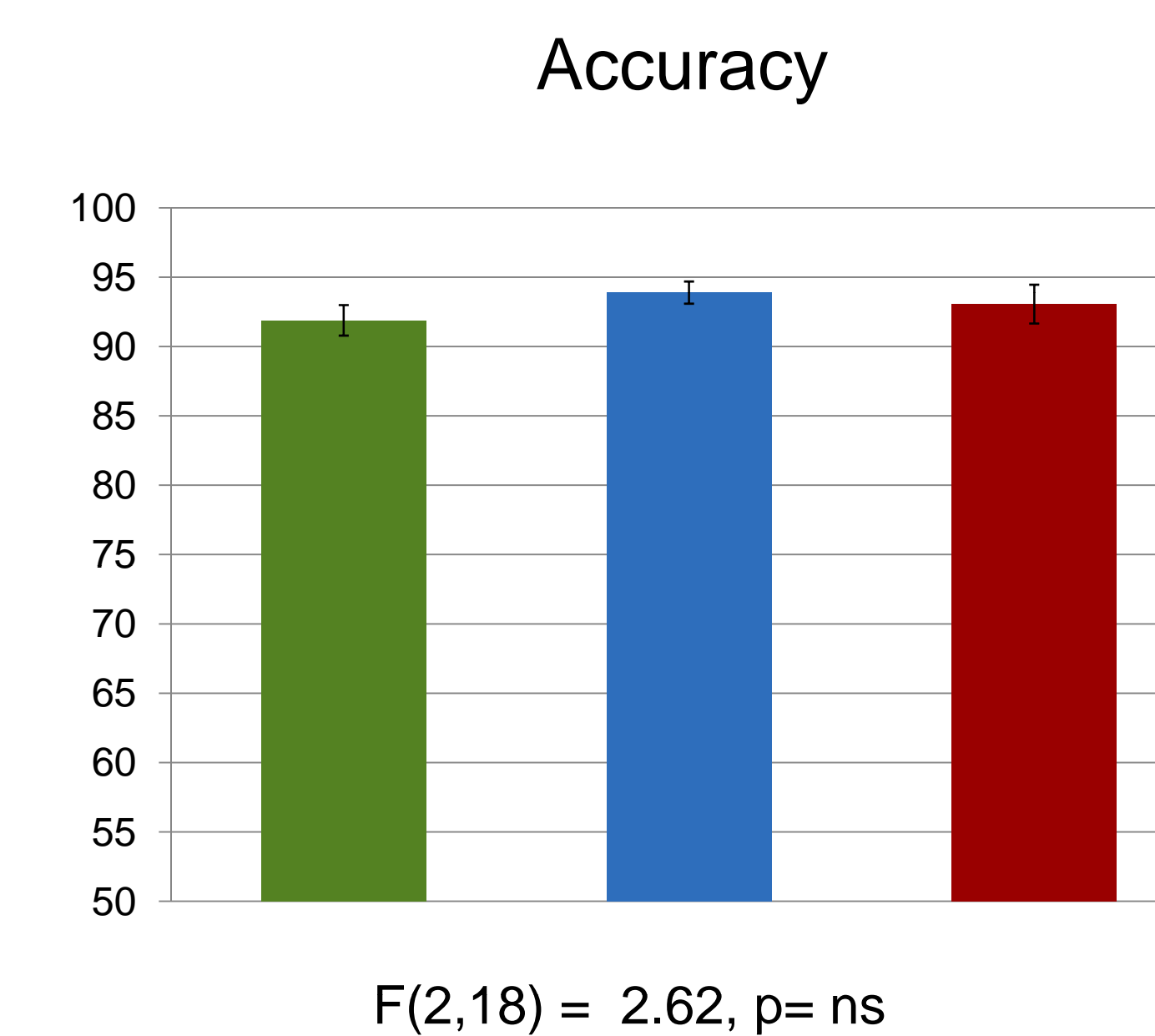
Nobre A, Correa A, Coull J (2007) The hazards of time. *Curr Opin Neurobiol* 17:465-470.

Task



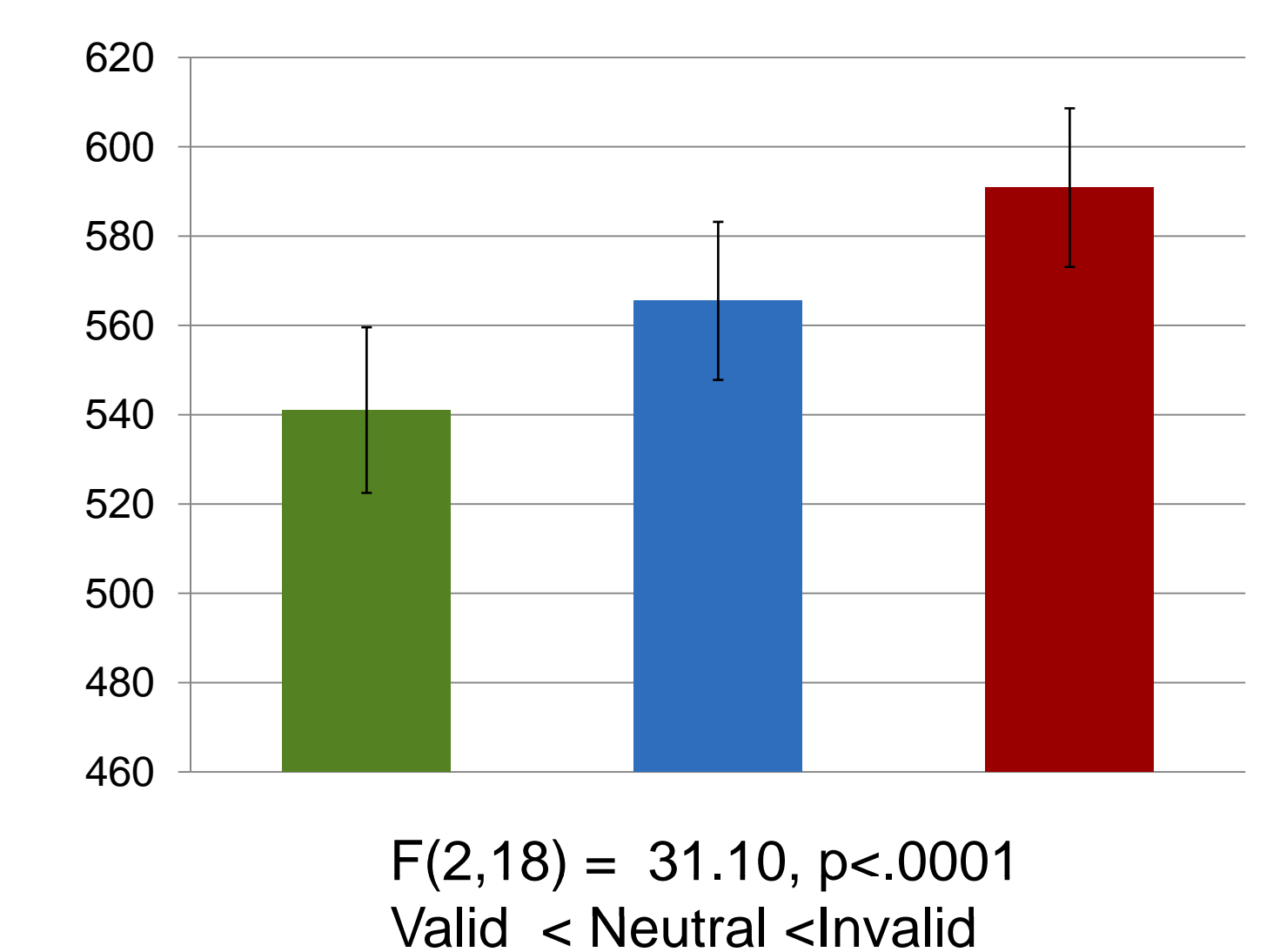
Participants (20) viewed a white ball that appeared at the left side of a grey screen and moved across the screen in discrete steps following a regular temporal rhythm or irregular intervals. The ball disappeared underneath an occluding band for one step. After reappearance, it contained either an upright or tilted cross. Participants made a forced discrimination accordingly.

Behavioural Results



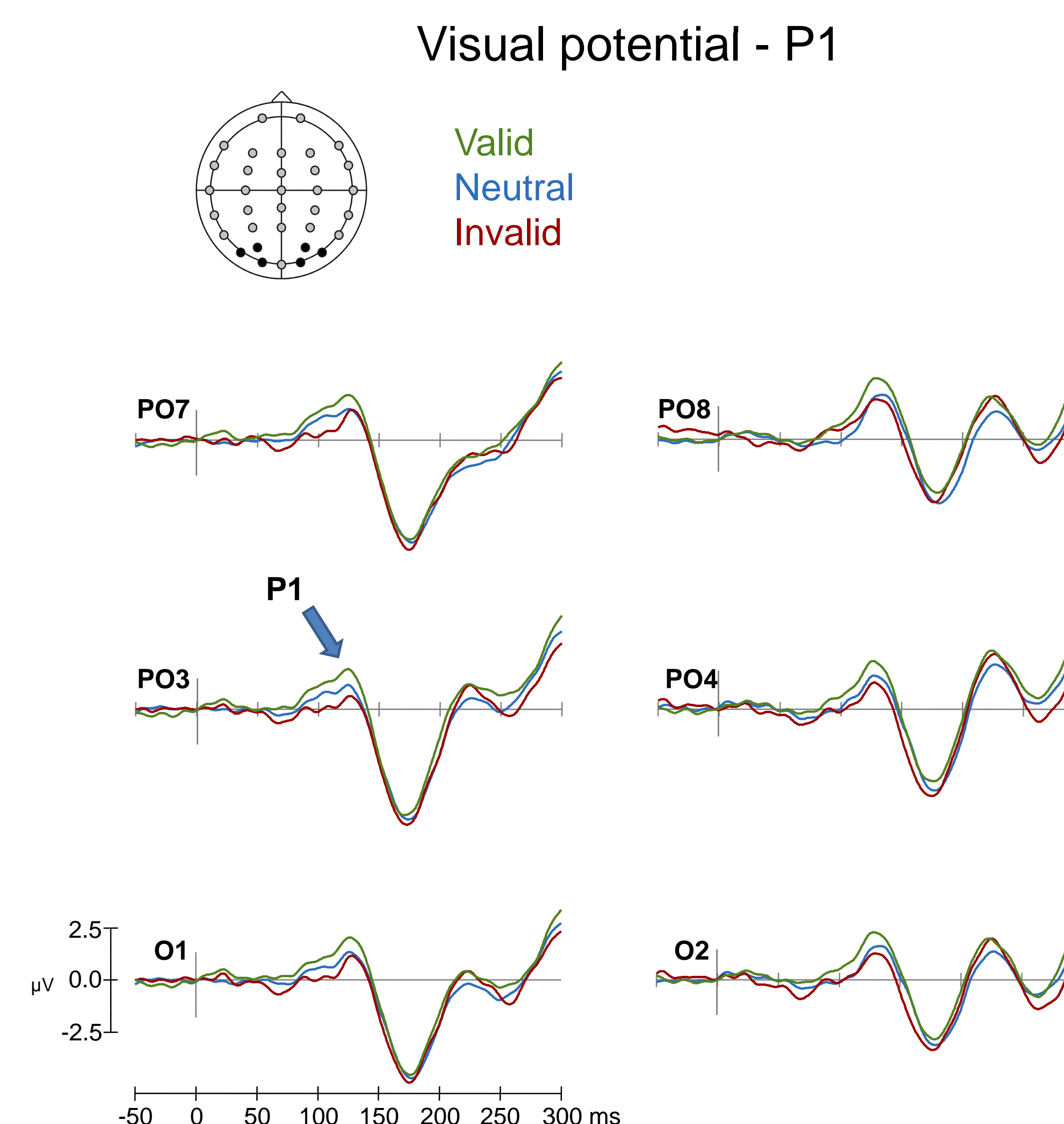
Accuracy was high and showed no benefit from temporal expectation.

Mean Reaction Times



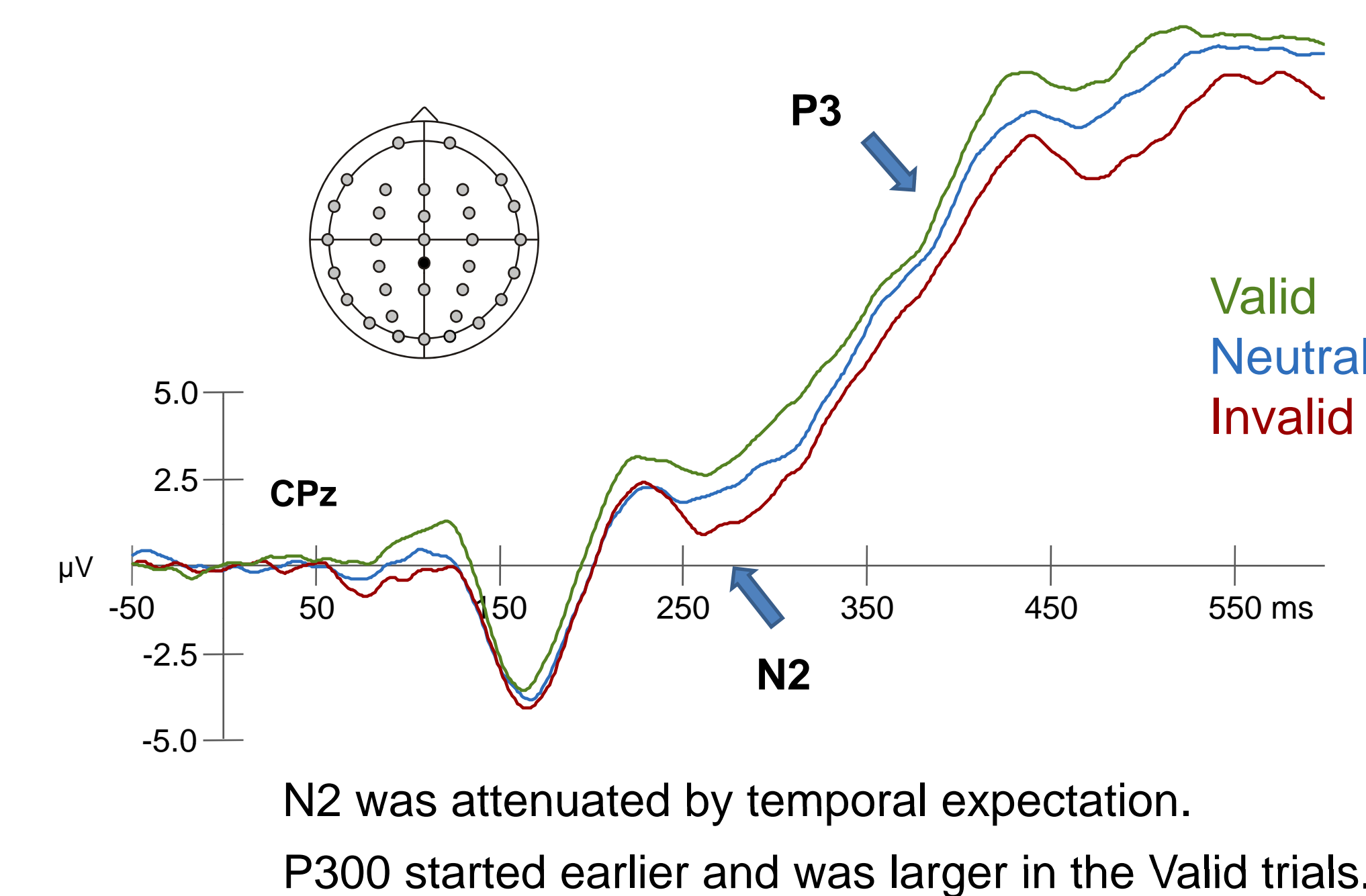
Temporal expectations significantly enhanced RTs. Both benefits and costs were observed.

Event-Related Potentials

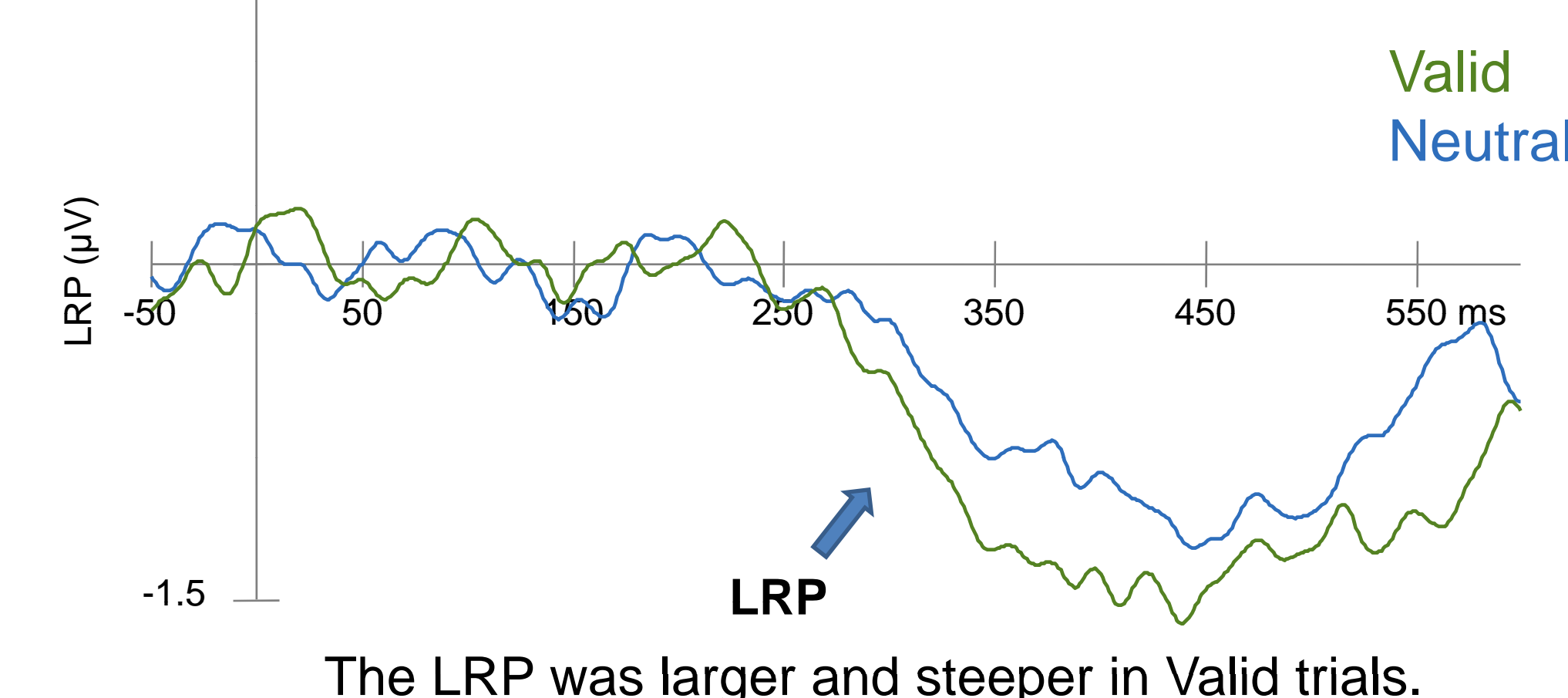


Temporal expectation enhanced the visual P1.

Later potentials – N2 & P3



Lateralized Readiness Potential



EEG Methods

EEG was acquired from 40 channels at 1000Hz (AFZ ground, R mastoid reference, 0-40Hz filter) and re-referenced offline to the average mastoids.

ERPs elicited by valid, neutral and invalid targets were derived offline (-200, 600ms). Trials with eye movements, blinks or errors were excluded.

The LRP was obtained by recording over motor cortex contralateral to the response hand relative to ipsilateral motor cortex.

$$LRP = [\text{mean } (C4-C3)_{\text{left-hand}} + \text{mean } (C3-C4)_{\text{right-hand}}] / 2$$

This gives a measure of motor preparation and execution, corrected for hemisphere asymmetries.