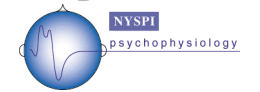


Event-Related Potentials (ERPs) in Depressed Patients and Healthy Adults During Hemifield Presentations of Emotional Stimuli: A Replication

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Presented at the 41st Annual Meeting of the Society for Psychophysiological Research (SPR), Montreal, Canada, October 13, 2001



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Animations of surface potentials and CSD estimates for Emotional Content and Visual Field effects can be accessed at this URL: <http://psychophysiology.cpmc.columbia.edu/mmedia/Kayser2001b/index.html>

Abstract

Behavioral and electrophysiologic evidence suggests that depression involves right parietotemporal dysfunction, a region also known to be activated during perception of affective stimuli. When ERPs were measured to emotional stimuli (pictures of cosmetic surgery patients showing disordered [negative] or healed [neutral] facial areas before or after treatment) using a visual half-field paradigm, healthy adults showed larger P3 to negative than neutral stimuli, particularly over the right parietal region (Kayser et al., 1997, 2000). In contrast, 30 depressed patients failed to show an increase in late P3 for negative compared to neutral stimuli over either hemisphere and had smaller late P3 than controls. Using new right-handed samples of 28 unmedicated depressed patients and 30 healthy adults with 30-channel EEG montage, spatially and temporally overlapping ERP components were measured by covariance-based principal components analysis, which extracted the distinctive, previously identified ERP factors (N150, N235, P310, P415, P600, slow wave) for both groups. Controls showed emotional content effects, i.e. enhanced amplitudes to negative stimuli, for P310 and P415 (inferior- or mid-parietal topography), with both factors revealing distinct hemispheric asymmetries of emotional processing, i.e. greater over right parietal region. For these two P3 subcomponents, depressed patients again had smaller amplitudes and showed no emotional content effects or related hemispheric asymmetries. However, both groups showed symmetric enhancements of central-parietal P600 for negative compared to neutral stimuli. Results further corroborate abnormalities in the evaluation of affective content in depression, presumably arising from a disengagement of right parietal regions essential for perceiving and processing emotional stimuli.

Introduction

- Several lines of research suggest a close involvement of right parietotemporal regions in processing of emotional stimuli (e.g., Gainotti & Caltagirone, 1989).
- Behavioral and electrophysiologic evidence also suggests that mood disorders are associated with right parietotemporal dysfunction (e.g., Bruder, 1995; Heller et al., 1998).
- In accordance with both hypotheses, healthy adults showed enhanced P3 amplitude to negative emotional stimuli particularly over right parietal regions, whereas depressed failed to show this ERP sensitivity to emotional content, and had smaller P3 than controls (Kayser et al., 1997, 2000).
- This study aimed to replicate and extend our previous ERP findings during perception of affective stimuli by applying the same methodology to new right-handed samples of depressed patients and healthy adults.

Participants

- Unmedicated, unipolar depressed outpatients ($n = 28$) [DSM-IV diagnosis: *major depressive disorder* (MDD), $n = 19$; *dysthymic disorder* (DYST), $n = 6$; both MDD and DYST, $n = 3$]
 - Healthy adults ($n = 30$) with no history of any psychopathology or neurology disorder
- | | Patients | Controls |
|--------------------------------|-------------|----------------|
| Gender (female/male) | 11/17 | 16/14 |
| BDI | 22.7 ± 9.6 | 1.5 ± 1.8 *** |
| Age (years) | 35.3 ± 10.4 | 28.8 ± 8.5 * |
| Education (years) | 15.1 ± 2.1 | 16.1 ± 2.0 (*) |
| Edinburgh Handedness Inventory | 80.5 ± 26.8 | 78.2 ± 20.4 |

Stimuli and Procedure

- ERPs were measured to 32 pictures of patients with dermatological diseases (16 negative/neutral pairs before/after cosmetic surgery)
- Negative:**
Facial areas before or during surgical treatment, e.g., a cheek with a melanoma or a wound with stitches

Neutral:
Same facial areas a few years after surgical correction, i.e., healthy skin or a scar
- Each stimulus presented to each visual field (64 trials, 250 ms exposure)
 - Stimuli mirrored for half of the subjects
 - Pseudo-randomized block sequence, variable ITI (12 to 18 s)
 - Participants attended to stimuli while maintaining fixation
 - No manual response

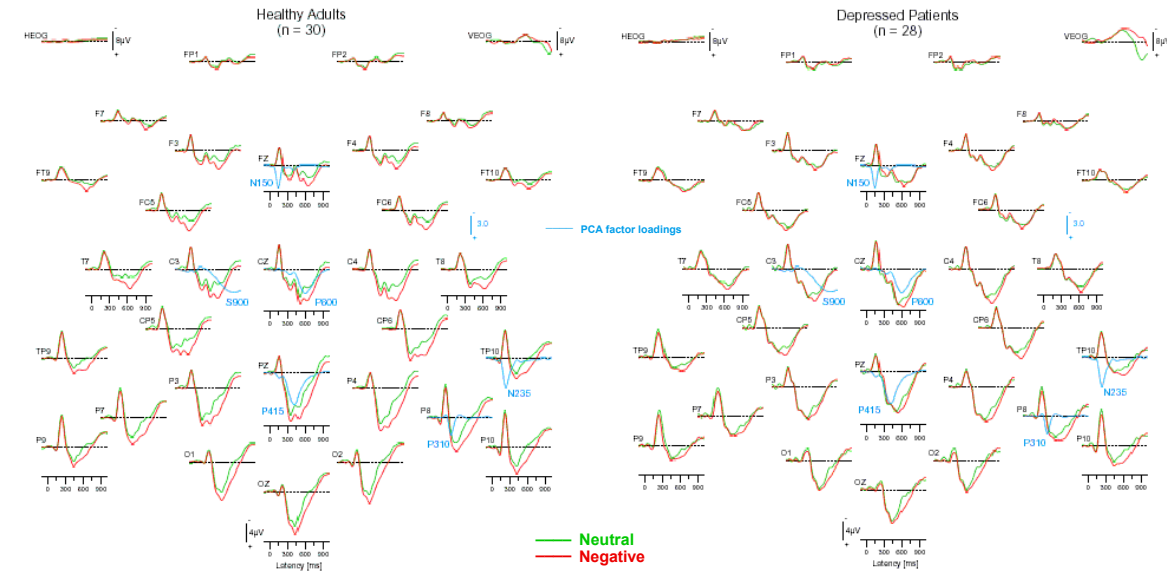


Figure 1. Grand average event-related potential (ERP) waveforms for 30 healthy adults and 28 depressed patients for neutral and negative visual stimuli at all 30 recording sites (averaged across visual field and gender). Distinct ERP components closely corresponded to the extracted PCA factors, as is evident from the time course of the PCA factor loadings shown at selected sites. Horizontal (HEOG) and vertical (VEOG) electrooculograms are shown at a smaller scale before eye blink correction. ERPs are characterized by a prominent N2-P3 complex over the right inferior temporal-parietal region (P8, P10, TP10), and more positive ERPs for negative than neutral stimuli. For patients, these differences of emotional content were less evident than for controls, and not present between 300 and 500 ms at midline sites, i.e., at the peak of P3 amplitude.

ERPs at lateral-parietal sites (P7/8)

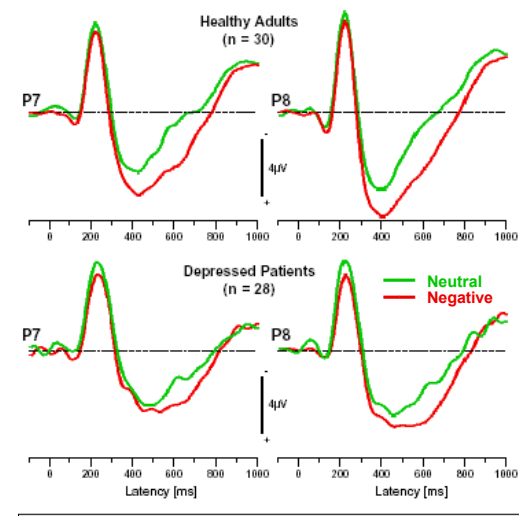


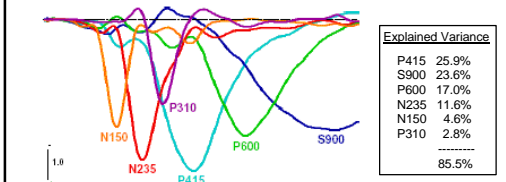
Figure 2. Grand average ERP waveforms for 30 healthy adults (top) and 28 depressed patients (bottom) for neutral and negative stimuli at lateral-parietal sites (averaged across visual field and gender). As in our previous study (Kayser et al., 2000), healthy control subjects compared with depressed patients showed larger overall P3 amplitude and greater differentiation of emotional content, particularly over the right hemisphere.

ERP Recording

- ERPs recorded from 4 midline and 26 homologous scalp placements using an electrode cap and a nose reference
- EEG data acquired at 1-30 Hz band pass (-6dB/octave), 200 samples/sec, 1,280 ms epochs, 200 ms pre-stimulus baseline
- ERP averages low pass filtered at 12.5 Hz (-24dB/octave)
- Horizontal and vertical EOGs (bipolar)
- EEG and horizontal EOG data artifacted at ±100 μV after blink correction (linear regression)

Data Analysis

- ERPs were computed for emotional content (negative/neutral) and visual field (left/right) and submitted [220 variables = samples -100 to 1000 ms; 6960 observations = subjects (58) x Emotional Content (2) x Visual Field (2) x Electrode Site (30)] to an *unrestricted* principal components analysis (PCA) derived from the covariance matrix, followed by *unscaled* Varimax rotation (Kayser & Tenke, 2000)
- PCA components considered for statistical analysis



- PCA factor scores were submitted to a repeated measures ANOVA:

Between-Group Factors	Within-Subjects Factors
Group (patient/control)	Emotional Content (negative/neutral)
Gender (female/male)	Visual Field (left/right)
	Site (3 symmetric electrode pairs)*
	Hemisphere (right/left)

*The electrode sites matched those used by Kayser et al. (2000), which were selected where PCA factors were largest and corresponded to areas of maximal radial current flow (CSD estimates), i.e., P7/8, P9/10, TP9/10 for N235; P3/4, P7/8, O1/2 for P310, P415, and P3 amplitude; P3/4, C3/4, CP5/6 for P600; and P3/4, P7/8, P9/10 for N2/P3 amplitude.

Topographies of PCA Factor Scores

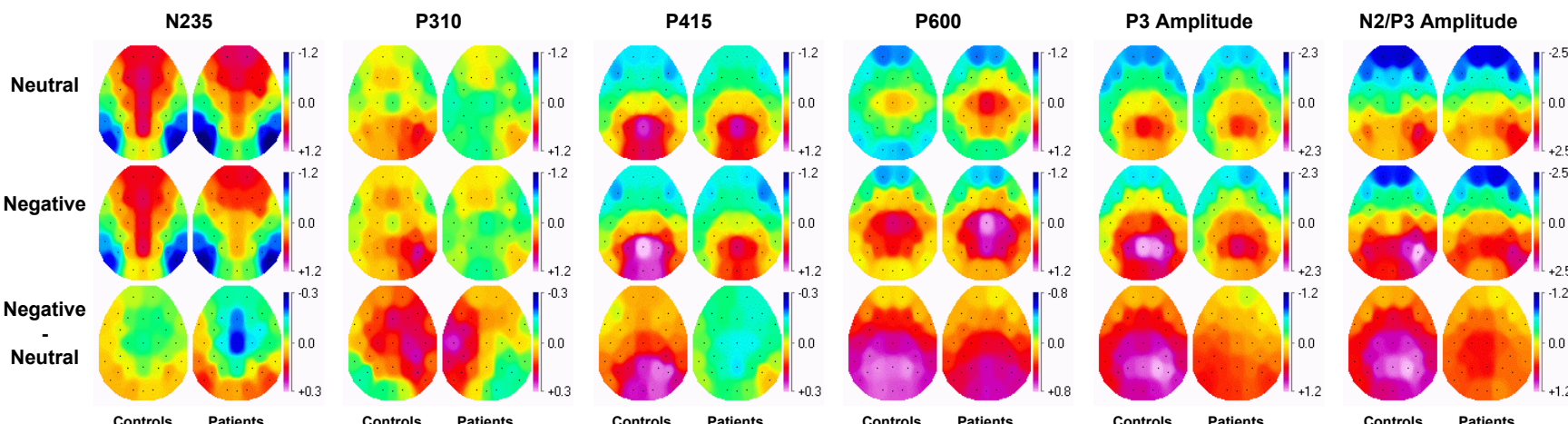


Figure 3. Posterior-lateral N235 topography, maximal over right hemisphere at P8 and P10. No significant group effects were found.
Emot x Site, $F_{(2,108)}=4.45$, $p=.02$, $e=0.78$

Figure 4. Asymmetric posterior-lateral P310 topography, maximal at P8. Significant group effects were found for Emotional Content and Hemisphere.
Grp, $F_{(1,54)}=7.30$, $p=.009$
Grp x Emot x Hemi, $F_{(1,54)}=13.8$, $p<.001$
Grp x Emot x Hemi x Site, $F_{(2,108)}=11.1$, $p<.001$, $e=0.93$

Figure 5. Parietal P415 topography with Pz maximum, more prominent for controls and negative stimuli. Significant effects involved Group and Emotional Content, and an overall Emotional Content x Hemisphere interaction indicative of right-greater-than-left enhanced P415 to negative than neutral stimuli.
Grp x Emot, $F_{(1,54)}=3.59$, $p=.06$
Emot x Hemi, $F_{(1,54)}=4.75$, $p=.03$
Simple effects at P3/4, Grp x Emot, $F_{(1,54)}=3.99$, $p=.05$

Figure 6. P600 had a central-parietotemporal topography, was more prominent for negative stimuli, and was larger over the right hemisphere. Significant effects involved Emotional Content but not Group.
Emot, $F_{(1,54)}=40.6$, $p<.001$
Emot x Site, $F_{(2,108)}=12.7$, $p<.001$, $e=0.75$

Figure 7. An overall P3 amplitude measure was computed from the sum of the three P3 subcomponents (i.e., P310 + P415 + P600), revealing a right-lateralized mid-parietal topography. Significant effects involve Group, Emotional Content, and Hemisphere.
Emot, $F_{(1,54)}=37.7$, $p<.001$
Grp x Emot, $F_{(1,54)}=4.03$, $p<.05$
Grp x Emot x Hemi, $F_{(1,54)}=4.66$, $p=.04$
Simple effects for Emot x Hemi, for Controls, $F_{(1,54)}=5.74$, $p=.02$ for Patients, $F_{(1,54)}<1.0$, $n.s.$

Figure 8. An estimate of N2/P3 amplitude was computed by subtracting N235 from the sum of the three P3 subcomponents (i.e., P310 + P415 + P600 - N235). This measure confirmed the findings for overall P3 amplitude.
Emot, $F_{(1,54)}=31.3$, $p<.001$
Grp x Emot, $F_{(1,54)}=3.60$, $p=.06$
Grp x Emot x Hemi, $F_{(1,54)}=3.79$, $p=.06$
Simple effects for Emot x Hemi, for Controls, $F_{(1,54)}=5.58$, $p=.02$ for Patients, $F_{(1,54)}<1.0$, $n.s.$

Summary and Conclusions

- The results showed the predicted effects of emotional content, i.e., enhanced amplitudes to negative stimuli for several subcomponents of the late positive complex. Two of these P3 subcomponents, P310 and P415, having a classical parietal P3 topography, revealed distinct hemispheric asymmetries of emotional processing, i.e., greater over the right parietal region.
- For these two P3 subcomponents, depressed patients had smaller amplitudes, showed no or little emotional content effects, and associated hemispheric asymmetries were smaller (P415) or opposite direction (P310).
- However, both groups showed symmetric enhancements of central-parietal P600 for negative compared to neutral stimuli.
- These findings are in close agreement with those reported previously for different control and patient samples (Kayser et al., 1997, 2000), and further corroborate abnormalities in the evaluation of affective content in depression, presumably arising from a disengagement of right parietal regions essential for perceiving and processing emotional stimuli.

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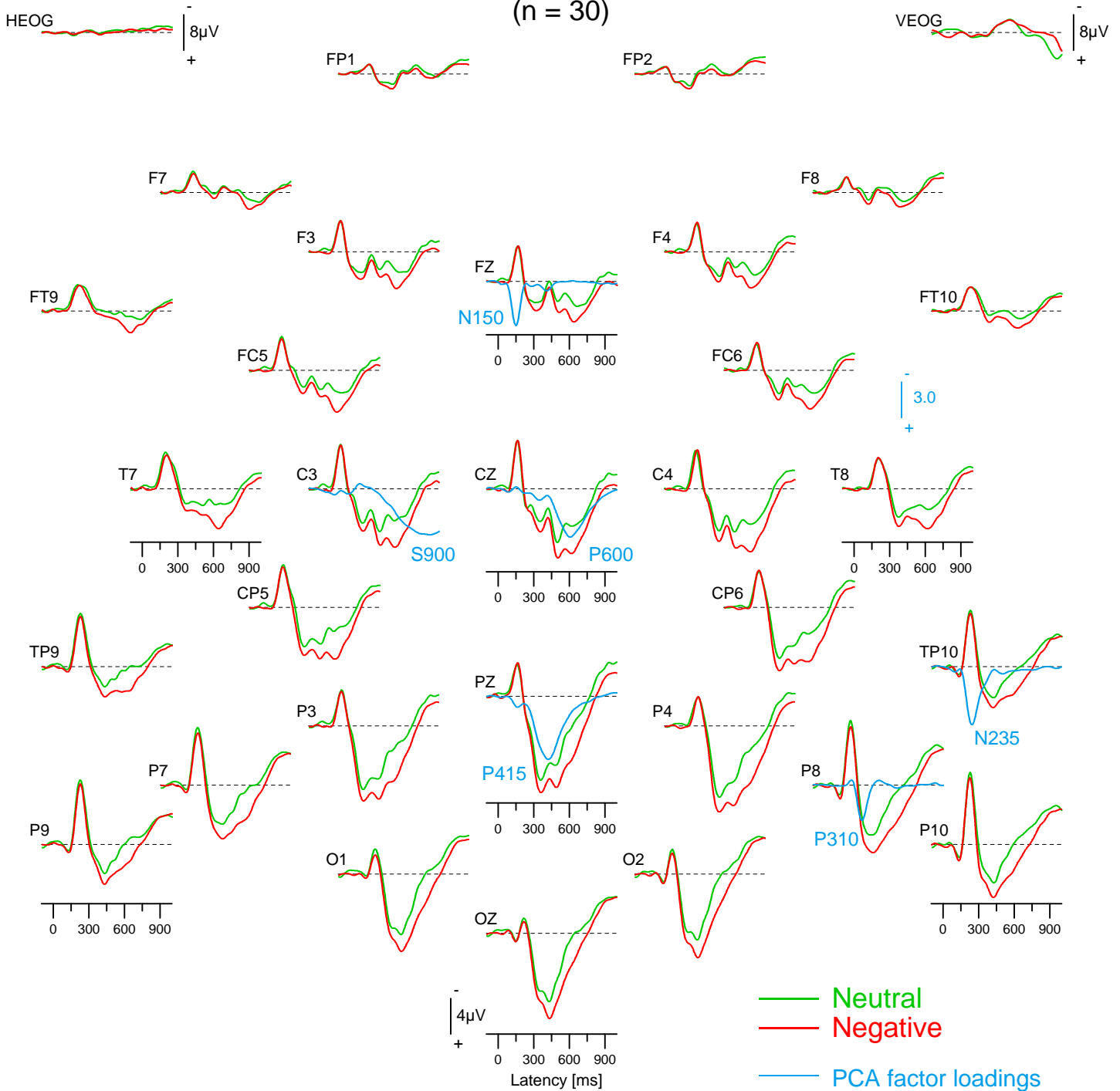
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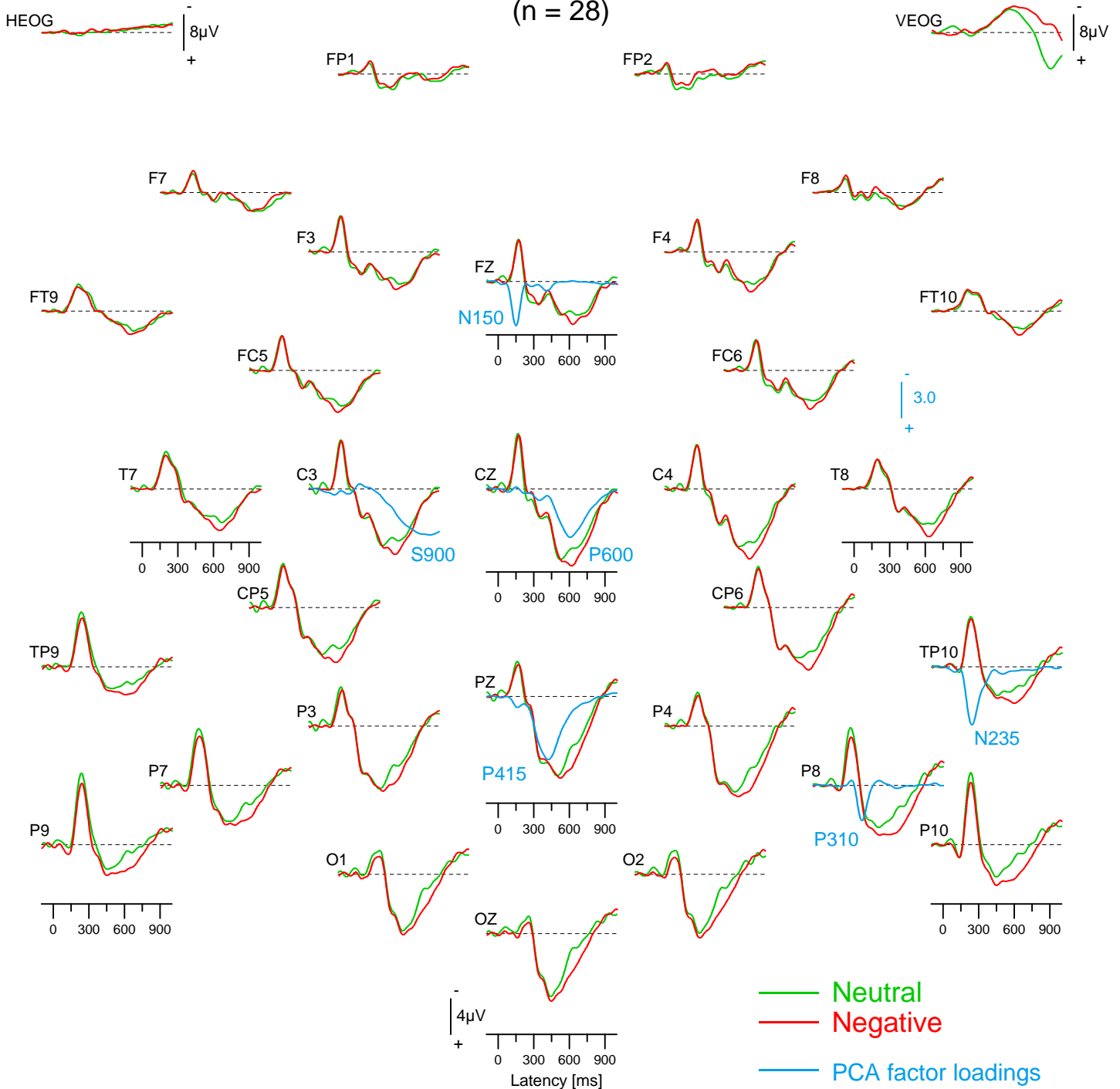
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Healthy Adults (n = 30)



Depressed Patients (n = 28)



Healthy Adults
(n = 30)

P7

P8

4 μ V

-
+

0 200 400 600 800 1000

0 200 400 600 800 1000

Depressed Patients
(n = 28)

— Neutral
— Negative

P7

P8

4 μ V

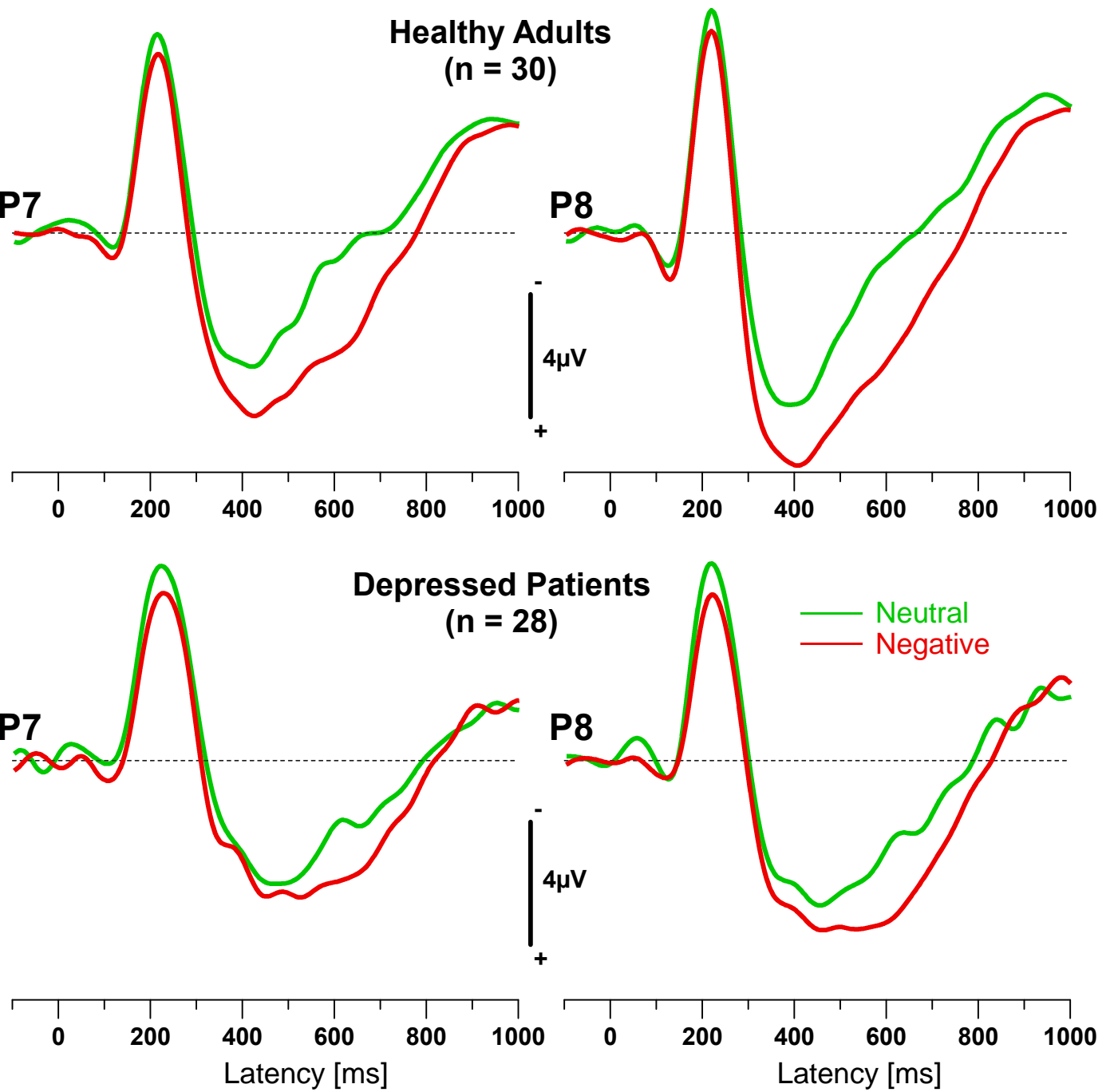
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+

0 200 400 600 800 1000

0 200 400 600 800 1000

Latency [ms]

Latency [ms]



PCA Factor Loadings

