ERPs to transitions from rivalrous to non-rivalrous binocular stimulation

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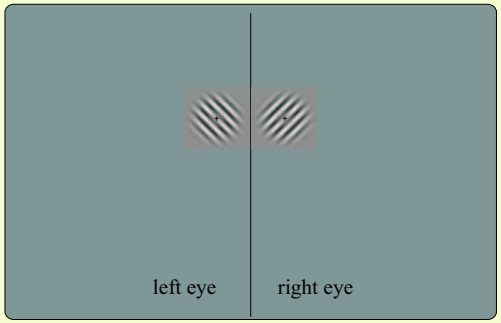
Introduction

The phenomenon of binocular rivalry evolves, when the two eyes of an observer are presented with different images: the percept alternates from one image to the other every few seconds (see Demonstration). Using the perceptual ambiguity during binocular rivalry, it is possible to create situations, in which the stimulation changes without changes in the percept (Kaernbach et al., 1999).
For this, transitions from rivalrous to non-rivalrous stimulation are introduced. Such transitions require the stimulus of one eye to be changed. Depending on the prevailing percept, these changes do not entail a change in perception (compatible change) or do entail a change in perception (incompatible change).

Demonstration



Instruction

To experience the phenomenon of binocular rivalry put your face close to the gray area above, such that:

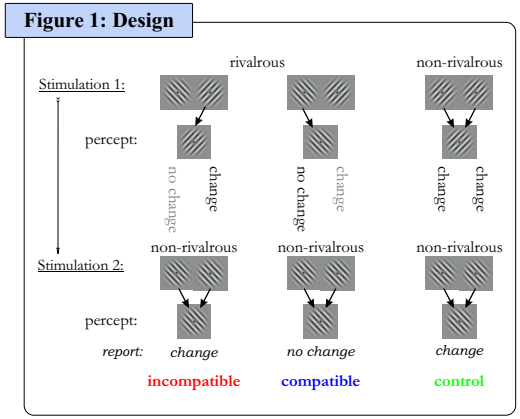
- your forehead, nose and chin roughly fit into the precut profile,
- your left eye views the left sine-wave grating and
- your right eye views the right sine-wave grating.

Stare at the fixation crosses within both gratings. Try to accomodate and relax your eyes so that both fixation crosses overlap. After a little while with normal viewing, you should perceive only one grating at a time which switches back and forth with the other one.

If you don't succeed try to get a little closer or further away from the stimuli.

Our study is aimed at investigating whether the early components of the human event-related brain potential (ERP) of physically identical transitions differ depending on the prevailing percept.

Figure 1: Design



Method

14 students participated in the study. During 21 blockss of ca. 4 minutes each, the observer viewed orthogonal gratings slanted to the left or right which were dichoptically presented using a stereoscope. Periods of rivalrous stimulation were followed either by maximal one other period of rivalrous stimulation or one or two periods of non-rivalrous stimulation.
The subjects' task was to report the current percept by pressing one of two keys.
ERPs to transitions from rivalrous to non-rivalrous stimulation were recorded on 64 electrode sites referenced to the right ear.
The events were classified into two different classes depending on the currently reported percept. The transition could either be incompatible with the report and hence the non-rivalrous stimulus elicited a different percept, or be compatible with the report and hence the non-rivalrous stimulus did not lead to a perceptual change. Transitions from non-rivalrous to non-rivalrous stimulation served as control condition (Figure 1).

Results

During rivalrous stimulation the distribution of the dominance phase durations followed the shape of a Gamma function.
As indicated in Figure 2, the earliest differences in the ERPs were found in the P1 range, i.e. 90-120 ms after a stimulus change. At occipital sites, the mean amplitude of the control condition was significantly larger than the mean amplitude elicited by incompatible changes ($F(1,13)=22.77^{**}$), and the mean amplitude of the incompatible changes was larger than the one of the compatible changes ($F(1,13)=6.06^{*}$). At parieto-occipital sites, the mean amplitude of the control condition was also significant larger than that elicited by incompatible changes ($F(1,13)=14.86^{**}$), but the mean amplitudes elicited by incompatible and compatible changes did not differ statistically ($F(1,13)=0.26$).

Figure 2: ERPs

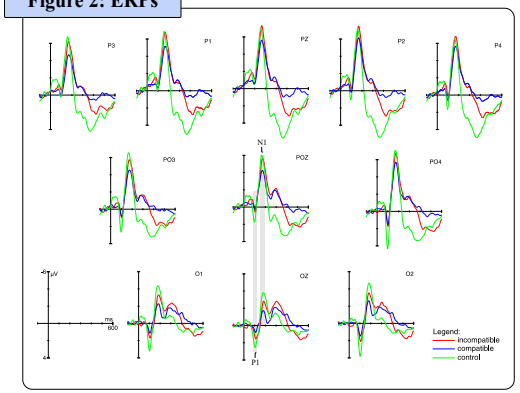
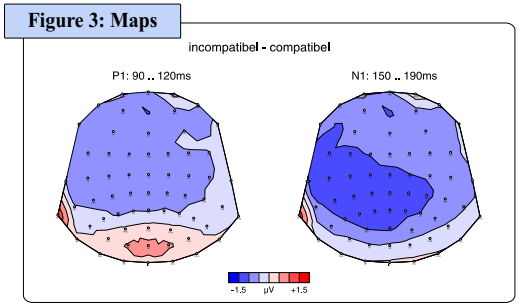


Figure 3: Maps



The following N1 (150-190 ms after a stimulus change) showed differing patterns from occipital to parietal sites. At occipital sites, the mean amplitude of the control condition was significant larger than that elicited by incompatible changes ($F(1,13)=14.01^{**}$), whereas the mean amplitudes elicited by incompatible and compatible changes did not differ statistically ($F(1,13)=2.68$). At parieto-occipital sites, incompatible changes elicited a larger mean amplitude than compatible changes ($F(1,13)=5.23^{*}$), whereas the mean amplitude of the control condition and incompatible changes did not differ ($F(1,13)=1.44$).
As to be expected, P3b was elicited by physical transitions causing a perceptual change (control, incompatible) but not when the physical change did not result in a perceptual change (compatible).

Discussion

The Gamma-distribution of the dominance phase durations can be taken as an assurance that we replicated the classical binocular rivalry phenomenon. The perceptual dominance reported by the observers showed the distributions that is typical for phenomenons of perceptual ambiguity.

The ERPs to transitions from rivalrous to non-rivalrous stimulation differ markedly depending on the perceptual state of the observer in binocular rivalry at the moment of the change. These differences start already in the P1 range and change their pattern slightly in the N1 range. The P1 as well as the N1 elicited by physically identical changes depend on whether the stimulus is compatible or incompatible with the prevailing percept. The percept dependency of P1 is largest at occipital sites whereas that of N1 at posterior sites (Figure 3). This topographical pattern suggests that the percept-depending modulations are confined to sub-components of P1 and N1.

The results demonstrate that these so-called exogenous ERP components go also with the percept and not only with the objective physical stimulation. Moreover, as P1 is assumed to be generated in extrastriate areas, it may be concluded that in humans the phenomenon of binocular rivalry is at latest (partly) resolved there.

Reference Kaernbach, C., Schröger, E., Jacobsen, T., & Roeber, U. (1999). Effects of consciousness on human brain waves following binocular rivalry. NeuroReport, 10, 713-716.