Supplement B. Experiment 2

To investigate the role of the visual offset of the central stimulus on the identified neural differences between conditions, an exploratory Experiment 2 was conducted. Participants were presented both with the non-competition condition and a novel condition in which the face disappeared while no peripheral bars appeared (offset condition). If the offset itself creates an ERP, this response should be visible in the offset condition. As temporally coinciding ERP components sum together to form the response that can be measured on the scalp (reviews e.g. Luck, 2005; Regan, 1989), subtracting the offset response from the non-competition condition can provide insights to the magnitude of the effect of the offset response on the overall response. If the offset significantly affects overall brain responses, it may contribute to the latency difference between the competition and non-competition condition observed in Experiment 1.

Method

Participants

Fourteen additional students from the UCL Psychology subject pool (M_{age} = 20.1 years, *SD* = 2.76, range = 18 to 27, 3 male, 13 right-handed) volunteered to participate in the study in exchange for course credit. They all had normal or corrected to normal vision and no known history of brain disease. The study was approved by the UCL ethics committee (Ref. number: CPB/2014/007), all methods were performed in accordance with the guidelines and regulations and all subjects gave written informed consent in accordance with the Declaration of Helsinki.

Materials and Stimuli

Identical stimuli as in the previous task were used, with the central face and dot appearing for a random inter-trial interval between 0.5 and 2.5 seconds (Figure B.1). When the subject fixated on the dot after the random inter-trial interval, the face and dot either disappeared and one peripheral target appeared until fixated (non-competition condition) or the face and dot disappeared for 0.7sec, without any target appearing until the next trial started (offset condition).

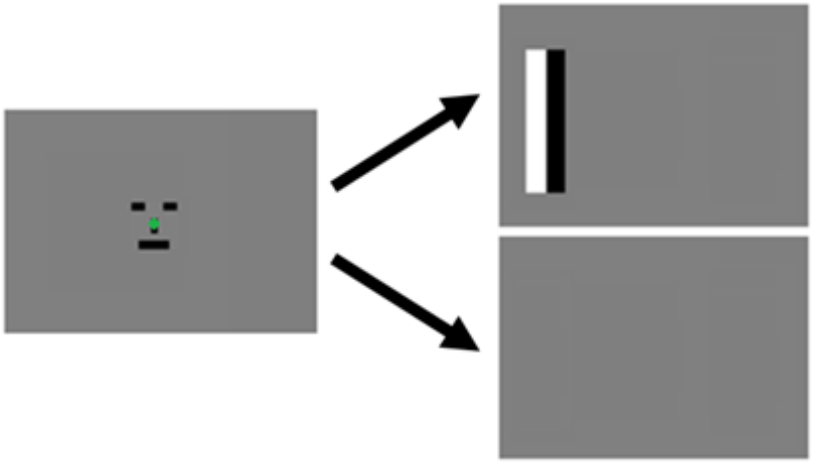

Figure B.1. Stimuli used for Experiment 2. Target displays in non-competition condition (central face disappears when bars appear) and offset condition (central face disappears).

Procedure

The participant was seated on a chair facing the screen. Participants were asked to focus on a central green dot and either look at the bars that randomly appeared on either side of the screen or keep fixating on the centre if the face disappeared while no bars appeared. When the central face and dot reappeared, the subjects were asked to shift their focus back to the green dot. Short breaks were given between each set of 100 trials, with a longer break occurring after 200 trials. The entire experiment was composed of 400 trials (200 for the offset condition, 100 for left targets and 100 for right targets, presented in a random order) and lasted for approximately 20 minutes.

Design

ERP amplitudes and latencies were compared in different steps to investigate the effect of the offset. The offset response was subtracted from the response in the non-competition condition for the subject groups recruited for the current experiment. A 2x2x2 mixed design investigated the effect of condition (non-competition minus offset or competition), brain hemisphere (ipsilateral or contralateral to the eye movement) and brain side (left or right) on the dependent variables ERP amplitude and latency.

Results

Data processing

On average, 12.7% (*SD* = 1.64%) of trials were interpolated across all subjects based on their individual MAD noise thresholds, with all subjects having less than 17.3% interpolated trials. The individual noise threshold for ERP samples was 17.4 µV (*SD* = 7.15 µV), and the

amplitude range threshold between minimum and maximum within epochs was on average 64.5 µV (*SD* = 23.16 µV). The average number of trials subjects successfully completed behaviourally was 389 (*SD* = 26.38). After exclusion of noisy EEG data, 353 (*SD* = 31.3) trials remained in the analysis.

In order to investigate the possibility that the differences in peak latencies and amplitudes may be due to an overlap of the offset response to the central target with the response to the onset of the peripheral stimulus, the data of the offset response was subtracted from the raw non-competition condition data. Peak latencies and amplitudes for the difference wave were calculated for the same time windows and electrode clusters used in Experiment 1. The following analyses were subsequently performed. (1.) A linear mixed model including participants as random effects was used to determine differences between the raw non-competition wave and the difference wave (2.) Non-competition condition data from group 1 was compared with the raw non-competition condition data from group 2 to test for significant differences between the two sample groups. If groups had not differed, additional comparisons with the competition conditions of experiment 1 would have been possible. However, group differences were detected and therefore this direct comparison cannot be made.

Eye-tracking results

Participants shifted their gaze in the non-competition condition after a mean of 305.1 ms (*SD* = 33.54). Although the latency was longer in the current experiment than in the non-competition condition of the previous experiment (*M* = 290.2 ms, *SD* = 47.08), the difference was not significant, $t(35) = 1.04$, $p = .308$.

EEG results

As in Experiment 1, there was a contralateral positivity coinciding with a frontal negativity (see topographical plots in Figure B.2). The similarity to the topographical response pattern in Experiment 1 suggests that responses of subject groups in both studies are comparable. Wave plots of the occipital response are displayed in Figure B.3. In the following amplitudes will be reported in µV and latencies in ms.

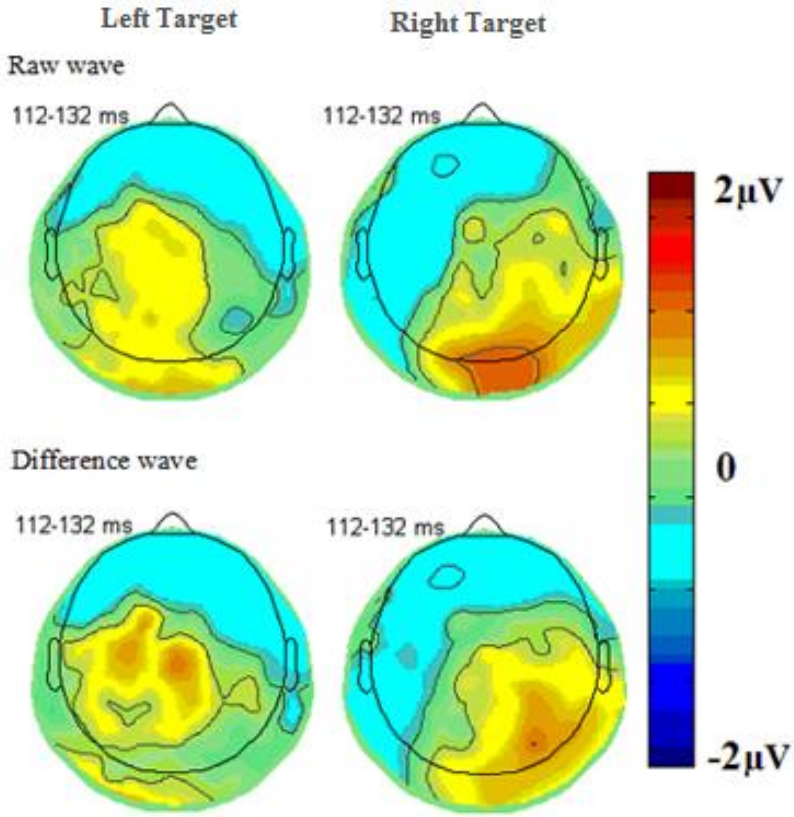

Figure B.2. Topographical plots suggest that posterior positive responses appear to targets on the left (left) and right (right) side, both for the raw data in the non-competition condition (top) and the difference wave between non-competition condition and offset response (bottom). Scale: -2μV (blue) to 2μV (red).

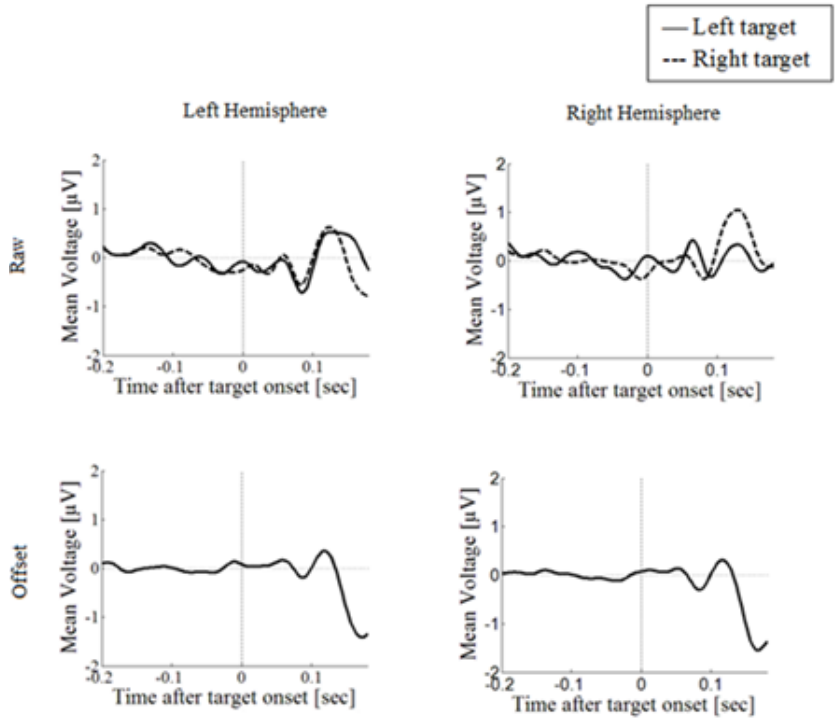

Figure B.3. Wave plots display the raw data in the non-competition condition (top) and the response in the offset condition (bottom) in occipital areas in the left (left) and right (right) brain hemisphere.

Posterior positivity

As in the previous experiment, responses were extracted in two electrode clusters around the occipital electrode locations O1 and O2 between 100-180 ms. The amplitude of the posterior positivity significantly differed between the raw and the difference wave, $F(1, 64) = 7.97$, $p = .006$, $d \sim 0.70$, with smaller amplitudes in the raw wave ($M = 1.68$, $SD = 1.60$) than in the difference wave ($M = 2.55$, $SD = 2.63$). Latencies also significantly differed between the raw and the difference wave, $F(1, 22) = 46.41$, $p < .001$, $d \sim 2.84$, with shorter latencies in the raw wave ($M = 141$, $SD = 26.2$) than in the difference wave ($M = 151$, $SD = 26.7$).

There were no significant differences between group 1 and 2 in peak amplitude, $F(1, 36) = 0.33$, $p = .569$ (group 1: $M = 1.32$, $SD = 2.91$, group 2: $M = 1.68$, $SD = 1.60$). However, groups differed in peak latency, $F(1, 36) = 8.61$, $p = .006$, $d \sim 0.652$, with significantly shorter latencies in the first group ($M = 127$, $SD = 18.2$), than in the second group ($M = 141$, $SD = 26.2$), suggesting that no further comparisons should be made between groups. Note that the difference in waveform latencies between the groups is similar, and in the same direction, as the difference in saccadic latencies, maintaining the association between these that is discussed in the main experiment.

Frontal responses

As in the previous experiment, frontal responses were extracted in two lateral fronto-central electrode clusters. Frontal areas showed a negative response between 100 and 180 ms that was comparable to the response observed in the previous experiment. For the frontal negativity there were no amplitude differences between the raw wave ($M = -0.93$, $SD = 3.14$) and the difference wave ($M = -0.99$, $SD = 3.87$), $F(1, 38) = 1.89$, $p = .178$, $d \sim 0.44$, but a significant difference in peak latency, $F(1, 64) = 6.15$, $p = .016$, $d \sim 0.62$, with significantly shorter latencies in the raw wave ($M = 141$, $SD = 30.0$) than in the difference wave ($M = 152$, $SD = 29.0$).

There were no significant differences between group 1 and 2 in peak amplitude, $F(1, 150) = 0.001$, $p = .972$ (group 1: $M = -0.96$, $SD = 6.50$, group 2: $M = -0.93$, $SD = 3.41$), or peak latency, $F(1, 36) = 3.79$, $p = .059$ (group 1: $M = 129$, $SD = 24.9$, group 2: $M = 140$, $SD = 30.4$).

Discussion: Experiment 2

The aim of Experiment 2 was to identify whether differences between non-competition and competition conditions are the result of a visual response to the offset of the centrally fixated target. For this purpose, the offset response was subtracted from the wave in non-competition conditions. Raw and difference waves differed significantly for both the posterior positivity and the frontal negativity. Longer latencies in the current than the previous experiment were observed both for saccades and for neural responses. This suggests that latencies of saccades and neural responses are related.

The *posterior positivity* had significantly greater *amplitudes* and longer latencies when the offset response was subtracted from the raw wave, suggesting that the response is significantly affected by an overlap with an additional response to the offset of the central stimulus.

The *latencies* were shorter in the raw wave, than when the offset response was subtracted from the raw wave. This suggests that the visual offset response may partially account for the latency difference between conditions (non-competition versus competition) in Experiment 1. Previous MRI research in human adults has shown that activity in the visual cortex increases when attention is directed towards an area, even without visual stimuli being present (Kastner, Pinsk, De Weerd, Desimone, & Ungerleider, 1999). These attentional processes may also affect response latencies.

The amplitude of the *frontal negativity* was not affected by the offset response; however, peak latencies were significantly shorter for the raw wave than for the difference wave, suggesting that the offset induced an earlier peak. The frontal negativity therefore seems at least partially related to the offset of a target.

No test of the competition condition was included for the group of participants who were tested with the offset condition, and these participants showed different latency on the non-competition condition from the group in Experiment 1. Thus, we cannot say how much of the difference between competition and non-competition EEG latencies can be attributed to the offset response that is present in the non-competition condition only. However the effect of subtracting the offset response from the non-competition response is to increase the peak occipital latency, and so reduce its difference from non-competition.

It should be noted that calculating differences between random variables may increase noise in the variable, so that the difference wave may be noisier than the non-competition wave. The results of this comparison should therefore be treated with caution.