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Implicit recognition of painting style: ERP studies on art perception

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INTRODUCTION

In art perception, style elements are usually recognized and described on the basis of explicit knowledge. Interestingly, deviancies among similar artistic stimuli can also be recognized implicitly (that is, without further explication or overt responses) [7,8].

Studies on oddball paradigms have successfully shown that rare deviants evoke changes in ERP, specifically P300 [3], even if no detection instructions are given [1,2,4,6]. That means electrophysiological changes indicate automatic deviancy detection while no overt responses occur.

So far, automatic recognition of deviant elements has been studied only for simple visual [2,6] and for more complex auditory material, i.e., musical cords [7]. This study investigates automatic recognition in complex visual stimuli, using stimuli derived from artistic paintings.

Hypotheses

Pictures that deviate within a series of artistic paintings evoke ERP changes even if the deviation is not explicitly recognized (marked by an overt response). Implicit recognition of deviating style elements, in means of P300 amplitudes values, occurs during picture series without a detection instruction (Exp. 1) as well as during picture series with a distracting detection instruction (Exp. 2).

EXPERIMENT 1

Rationale

In experiment 1, we investigated P300 amplitudes related to the implicit recognition of deviating style elements in artistic paintings *without providing any detection instructions.*

Methods

Subjects

23 students (2 male, 21 female; mean age=25.6, range=20-39)

Task and Stimuli

Subjects repeatedly viewed a series of 10 artistic paintings. For each picture, they were instructed to decide whether it was a standard picture (i.e., in some way similar to the majority of the paintings) or a deviant picture (i.e., in some way deviating from the majority of the paintings). Identified deviants had to be marked by button press. Subjects did not receive any instructions or hints concerning the features, elements, strategies, etc. upon which to base their decisions. Throughout the experiment, subjects were free to change their detection behavior (i.e., to press the button after pictures they did not choose before).

The artistic paintings consisted of 8 pictures by W. Kandinsky (prob. 0.8) and 2 paintings similar in style by J. Miro and W. Baumeister (prob. 0.2), with 270 overall stimulus presentations according to the defined probability ratio (Fig. 1).

Figure 1. Example stimuli including paintings by J. Miro and W. Baumeister (deviants) and by W. Kandinsky (standards)

Data analysis

EEG data were analyzed for the following three conditions: 1) *Kandinsky* (correct rejections), 2) *Identified Miro* (hits), and 3) *Non-identified Miro* (misses). For data analyses, only the picture by Miro served as a deviant, since the picture by Baumeister was rarely identified.

Statistical analyses were separately performed at channels P3 and P4 with a repeated measures ANOVA for stimulus type, followed by planned pair-wise comparisons between Kandinsky, identified Miro, and non-identified Miro paintings.

Since we were interested in the within-subject comparisons between hits and misses, only data from 10 subjects (with responses in both categories) were analyzed.

Results

Conditions varied significantly at both electrode sites P3 ($F=10.01$, $p=.001$) and P4 ($F=23.3$, $p<.001$) with the largest P300 amplitudes for the correctly identified Miro paintings and the non-identified Miro paintings (with statistically non-significant differences) and the smallest P300 amplitudes for the standard Kandinsky paintings (Fig. 2). As proposed, not only the measures for the identified Miro pictures (P3 $p=.002$, P4 $p<.001$) but also the ones for the non-identified Miro pictures (P3 $p=.028$, P4 $p<.001$) were significantly larger than the expectedly small values for the Kandinsky condition.

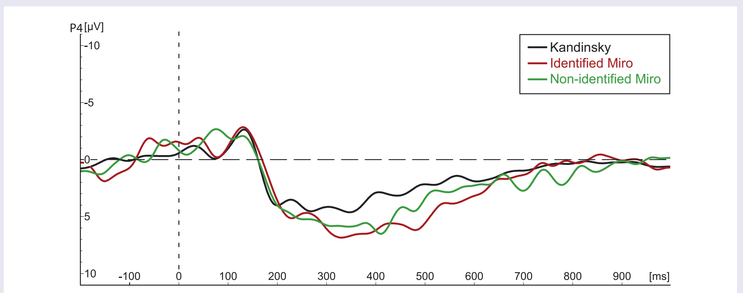

Figure 2. Grand-average ERP plots in response to standard Kandinsky (black), identified Miro (red), and non-identified Miro pictures (green), recorded at P4

EXPERIMENT 2

Rationale

In experiment 2, we measured P300 amplitudes that reflect the automatic recognition of deviating artistic paintings *while a detection instruction was given for a different class of deviating stimuli.*

Methods

Subjects

24 students (14 male, 10 female; mean age=24.2, range=20-30)

Task and Stimuli

Subjects solved a novelty-oddball task by mentally counting the designated target stimuli. Stimuli were constructed from paintings by P. Klee (Fig. 3). 22 abstract paintings composed of chess-like color patterns were chosen as standard stimuli (prob. 0.7). Eight abstract paintings served as target stimuli (task-relevant deviants) and differed from the standards in the way that the color patterns were composed of at least some or all slanted lines as opposed to all horizontal and vertical lines (prob. 0.15). Novel stimuli (task-irrelevant deviants) covered 40 non-repeating color paintings by P. Klee (prob. 0.15). The experiment consisted of 300 overall stimulus presentations in the defined probability ratio.

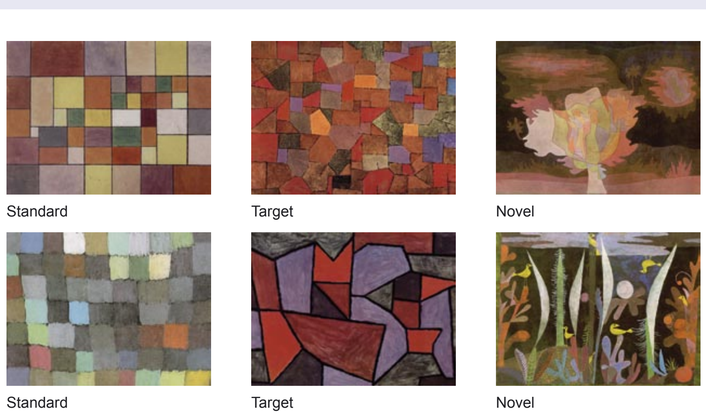

Figure 3. Example stimuli derived from paintings by P. Klee including standards, targets, and novels

Data analysis

EEG data were analyzed for the following three conditions: 1) *Standards*, 2) *Targets*, and 3) *Novels*.

Statistical analyses were separately calculated at channels P3 and P4 with a repeated measures ANOVA for stimulus type, followed by planned pair-wise comparisons between standard, target, and novel stimuli.

Results

Stimulus types varied significantly at both electrode sites P3 ($F=90.03$, $p<.001$) and P4 ($F=58.49$, $p<.001$). Targets evoked the largest P300 amplitudes, followed by responses to novels, followed in turn by responses to standards (Fig. 4). Although there was no detection instruction on novels, these deviating stimuli evoked significantly larger P300 amplitudes (P3 $p=.011$, P4 $p=.014$) than did standards, which is in line with our hypothesis.

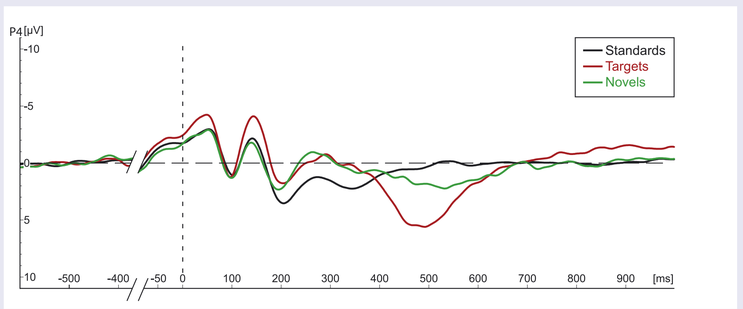

Figure 4. Grand-average ERP plots in response to standard (black), target (red), and novel stimuli (green), recorded at P4

DISCUSSION

As proposed, both non-identified deviants (Miro pictures in Experiment 1) as well as task-irrelevant deviants (Novels in Experiments 2) evoked changes in P300 amplitudes while no overt responses occurred. P300 amplitudes in response to Miro paintings and novels were significantly larger than responses to the standard stimuli in both experiments (Kandinsky and Standards). The effects for both deviant types are comparable since deviants were implicitly recognized within a pictures series without any given detection instructions. Moreover, Experiment 1 showed similar P300 responses for identified as for non-identified Miro pictures. That means deviancy recognition in means of P300 amplitude changes was independent of whether subjects responded to the stimuli or not.

Conclusion

We demonstrated that implicit recognition of deviating style elements in artistic paintings occurs during picture series without a detection instruction as well as during picture series with a distracting detection instruction. Thus, in our study we delivered support for the automatic recognition of deviant elements in the previously unexplored area of complex visual stimuli.

EEG recordings and analyses

EEG was recorded from 23 scalp electrodes (10-10 system), referenced against linked mastoids. Recorded data (Synamp Neuroscan amplifier, 500Hz sampling rate) were filtered (band-pass 1-20Hz, notch 50Hz) and subjected to the eye movement correction algorithm of Gratton and Coles (1983) [5], implemented in the Vision Analyzer software (Brain Vision).

For each condition, EEG averages were calculated at channels P3 and P4. P300 amplitudes were determined with a peak detection algorithm that searched for maximal amplitudes within the window of 300-600 msec after stimulus onset.

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