

An EEG study of masking effects in RSVP

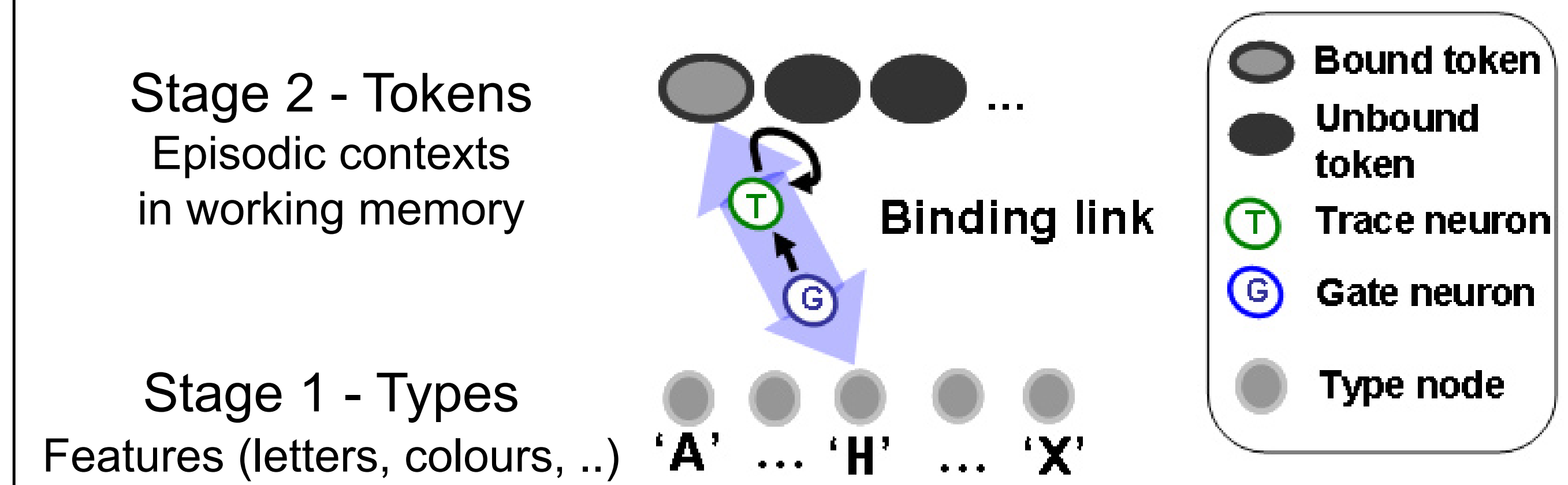
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Introduction

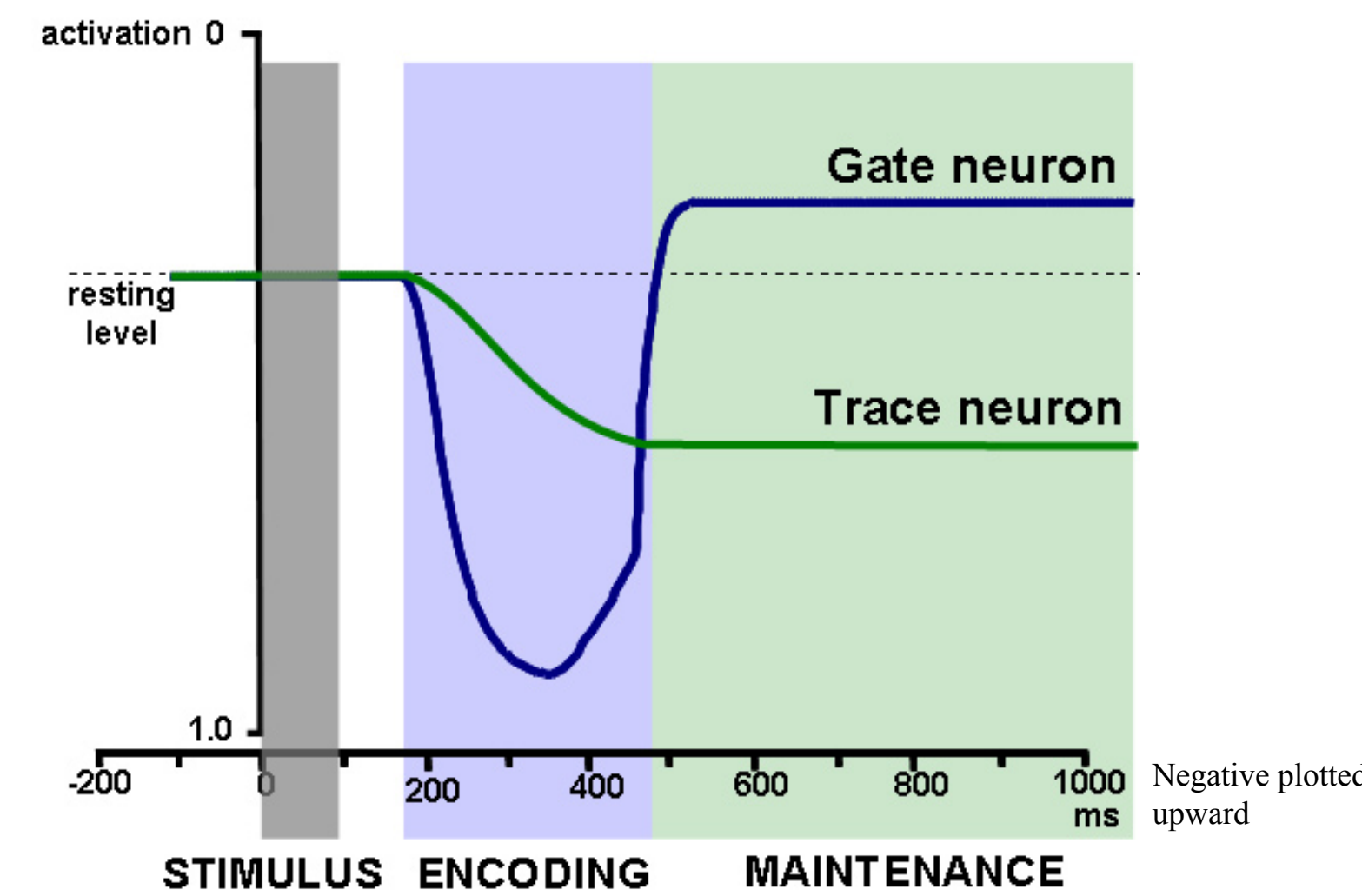
The limits of temporal attention are commonly studied by presenting subjects with target items that are difficult to perceive. Rapid Serial Visual Presentation (RSVP), where items are presented in the same spatial location at a rapid rate, evokes the Attentional Blink (AB; Raymond et al., 1992), an impairment in detecting a second target if it follows within short temporal proximity of an attended first target. In addition to behavioural experiments, the AB has also been explored by means of EEG (Vogel et al., 1998) and MEG (Kessler et al., 2005). However, for the AB to occur, targets have to be presented within 700ms of each other and each target item generates an EEG/MEG signal, which lasts up to 800ms. Hence, the close temporal proximity causes Event-Related Potential (ERP) signals to overlap. Our study explores the processing of single targets in RSVP to aid the understanding of results gained from multiple target paradigms.

Simultaneous Type Serial Token (ST²) model

(Bowman & Wyble, 2006; Wyble & Bowman, 2005)



Working memory encoding



Methods

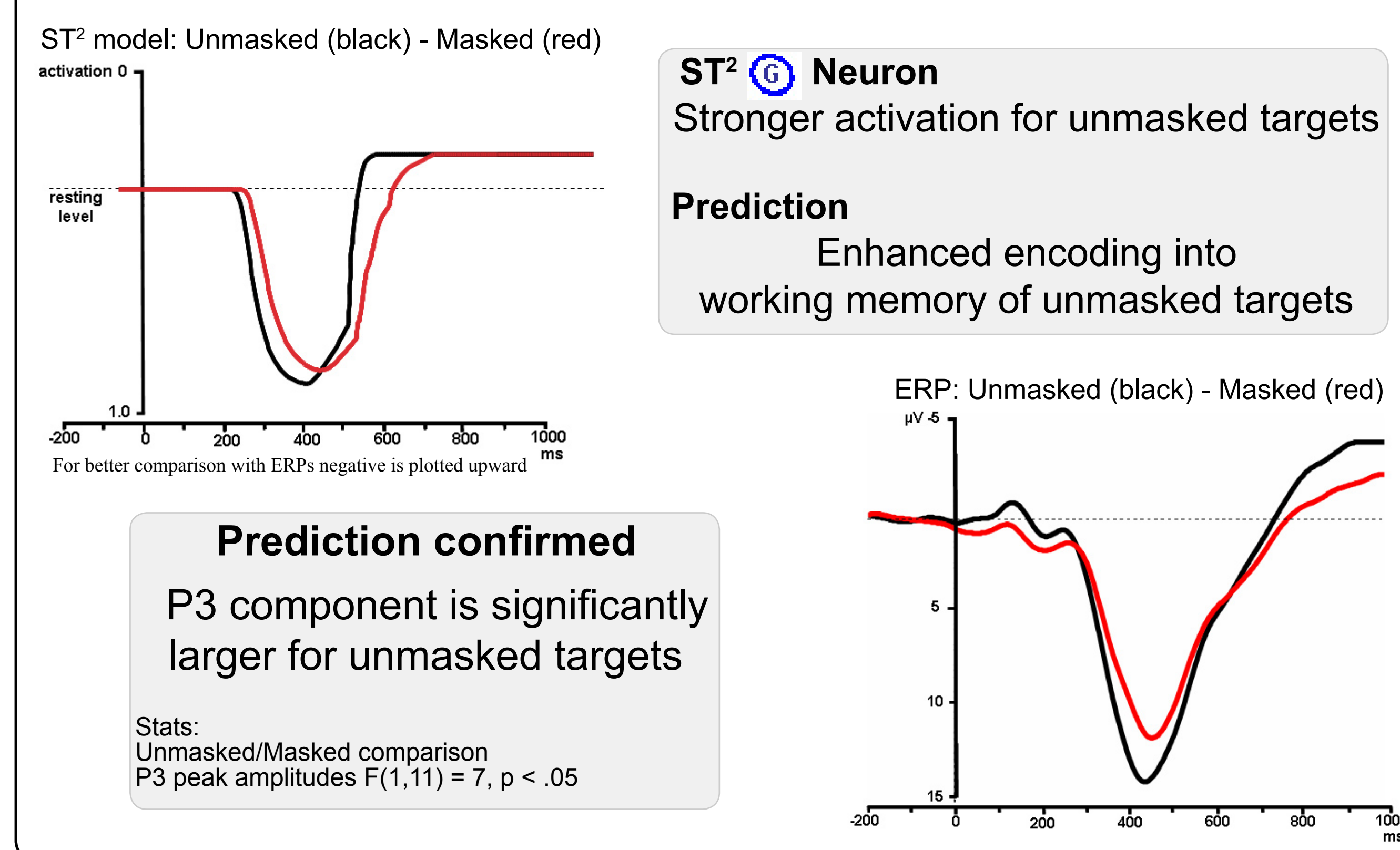
Presentation

- 12 subjects with normal or corrected-to-normal vision (mean age 24.1; 6 male / 6 female; 11 right-/1 left-handed; paid 10 GBP).
- Alphanumeric characters (Arial font, 5 cm mean height) presented at a distance of 100cm (2.86° visual angle) on 21" CRT computer screen (1024x768 @ 85Hz) using Psychophysics toolbox (Brainard, 1997) on Matlab 6.5 under Microsoft Windows XP
- 4 blocks (3 RSVP/1 Skeletal) of 100 trials; Each block: 96 target & 4 distractor only trials; 50% of targets masked and 50% unmasked; 5 practice trials before first RSVP and Skeletal block
- Target letters: B, C, D, E, F, G, J, K, L, P, R, T, U, V; Distractor digits: 2, 3, 4, 5, 6, 7, 8; Last item: (.) or (, comma)
- 500ms fixation cross before each stream; RSVP stream: 70 items (47.1ms SOA; no inter-stimulus interval; total stream length 3.3 seconds); Skeletal stream: Blank screen for 471ms to 2.5 seconds - then the target (and its mask in the masked condition) for 41.7ms - then blank screen for another 706ms to 2.8 seconds
- After viewing the stream subjects entered the target letter or pressed space if they did not see a target; then pressed dot or comma depending on what the last item of the stream was (included to keep subjects' attention with the stream)

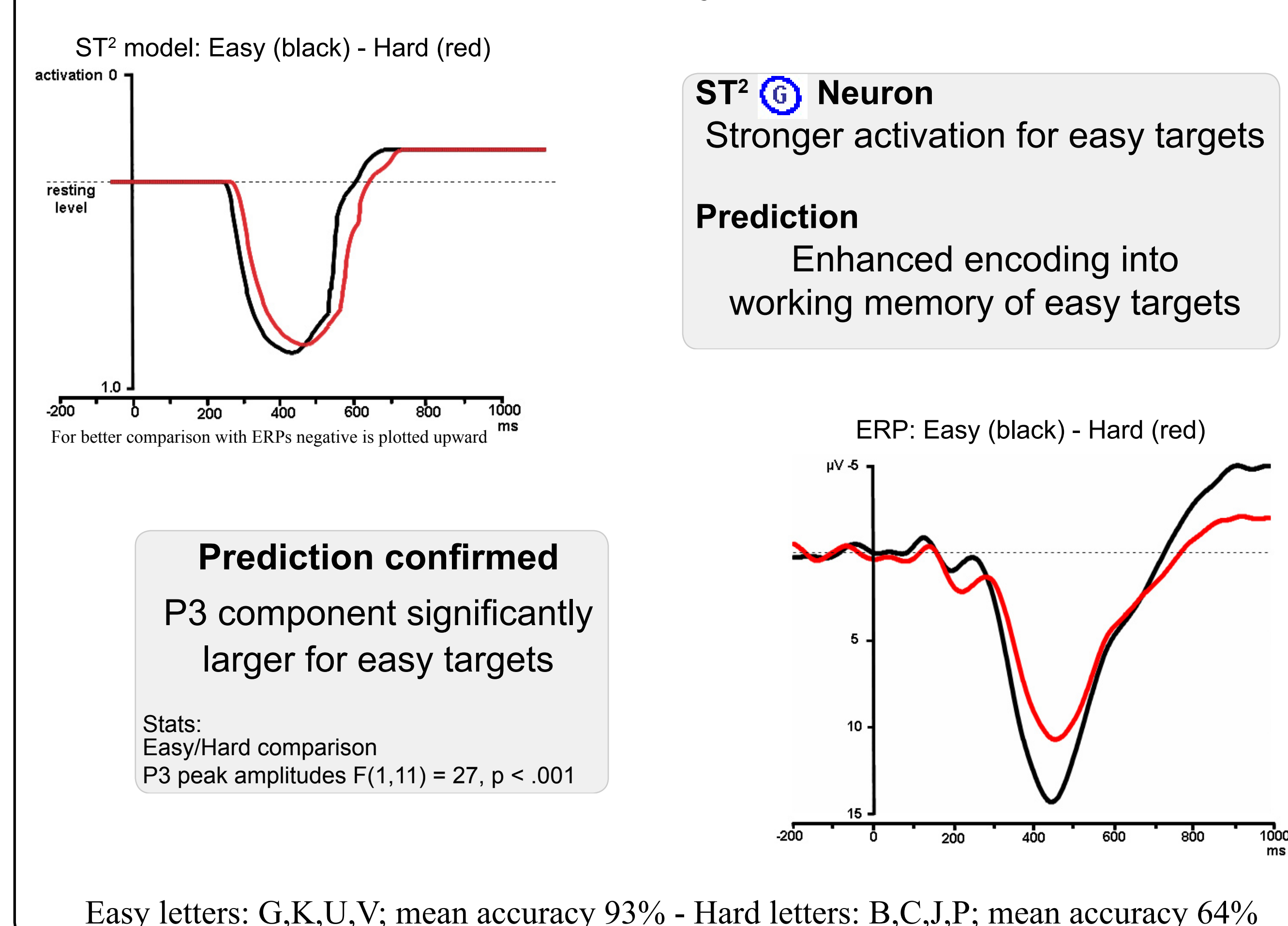
EEG

- Quickamp amplifier (22-bit digital-to-analog converter; BrainProducts, Munich, Germany)
- 2000Hz sampling rate, digitally filtered 0.5Hz (low-pass) to 85Hz (high-pass) at recording
- Electrodes: Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T7, T8, P7, P8, Fz, Cz, Pz, Oz; EOG (above/below right eye)
- Referenced to common average online and re-referenced to linked earlobes offline. Left mastoid acted as ground.
- Eye movement artefacts were removed by rejecting data in the window of 200ms before and after an eye blink.
- Data was inspected for sudden high/consistently low activity. Epochs from 500ms prior to 500ms after an artefact were marked as bad & removed from further analysis.
- Channel data was grouped into five regions of interest: Frontal, Central, Temporal, Parietal & Occipital.
- EEG data analysed using BrainProducts Analyzer software and the Matlab EEGLAB toolbox (Delorme & Makeig, 2004)
- ERP: negative plotted upward; 8Hz low-pass filter to enhance visualisation. Stacked plot: Smoothed by a factor of 5.
- Easy/Hard and Masking ERP effects were statistically tested using ANOVA on component peak amplitude. Due to increase variance, the RSVP/Skeletal comparison used ANOVA on area measures to test component latency (Luck & Hillyard, 1990).

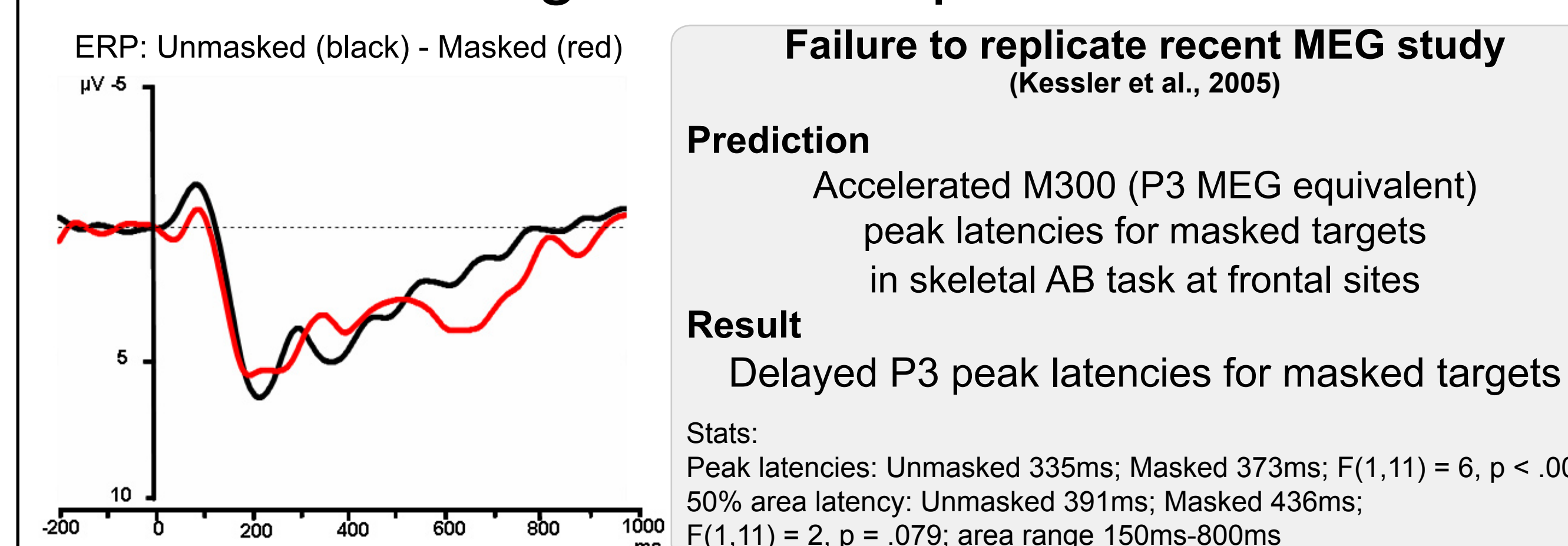
Masking in RSVP



Task difficulty in RSVP



Masking in skeletal presentation



Skeletal is not a perfect substitute

Occipital - Sensory components (P1/N1)

RSVP
Minimal P1/N1
Visual percept is continuous

Skeletal
Clear P1/N1
Targets are marked by visual onset

Stats:
RSVP/Skeletal comparison
P1/N1 mean value $F(1,11) = 13, p < .01$
Mean value determined by taking baseline corrected absolute values of area underneath the ERP curve in the range of 60-200ms

ERP: RSVP (black) - Skeletal (red)

Parietal - P3 component

RSVP
Task filter determines targets

Skeletal
Targets marked by visual onset

Stats:
RSVP/Skeletal comparison
Onset (1/3 of max. amplitude) $F(1,11) = 13, p < .01$
50% area latency $F(1,11) = 6, p < .05$; area range 0ms-800ms

Accelerated P3 onset & latency for skeletal targets

EEG stacked plot

RSVP
Homogeneous

Skeletal
More variance

Skeletal presentation (e.g. Ward et al., 1997) - the best of both worlds?
 RSVP effects without interference from surrounding distractors?
 EEG analysis reveals there is a cost:
Considerable differences in how targets are processed

References

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