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## Abstract

Although reduced P3 amplitude has frequently been reported for clinically-depressed individuals, little is known how depression affects subcomponents of the late positive complex. ERPs (30-channel; nose reference) were recorded from 25 depressed, unmedicated outpatients and 23 healthy adults during a novelty oddball task (Fabiani & Friedman, 1995). Eight 50-trial blocks consisted of two 300-ms tones (350 Hz nontargets, p=.76; 500 Hz targets, p=.12) and novel sounds (e.g., dog bark, human cough: 100-400 ms, p=.12) presented in pseudorandom order at 1000 ms ISI. Participants responded as quickly as possible to target tones only. Response hand was counterbalanced across blocks. Both groups performed well (hits vs. false alarms: controls 99.5% vs. 1.5%, patients 98.5% vs. 2.6%), yielding comparable ERP components: N1, P2/N2 and early P3 (325 ms peak latency; 220-365 ms integrated time window amplitude) and late P3 (490 ms; 400-650 ms). Early P3 was most prominent for novel stimuli (novelty P3) and had a more frontal topography than late P3, which showed a parietal topography for targets consistent with classic P3b. Although both positive potentials were reduced in depressed patients, the reduction attained statistical significance only for early P3. Moreover, analysis of simple effects confirmed that the group reduction was present only for novel stimuli. Data are compatible with the hypothesis that clinical depression is associated with a reduced frontocentral response to novel stimuli, likely reflecting a deficit in orienting and alerting.

## Introduction

There have been conflicting findings as to whether or not depressed patients show reductions in the cognitive P3 event-related potential (Roth et al., 1986). One possible reason is that the reduction may occur in only a subcomponent of P3. The classical P3b subcomponent is often preceded by a subcomponent with a more frontocentral topography, referred to as P3a or novelty P3, which is thought to reflect attentional or orienting processes involving frontal cortex (Knight, 1984). Based on our findings in standard oddball paradigms (Bruder et al., 2002), we hypothesized that depressed patients in a 3-stimulus oddball task (frequent nontarget tones, infrequent target tones, and infrequent novel sounds) would show reduced amplitude of the novelty P3.

## Participants

	Healthy Adults (n = 23)	Depressed Patients (n = 25)
	no history of any psychopathology or neurology disorder	unmedicated outpatients meeting criteria for MDD or dysthymia
Gender (male/female)	9/14	15/10
Age (years)	29.35 ± 6.2	37.16 ± 10.7
Education (years)	16.61 ± 1.6	16.48 ± 2.2
Handedness (EHI)	77.87 ± 20.6	82.77 ± 19.0
Beck Depression Inventory (BDI)	1.39 ± 2.1	25.08 ± 8.5

## Novelty Oddball Task

- An auditory novelty oddball task (Friedman et al., 1993), was implemented on a Neuroscan STIM system. Each subject was presented with 8 blocks of 50 trials consisting of two 300 ms tones presented in pseudorandom order (ISI=1000 ms). One nontarget tone of 350 Hz was presented to the subject frequently (p=.76) while the other was an infrequent 500 Hz target tone (p=.12).
- Novel sounds (i.e. animal sounds, musical instruments, environmental sounds) possessing durations of 100-400 ms, were infrequently (p=.12) intermixed with the frequent tones and infrequent target tones.
- All stimuli were presented binaurally over headphones at 75 db SPL.
- Subjects were instructed to focus their eyes on a fixation cross displayed on a computer monitor and to respond with a button press as quickly as possible when, and only when, they hear the infrequent target tones.
- Response hand (right or left) was counterbalanced across blocks.

## ERP Recording and Data Analysis

- EEG Recording:** EEGs were recorded using Grass Neurodata amplifiers (5K; .01-30 Hz) from 4 midline (Fz, Cz, Pz, Oz) and 26 homologous scalp placements from both hemispheres (Fp1/2, F3/4, F7/8, FT9/10, FC5/6, C3/4, T7/8, TP9/10, CP5/6, P3/4, P7/8, P9/10, O1/2) using a nose reference and an electrode cap with an Fpz ground (impedances maintained at 5 kΩ or less). Bipolar recordings of horizontal and vertical eye movements (using four facial leads with impedances at or below 5 kΩ) were also recorded for blink correction using spatial SVD.
- Artifact rejection** was performed based on a reference-free approach suggested by Kayser and Tenke (See Poster Session 1 #30). Trials containing artifacts in more than eight channels were rejected. Artifact detection and electrode replacement was verified by visual inspection.
- Signal Processing** Artifact free data was averaged for correct targets, novels, and nontargets.
- P3 amplitudes** were quantified as mean amplitudes across early (220-365 ms) and late (400-650 ms) windows at 12 electrode sites (four medial pairs: F3/4, C3/4, P3/4, O1/2; four midline: Fz, Cz, Pz, Oz).
- Statistics:** Controls and patients were compared using a repeated measures analysis of variance (ANOVA) with three within-subject factors: Hemisphere (left, midline, right), Anterior-Posterior region (frontal, central, parietal, occipital, and Condition (target, non-target, and novel).

## ERP Topographies for Rare, Frequent, and Novel Stimuli Across Participants

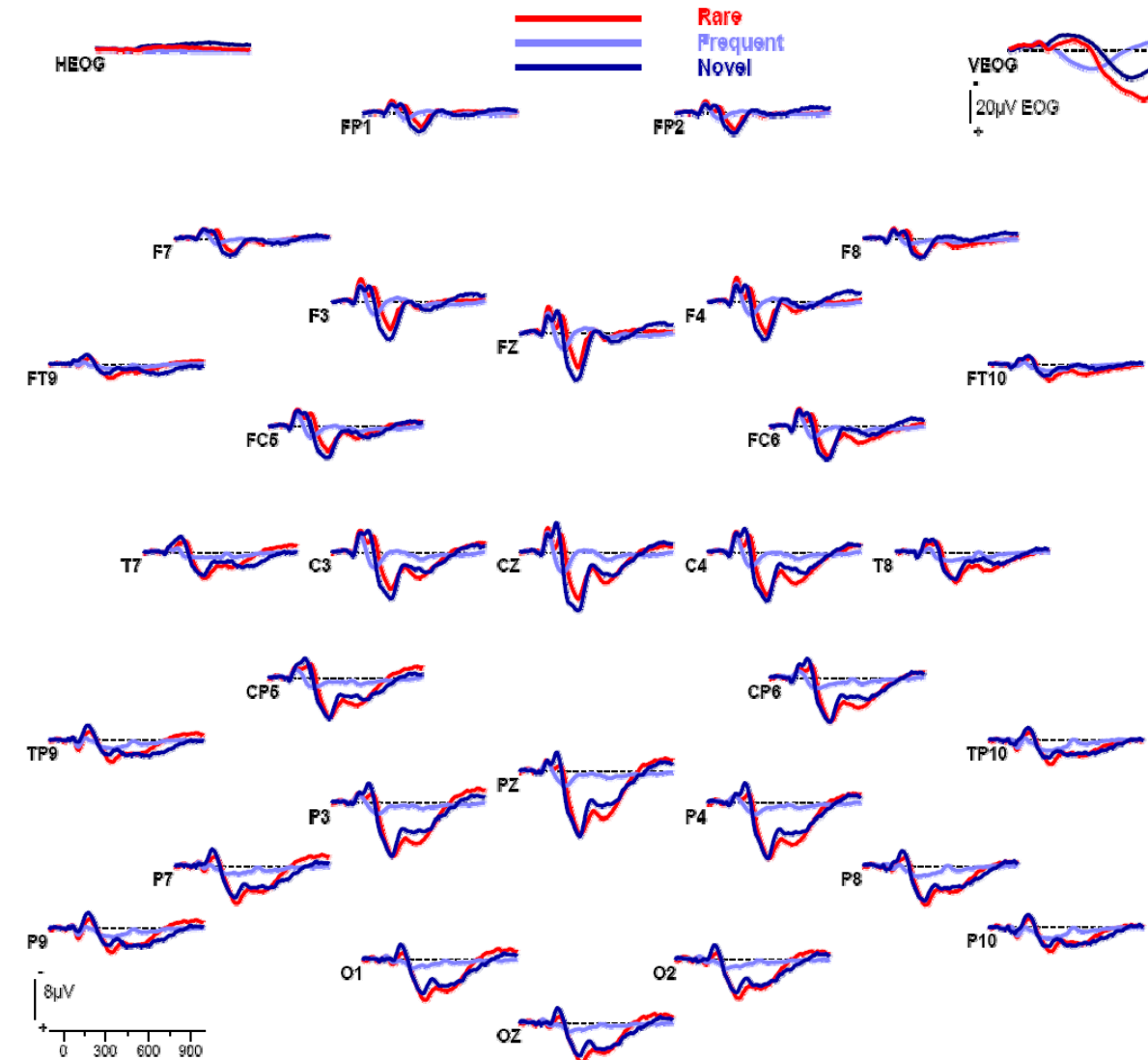


Figure 1. ERPs averaged across participants show a distinct component structure consisting of N1, P2/N2, early P3 (325 ms peak latency) and late P3 (490 ms peak latency). Early P3 was most prominent for novel stimuli (novelty P3) and had a more frontal topography than late P3, which showed a parietal topography for targets consistent with classic P3b.

## ERPs for Novel and Rare Stimuli In Healthy Adults and Depressed Patients

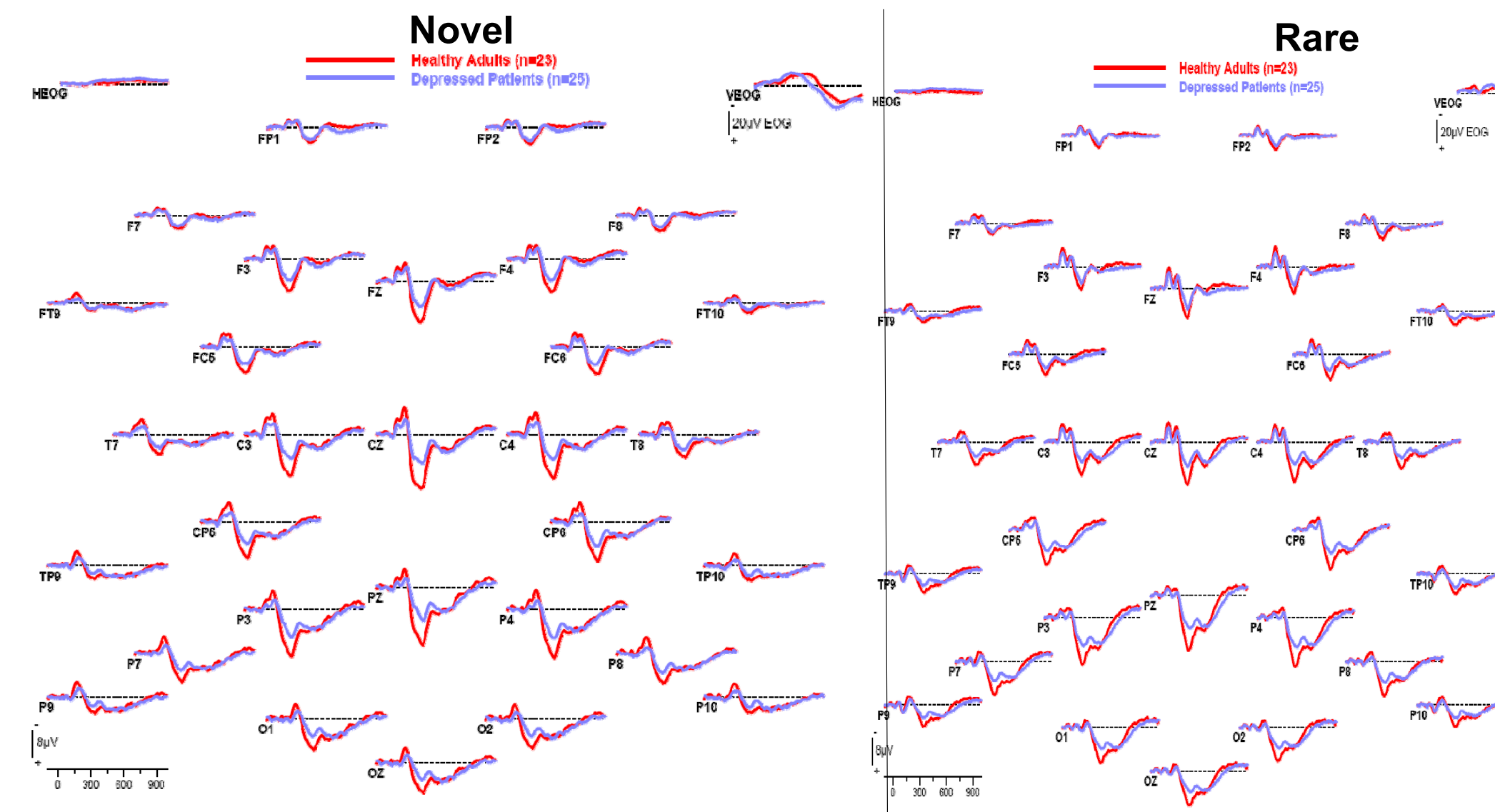


Figure 2. Grand mean ERP surface potentials illustrating a significant overall Group main effect  $F(2,88) = 3.83, p < .05, \eta^2 = 0.96$  for early P3 time window but not for late P3 time window.

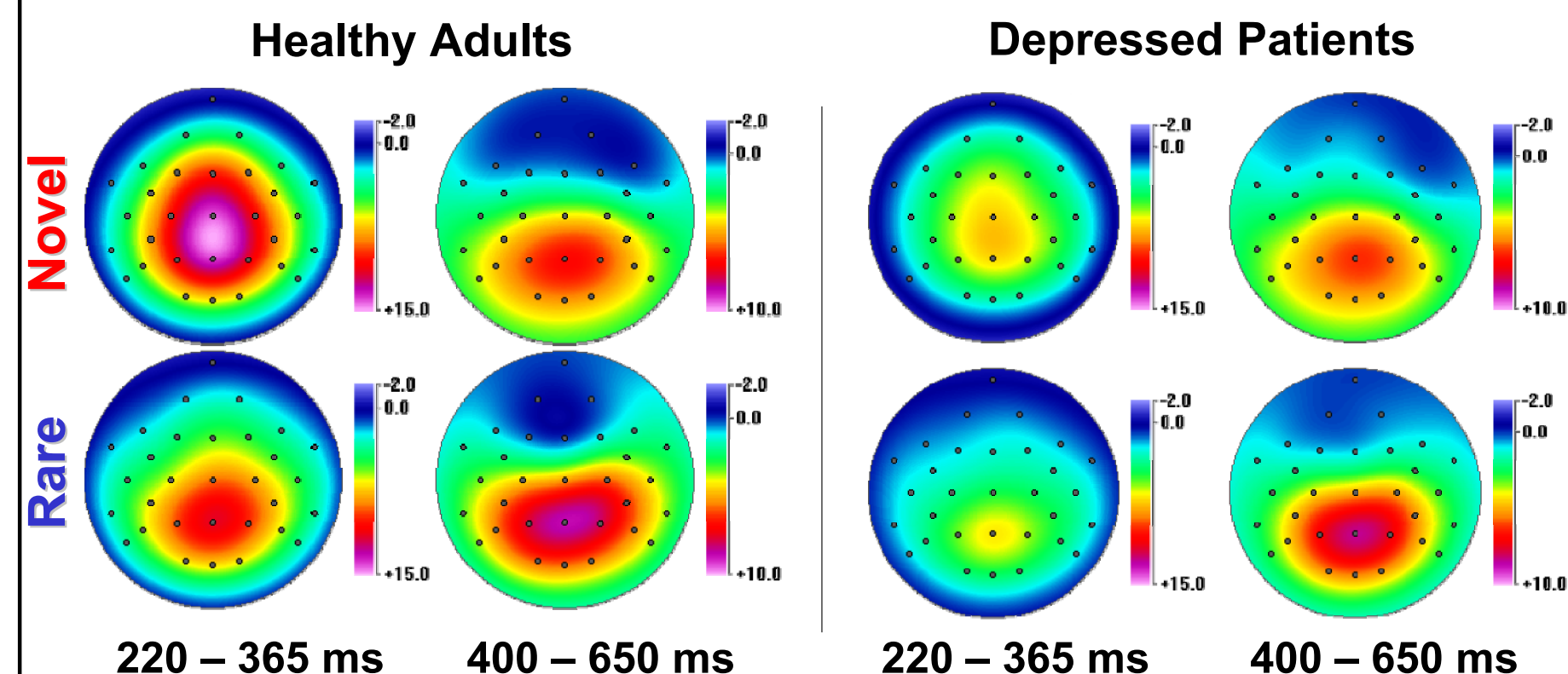


Figure 3. ERP surface potential topographies illustrate a reduced early P3 for both novel and target stimuli in depressed patients when compared to healthy adults as seen in the 220 - 365 ms time window above. In contrast, no group difference was seen in the late P3 window (400 - 650 ms).

## Results

- Both groups performed well (hits vs. false alarms: controls 99.5% vs. 1.5%, patients 98.5% vs. 2.6%), and responded with comparable RTs (controls: 421 ± 83; patients: 464 ± 74) yielding comparable ERP components: N1, P2/N2 and early P3 (325 ms peak latency; 220-365 ms integrated time window amplitude) and late P3 (490 ms; 400-650 ms).
- Early P3 was most prominent for novel stimuli. The novelty P3 had a more frontal topography than target P3 in either time window, which showed a parietal topography consistent with classic P3b.
- Both novelty P3 and early target P3 were significantly reduced in depressed patients while late target P3 was not significantly reduced.

## References

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## Acknowledgements

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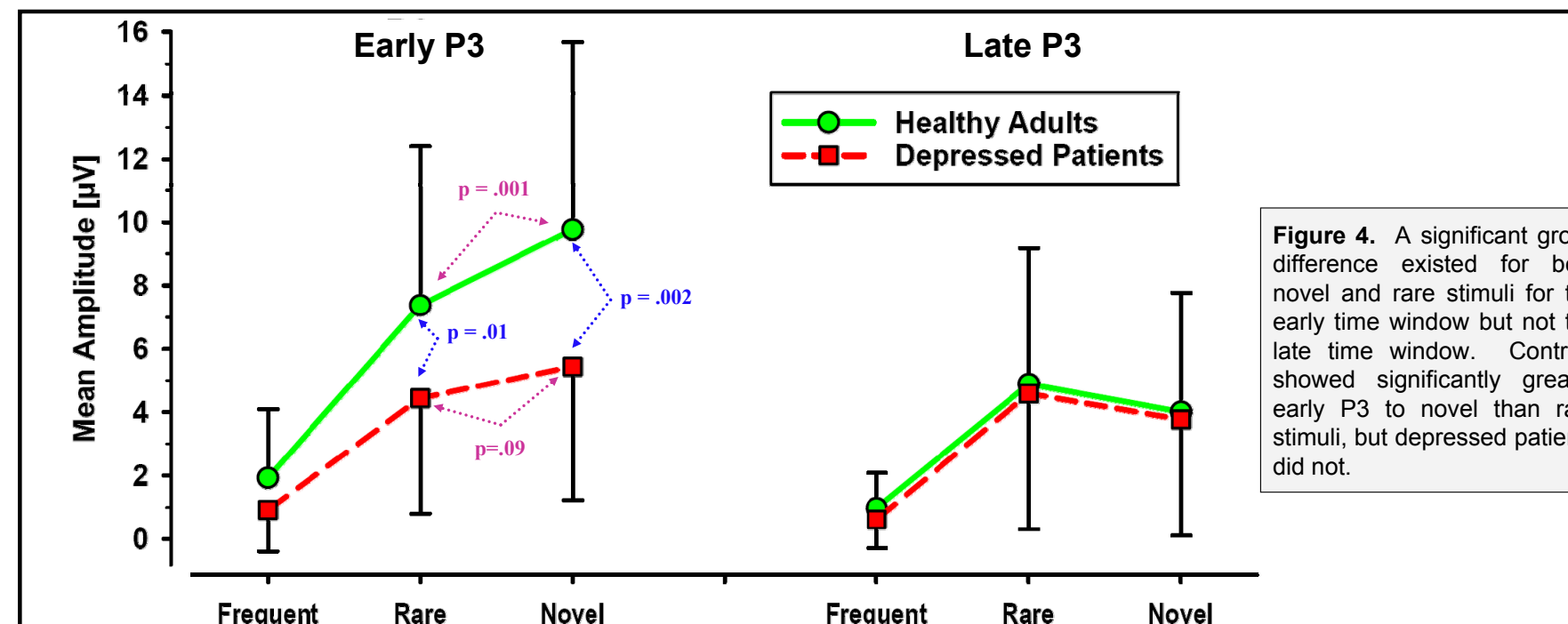


Figure 4. A significant group difference existed for both novel and rare stimuli for the early time window but not the late time window. Controls showed significantly greater early P3 to novel than rare stimuli, but depressed patients did not.

## PCA of Laplacian

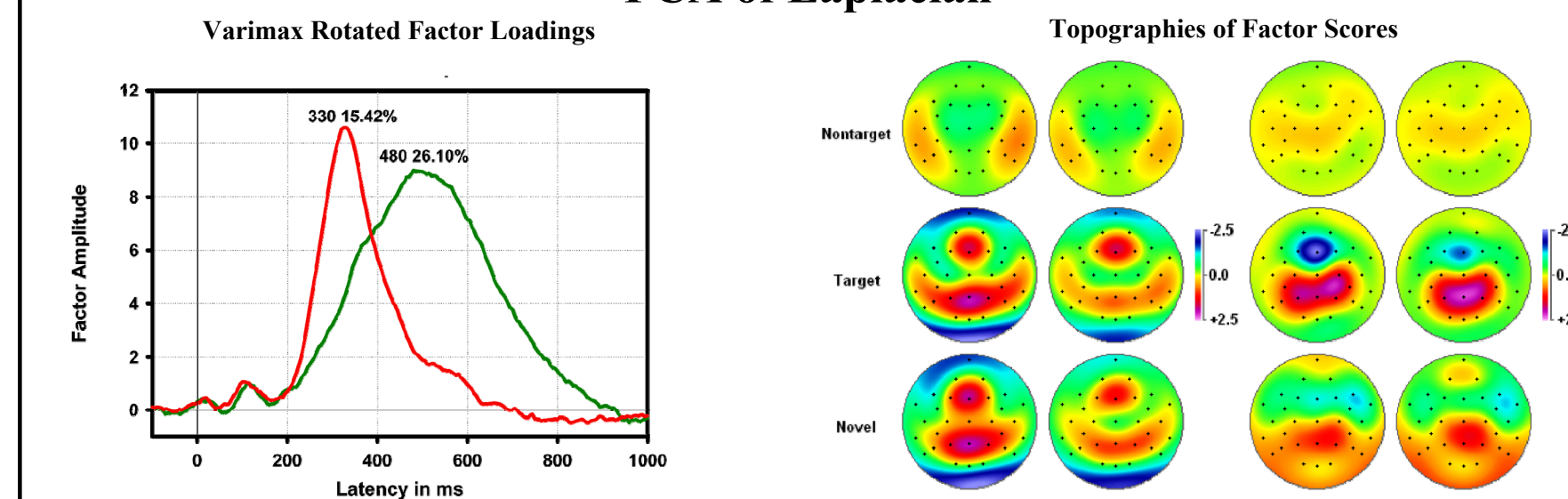


Figure 5. PCA factor loading and factor score topographies corresponding to early P3 (peak latency 330 ms) and late P3 (480 ms). In contrast to the late P3 mid-parietal source, the early P3 source also included a mid-frontal source topography.

## Conclusions

- Depressed patients showed a significant reduction in amplitude of an early P3 subcomponent to both novel stimuli and rare target stimuli when compared to healthy control subjects.
- There was no reduction in the late P3 subcomponent to target or novel stimuli in depressed patients.
- The early P3 (P3a) component had a more frontocentral topography than the late P3 (P3b) component and involves sources in midfrontal and parietotemporal regions.