

Supplement A. Additional analyses including the double target condition

In the current study, participants completed a double target condition as well as a single target condition (see Figure A.1 for a display of the sequences in different conditions). Although the double target condition was not the focus of the main paper, this section summarizes findings for analyses in which the double target condition was included.

For this purpose, in the behavioural analysis, a 2x2x2 within-subject design was used to investigate the effects of competition condition (competition or non-competition), screen side looked at (left or right) and the number of peripheral targets (one or two) on saccade latency. For the neural analysis, the effects of competition condition (competition or non-competition), number of peripheral targets (one or two), brain hemisphere (ipsi- or contralateral brain hemisphere to the eye movement) and brain side (left or right side of the brain) on ERP amplitude and latency were determined.

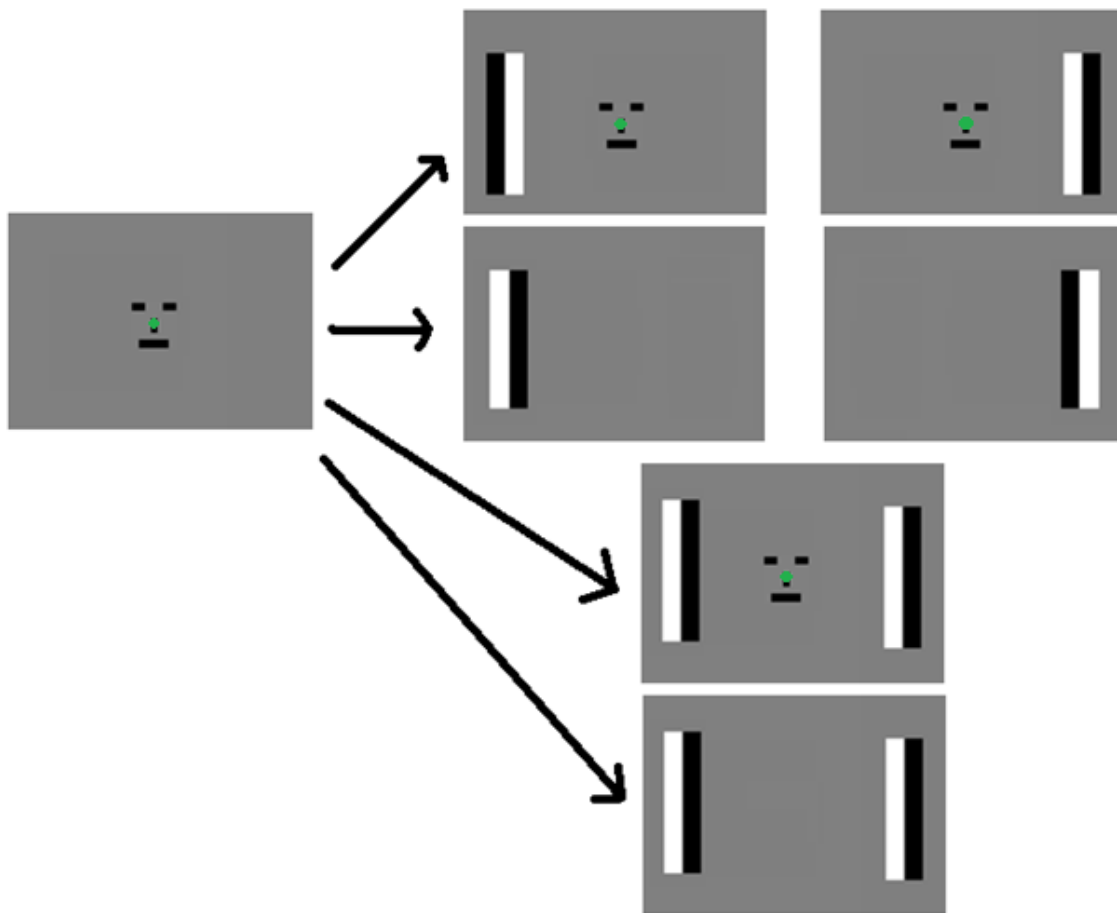


Figure A.1. Target displays in single target (top) and double target (bottom) conditions and competition (central face visible) and non-competition (central face disappears) conditions.

Behavioural results

Saccade latencies ($M = 0.309$ sec, $SD = 0.161$) were analysed using a mixed linear model including participants as a random effect and screen side, condition and number of stimuli as

fixed factors. It showed significant main effects of condition, $F(1, 63) = 32.14, p < .001, d \sim 1.42$, and number of targets, $F(1, 63) = 20.36, p < .001, d \sim 1.13$. Latencies were shorter in the non-competition condition ($M = 0.293$ sec, $SD = 0.171$) than in the competition condition ($M = 0.325$ sec, $SD = 0.151$) and shorter for single targets ($M = 0.302$ sec, $SD = 0.141$) than for double targets ($M = 0.324$ sec, $SD = 0.196$, Figure A.2).

EEG Results

Additional analyses were conducted based on the analyses in the main paper but adding data from the double target condition and considering number of targets as a separate factor.

Linear mixed models including participants as a random intercept were calculated to predict amplitudes and latencies from condition, number of targets, brain hemisphere (ipsi- or contralateral) and brain side (left or right). In the following, amplitudes are displayed in μV , latencies are reported in ms.

Occipital positivity

The posterior positivity peaked on average around 130 ms ($SD = 23.7$) and had an average amplitude of $0.85 \mu V$ ($SD = 3.49 \mu V$). There was a marginal effect of condition, $F(1, 179) = 5.44, p = .021$, on peak amplitude, which did not withstand Bonferroni-Holm correction.

Peak latency showed a significant main effect of condition, $F(1, 303) = 23.37, p < .001, d \sim 0.56$, with shorter latencies in the non-competition ($M = 125, SD = 20.5$) than in the competition condition ($M = 134, SD = 25.7$), and a significant effect of number of targets, $F(1, 303) = 20.13, p < .001, d \sim 0.52$, with longer latencies for single targets ($M = 135, SD = 22.9$) than for double targets ($M = 125, SD = 23.7$, Figure A.2). There was a significant interaction effect of condition and number of targets, $F(1, 303) = 8.73, p = .003, d \sim 0.34$. Separate analyses for only the double target conditions showed no significant effect of condition for double targets, $F(1, 143) = 2.00, p = .159, d \sim 0.24$.

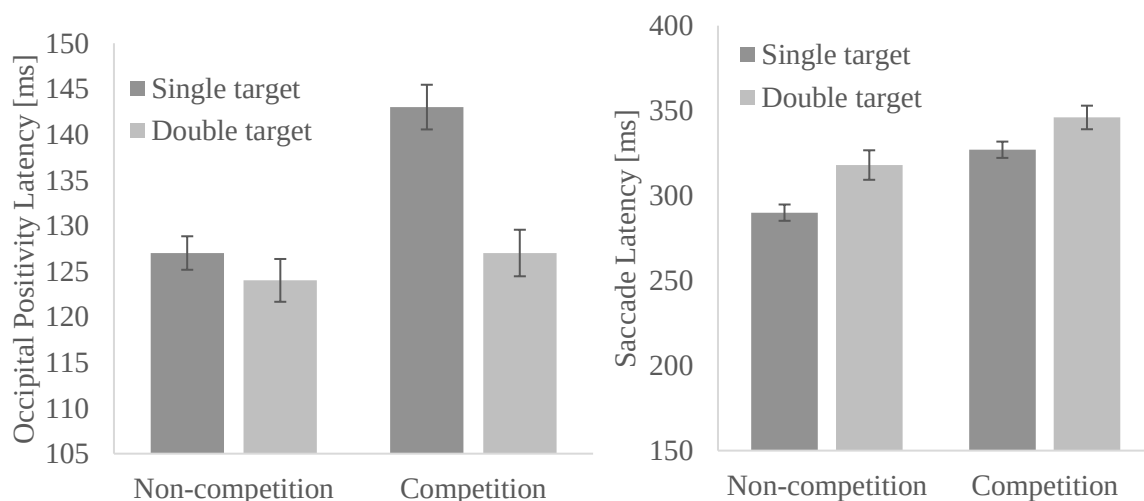


Figure A.2. Plots of the mean latency of the occipital positivity (left) and the saccades (right). Error bars depict the standard error.

Frontal response

Frontal responses were extracted in two lateral fronto-central electrode clusters between 100 and 180 msec after stimulus onset, based on previous research (Kulke, Atkinson, & Braddick, 2016). The frontal negativity peaked at 131 ms ($SD = 24.5$) and had an average amplitude of $-1.69 \mu V$ ($SD = 7.40 \mu V$). No effects on peak amplitude were significant.

Peak latency showed significant effects of condition, $F(1, 306) = 17.52, p < .001, d \sim 0.48$, with shorter latencies in the non-competition ($M = 127, SD = 26.0$) than in the competition condition ($M = 136, SD = 26.3$), number of targets, $F(1, 306) = 14.87, p < .001, d \sim 0.44$, with longer latencies for single ($M = 136, SD = 25.3$), than for double targets ($M = 128, SD = 27.1$), and hemisphere, $F(1, 306) = 15.47, p < .001, d \sim 0.45$, with shorter latencies in the ipsilateral ($M = 128, SD = 24.5$), than in the contralateral hemisphere ($M = 136, SD = 27.8$).

Separate analyses for single and double targets confirmed a significant effect of condition on peak latency for single targets, $F(1, 150) = 24.68, p < .001, d \sim 0.81$, with shorter latencies in the non-competition ($M = 129, SD = 25.0$) than in the competition condition ($M = 143, SD = 24.1$), but not for double targets, $F(1, 146) = 1.74, p = .189$. The effect of hemisphere on peak latency was confirmed for single, $F(1, 150) = 14.07, p < .001, d = 0.61$, and marginally for double targets, $F(1, 146) = 4.33, p = .039, d \sim 0.34$ (note that this effect would not withstand Bonferroni-Holm correction), showing earlier peaks in the ipsilateral (single: $M = 130, SD = 24.0$, double: $M = 124, SD = 24.7$) than in the contralateral hemisphere (single: $M = 141, SD = 25.6$, double: $M = 131, SD = 29.0$).

Discussion

The findings show that saccadic and neural responses are faster in the non-competition than in the competition condition if only one target appears. However, the differences are no longer significant when two peripheral targets are visible. In this double-target condition, an additional cognitive task is required. Participants need to decide which side to look at before making an eye-movement, as targets are visible on both sides. In contrast, in the single-target condition there is only one target to look at and the task is purely guided by bottom-up features of the target attracting overt attention. The additional time required to make a decision may lead to the longer saccade latencies observed in the double target condition. The diverging findings suggest that the task plays a role in determining the timing of neural responses during overt attention shifts. In particular, top-down task demands may interact with bottom-up attention mechanisms. Interestingly, neural response latencies showed a different pattern to saccadic latencies: Occipital responses were faster towards double targets than towards single targets. During double target conditions, the visual stimulation is stronger, as two rather than one stimulus appear. Neural responses are strongly affected by visual stimulation, with shorter ERP latencies related to stronger stimulation due to higher stimulus intensity, for example for the P1 (Osaka & Yamamoto, 1978) and N2pc (Brisson, Robitaille, & Jolicœur, 2007). The stronger visual stimulation in the double target condition may therefore result in faster occipital

responses. Taken together, two additional mechanisms seem to be in place in the double target condition: firstly, the additional visual stimulation accelerates neural responses in occipital areas; secondly, the additional processing required to choose a target to look at increases saccade latencies. Consequently, saccade latencies only seem to reflect neural response latencies under specific conditions of visual content and task requirements.

- Brisson, B., Robitaille, N., & Jolicœur, P. (2007). Stimulus intensity affects the latency but not the amplitude of the N2pc. *Neuroreport*, 18(15), 1627-1630.
- Kulke, L., Atkinson, J., & Braddick, O. (2016). Neural differences between covert and overt attention studied using EEG with simultaneous remote eye tracking. *Frontiers in Human Neuroscience*, 10.
- Osaka, N., & Yamamoto, M. (1978). VEP latency and RT as power functions of luminance in the peripheral visual field. *Electroencephalography and clinical neurophysiology*, 44(6), 785-788.