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Research Report

Event related beta and gamma oscillatory responses during perception of affective pictures



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ABSTRACT

Several studies reveal that unpleasant pictures elicit higher beta and gamma responses than pleasant and/or neutral pictures; however, the effect of stimulation design (block or random) has not been studied before. The aim of the study is to analyze the common and distinct parameters of affective picture perception in block and random designs by means of analysis of high frequency oscillatory dynamics (beta and gamma). EEG of 22 healthy subjects was recorded at 32 locations. The participants passively viewed 120 emotional pictures (10 × 4 unpleasant, 10 × 4 pleasant, 10 × 4 neutral) in block and random designs. The phase-locking and power of event related beta (14–28 Hz) and gamma (29–48 Hz) oscillations were analyzed for two different time windows (0–200 ms/200–400 ms). Statistical analysis showed that in the 0–200 ms time window, during the block design, unpleasant stimulation elicited higher beta phase-locking and beta power than the pleasant and neutral stimulation ($p < 0.05$). In the 200–400 ms time window, during the block design, over occipital electrodes unpleasant stimulation elicited higher gamma response power than the pleasant stimulation and neutral stimulation ($p < 0.05$). Unpleasant stimulation did not elicit higher beta or gamma responses in the random design. The present study showed that experimental design highly influences the perception of IAPS pictures. Unpleasant stimulation elicited higher event related beta and gamma phase-locking and power only in block design but not in random design. It seems that longer blocks of aversive pictures affect the brain more than the rapid observation of these pictures.

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1. Introduction

In the last decade, understanding human emotional processes by neuro-imaging methods has flooded the literature. Numerous studies have been conducted in the research of emotional processes by means of event related potentials. In these studies, short latency (100–200 ms), middle latency (200–300 ms), long latency (>300 ms) and slow wave potentials were analyzed

(Eimer and Holmes, 2007; Olofsson et al., 2008; Palermo and Rhodes, 2007). The ERP research on affective picture processing showed that valence is likely to influence relatively early (100–250 ms) components, while arousal influences late (200–1000 ms) components (Olofsson et al., 2008).

It is possible to analyze the amplitude and time differences between different groups of affective pictures by classical ERP research. However, besides the amplitude and

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time properties of the ERP signals, there are also frequency properties to consider. Numerous variants, such as evoked power responses, phase-locking between epochs in different frequency bands, coherence between different electrode sites in different frequency bands, time–frequency composition of the evoked/event-related/induced responses, cross-frequency couplings, and the relationship between prestimulus and poststimulus activities, have been introduced into oscillatory response methodology. Accordingly, the more comprehensive results on ERP dynamics of affective pictures can be achieved by brain oscillations methodology (Başar, 1980, 1998, 1999; Herrmann et al., 2004; Klimesch, 1999; Knyazev, 2007; Knyazev et al., 2008, 2009).

Perception of Face/Face expression and Affective picture processes were analyzed in different frequency and time windows by means of the event related/evoked oscillatory responses. The difference between negative and positive facial expressions was reported for beta and gamma oscillations. Keil et al. (1999) found that angry facial expressions elicited higher gamma oscillatory responses than happy and neutral facial expressions. In our previous study, we reported that angry facial expressions elicited higher beta oscillatory responses than happy facial expressions (Güntekin and Başar, 2007a). Not only for facial expression paradigms but also in for IAPS pictures, negative stimulation elicited higher beta (Güntekin and Başar, 2010b; Miskovic and Schmidt, 2010; Woodruff et al., 2011) and gamma (Garcia-Garcia et al., 2010; Keil et al., 2001, 2007; Martini et al., 2012; Müller et al., 1999; Oya et al., 2002) oscillatory responses than neutral or positive stimuli.

Almost all studies (Miskovic and Schmidt, 2010; Woodruff et al., 2011; Garcia-Garcia et al., 2010; Keil et al., 2001, 2007; Martini et al., 2012; Müller et al., 1999; Oya et al., 2002)

mentioned above presented IAPS pictures in randomized designs. In a recent study, increased beta responses on presentation of unpleasant pictures in comparison to pleasant and neutral pictures were reported by our group, but only when the IAPS pictures were presented in block design sequence (Güntekin and Başar, 2010b). There were no significant differences between picture groups when the pictures were presented in randomized sequence. According to this result, the following question was raised: what will differ between the pictures presented in random sequences or block design sequences? It seems that these two presentations elicit different processes. In the random design, the subject perceives and differentiates the unpleasant, pleasant and neutral pictures. On the other hand, showing pictures in a block design elicits another type of perception.

Garrett and Maddock (2001) showed that longer blocks of aversive pictures may require longer recovery times; on the other hand, single pictures may be followed by more rapid recovery. From a theoretical point of view, block and random presentations of emotional stimuli may result in different subject's states, i.e., sustained positive or negative emotional state vs. rapid perception of different emotional stimuli without switching to one or another state. This is important to understand, but this actually has never been appropriately studied. In many fMRI experiments the pictures were usually presented in block designs. To show the effect of experimental design on brain dynamics could also be beneficial for the fMRI research.

The present study analyzes event related beta and gamma oscillations on presentation of affective pictures in block and random design. We think that the presentations of unpleasant pictures consecutively will elicit higher beta and gamma

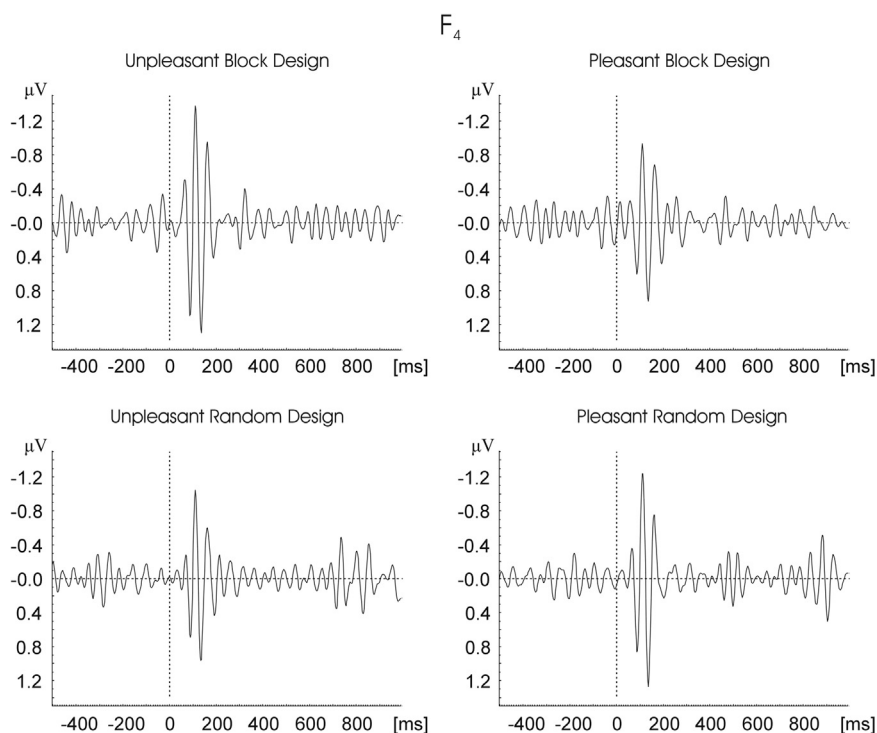


Fig. 1 – Grand average of filtered (14–28 Hz) beta oscillatory responses of 22 healthy subjects upon application of unpleasant and pleasant pictures during random and block designs.

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