Exploration of differential effects in studying the interaction of emotions and attention: Negative affectivity and P3

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Theoretical Background

Previous research in the field of electroencephalography (EEG) supplied evidence for a differential allocation of attentional resources in a very early stage of processing (100 ms post stimulus-onset and shortly after) during the inspection of emotional comparing to neutral stimuli (attentional bias). In addition, late potentials of the EEG show greater amplitudes for the presentation of emotional stimuli compared to neutral ones. These late potentials are primarily involved in the emotional cognitive processing, whereas the early potentials are concerned with extracting the emotional contents of the stimuli. The P300 event-related brain potential (ERP) can be understood as the neuroelectric correlate of attention allocation.

Based on different electrophysiological studies investigating the attentional bias of subjects with increased state and trait anxiety, it seemed interesting to explore the concept of negative affectivity (NA) on an electrophysiological level. Investigations studying frontal asymmetry supply evidence for a differential activation of the left and right brain hemisphere depending on the individual specificity of affectivity. Greater activations in the left hemisphere are associated with a more positive affectivity, whereas people reporting increased negative affectivity show a larger activation in the right hemisphere. Studies exploring the relation between habitual affectivity and ERPs are much less frequent. In this study, the question will be *explored* if negative affectivity modulates the influence of fear relevant stimuli on the P300 component.

Methods

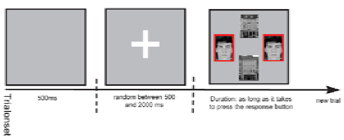

Figure 1: Easy version

Figure 2: Difficult version

Participants: The experimental paradigm is largely based on the work of Vuilleumier et al. [1]. Analyses were conducted on the data obtained from 38 participants (20 males). All participants were right-handed. Mean age varied between 21.2 years for women and 21.7 years for men.

Material: 60 black/white colored images of houses. 24 pictures with faces [2]; 12 of these 24 pictures showed an emotional facial expression (8 fearful & 4 anger). The rest (12 pictures) showed the same faces with a neutral expression. Four pictures were arranged on a computer screen with 2 pictures being horizontally presented and 2 pictures vertically. A red border indicates the two pictures the participants had to pay attention on (relevant pictures) (compare figure 1 & 2). Negative affectivity has been operationalized using the PANAS [3].

Block- & Trialprocedure: Two experiments were randomized between the participants. Both differed in difficulty from each other (figure 1 & 2). Each experiment was composed out of 448 trials (16 blocks with 28 trials each). The participants' task was to judge on every trial if the attended pictures (red border) are equal or if they differ from each other.

Electrophysiological recordings: 29 electrode sites, referenced to Cz and re-referenced to linked mastoids, were recorded according to the International 10-20 standard system, replenished by VEOG and HEOG. Impedances were kept below 12 kΩ. Data were filtered to 0.1-8 HZ (low pass at 8 Hz with 24 db octave/slope), digitized and sampled at 200 Hz. After ocular correction, artifact rejection and baseline correction, segmentations were made for the periods of -200ms to 800ms. Grand averages were determined. The analyses of the study were limited to the following post-stimuli time periods: 300-420ms; 440-595ms; 610-750ms.

Statistical analyses: General linear models (GLM) were calculated with 2 repeated measures (relevance and emotion). The dependent variable was the amplitude, averaged over time intervals on each electrode. NA was introduced as a continuous predictor. Pearson correlations were calculated between each factor and NA.

Results

- P300 wave

Averaged ERPs on the electrode sites P3, Pz, P4, CP3, CPz, and CP4 as well as the typical course of the P300 are presented. The P300 ranges from approximately 400 ms to 650 ms post-stimulus.

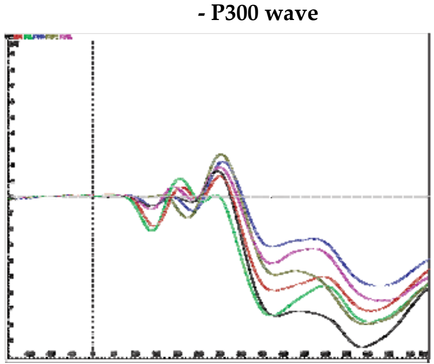

Figure 3: P300 wave - Grand Averages of the event-related potentials on the electrodes P3, Pz, P4, CP3, CPz, CP4 (Scale: -10 µV to + 10 µV; vertical dashed line indicates stimulus onset)

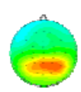

Figure 4: Scalp topography of the P300 wave.
Interval: 400-455
Scale: -9 µ V to + 9 µ V

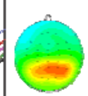

Figure 5: Scalp topography of the P300 wave.
Interval: 600-655
Scale: -9 µ V to + 9 µ V

Table 2: Mean (M), Standard deviation (SD), Sample number (N) and Cronbach's alpha of the NA scale of the PANAS [3]

M	SD	N	Cronbach
18.76	6.64	38	.88

- General psychological effects compared to differential psychological effects

A)

	FP1	.004	.003	
F7	.048	.018	.016	.013
FT7	.019	.003	FC4	FT8
	C3	.000	C4	
T7	.000	.003	.023	T8
P7	P3	.000	.012	P8
	O1	Oz	O2	

B)

	FP1	.14	.16	
F7	.12	.17	.16	.11
FT7	.28	.11	FC4	FT8
	C3	.13	C4	
T7	.17	.18	.11	T8
P7	P3	.13	.12	P8
	O1	Oz	O2	

Figure 6: Topographical presentation of the general psychological effects (green) compared to the differential psychological effects (red); only effect sizes of $eta^2 \geq .1$ are included in the presentation.
A) *General psychological interaction: Relevance x Emotion*
B) *Differential psychological interaction: Relevance x Emotion x Negative affectivity*

Table 1: Pearson correlations of the interaction Relevance x Emotion x NA

		Relevance		Emotion		
		Face on relevant position	Face on irrelevant position	Negative facial expression	Neutral facial expression	Relevance x Emotion
Negative Affectivity (z-stand.)	Correlation	.22	.29	.27	.25	-.08
	Sig.(2-tailed)	.18	.08	.10	.14	.63
	N	38	38	38	38	38

The comparison between the general psychological interaction (Relevance x Emotion) and the differential psychological interaction (Relevance x Emotion x Negative affectivity) clearly shows the impact of negative affectivity at the cortical level. Effect sizes vary between $eta^2 = .000$ in figure 6A (green) and $eta^2 = .28$ in figure 6B (red). Regardless of the typical topography and the shape of the P300 (Figure 3 to 5), this effect is not limited to parietal and centro-parietal electrode sites (the typical P300 topography). This effect is distributed over large parts of the scalp. No significant correlations (Table 1) between emotionally negative pictures and the ERP amplitudes of high negative affectivity could be observed ($r = .27$; $p = .10$) at the 5% level. ERPs of high negative affectivity and unattended facial pictures fail to show significant correlations ($r = .29$; $p = .08$).

Conclusion

Results on an earlier interval (300-420 ms) in the same study indicate a significant correlation between attended (relevant) faces and negative affectivity. The correlation between the unattended faces and the negative affectivity might be interpreted in the way that it takes longer to allocate attentional resources to unattended faces. It can be argued that the increase of the P300 amplitude plays a certain role within this relation, but seems not to be the only crucial electrophysiological component influencing the correlation. Furthermore, the differential effect sizes distributed over the entire cortex do not seem to be exclusively due to the P300. Evidently, there are other electrophysiological correlatives involved.

In the present study, we failed to demonstrate considerable differences in ERP amplitudes during the inspection of emotional facial expressions according to subjects with greater negative affectivity compared to subjects with lower negative affectivity.

Systematic ameliorations to the paradigm in future research are a challenge.

Literature:
[1] Vuilleumier, P., Armony, J.L., Driver, J. & Dolan, R.J. (2001). Effects of attention and emotion on face processing in the human brain: an event-related fMRI study. *Neuron*, 30, 829-841.
[2] Ekman, P. & Friesen, W. (1976). *Pictures of facial affect*. Palo Alto: Consulting Psychological Press.
[3] Watson, D., Clark, L.A. & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, 54(6), 1063-1070.

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