



Visual Search for Fearful Stimuli: A Combined ERP and fMRI Study



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Introduction

Emotions have a crucial impact on human cognition. One line pointing in this direction comes from a paradigm of visual search for fear-relevant stimuli. When subjects had to judge whether all the pictures of a 2 x 2 or 3 x 3 grid were from the same category or not, fear-relevant deviants are detected faster than neutral deviants ([1]). So far, however, there is little empirical physiological evidence that the observed effect is due to fear-relevance and there is firm criticism that the results reflect an impact of fear-relevance. "An ability to find threatening snakes and spiders efficiently seems to have more to do with their visual status as distinctive shapes than their affective status as scary objects." ([2] p. 500). Two optimizations were applied to the paradigm. First, fear-relevant and neutral target stimuli from the same category were tested intraindividually in front of a neutral background. Second, all subjects were investigated on three levels of measurement: behavioral, event related potentials (ERP) and event related functional magnet resonance imaging (efMRI).

Methods

Subjects

Twenty healthy volunteers - 10 female and 10 male, ages ranging from 20 to 29 years, mean 23

Design

Subjects viewed 288 stimuli consisting of 9 pictures arranged in a 3 x 3 grid. They took part in two sessions (EEG and fMRI) with the sequence counterbalanced across subjects.

Independent Variables:

- I: Background: levels snake, turtle and flower.
- II: Target: levels snake, turtle and flower.

Beside the homogeneous matrixes (background and target from identical category) the design results in matrixes which allows the comparison of fear relevant and neutral deviants from the same subcategory behind a constant background (snake among flowers vs. turtle among flowers) as well as the comparison of fear relevant and neutral deviants behind the same background category (snakes among turtles vs. turtles among snakes)

Trial: Fixation 2 s; Stimuli 4 s or until response; Fixation for the remaining time of the 4 s; Empty screen random 0 to 2,5 s.

EEG Acquisition

- 32 sites of the 10-10 electrode system
- Ag/AgCl electrodes – impedance below 5 kOhm
- Filter band pass 0.05 Hz – 40 Hz (24 dB/octave)

fMRT Acquisition

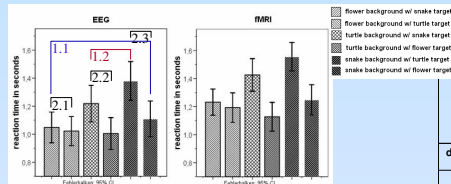
- Siemens Symphony 1.5 T Scanner; 29.53 min. TR=2,5 s
- T-2* EPI Sequence, 25 Slices (5mm), 820 Volumes
- 64 x 64 Matrix, FOV=192 mm, TA=100 ms, TE=55 ms,

Statistical Analysis

- Five planned comparisons:
 - original comparison: snake among flowers vs. flower among snakes (1.1)
 - category optimized comparison: snake among turtles vs. turtle among snakes (1.2)
 - comparisons among constant backgrounds: among flowers (2.1), among turtles (2.2), among snakes (2.3)
- Software: SPSS 15, Vision Analyzer 1.05, SPM2
- EEG: 5 Spatiotemporal areas – by visual inspection of the difference wave of the original comparison
- fMRI: Whole-head-Analyses (FDR-cor; t = 3,84; extended threshold 40 Voxel) ROI-Analyses for Amygdala (FDR-cor; p = 0.01; extended threshold 20)

Results

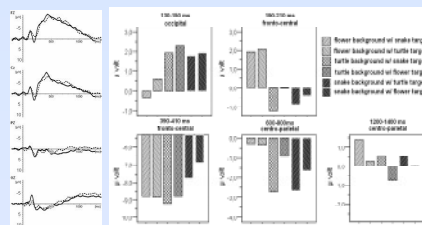
Behaviour (response time)



	planned comparison: t-test (for averaged EEG- & fMRI-behavioural results)				
	two sub categories		same background		
	1.1	1.2	2.1	2.2	2.3
difference ms	38	146	32	256	289
t-value	1.97	7.61	3.09	18.50	14.78
p-value	.031*	.000**	.003*	.000**	.000**

Faster reactions for the original comparison and for the optimized comparison. The optimization worked as expected (compare 1.1 to 1.2). For the comparison among flowers, turtles were found faster! For the comparison among turtles, the flowers were found faster.

Event related Potentials (ERP)

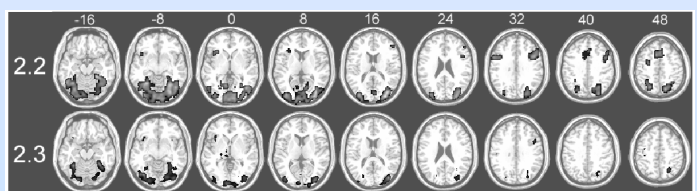


analysis	time in ms	planned comparison: t-test				
		two categories		same background		
		1.1	1.2	2.1	2.2	2.3
1. Occipital	130-150	3.23*	-.26	-1.28	-.66	-.24
2. Frontocentral	190-210	-2.29*	.53	-.13	-2.62*	-.82
3. Frontocentral	390-410	2.62*	1.66	.74	-.48	-1.27
4. Centroparietal	600-800	-2.09	.08	.07	-2.37	-1.47
5. Centroparietal	1200-1400	-1.97	.02	1.55	1.99	.71

No spatiotemporal area revealed an effect specific to emotion, as the three early effects of the original comparison were not found for the comparisons 1.2 & 2.1.

Hemodynamic Response (BOLD)

No activity differences were found when comparing (a) snake among flowers vs. flower among snakes, (b) snake among turtles vs. turtle among snakes and (c) snake among flowers vs. turtle among flowers. The ROI-Analyses did not find Amygdala activity differences for any of the contrasts.



Only activity differences for the comparison of targets from different categories were found (2.2, 2.3).

Discussion

- Results showed that former behavioral findings could be replicated and that the applied optimizations worked as expected.
- Results also suggest that fear-relevant stimuli have no general search advantage in this setting.
- Physiological results question, whether the fear-relevance of the stimuli is processed in the investigated paradigm.

References

- [1] Ohman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: detecting the snake in the grass. J Exp Psychol Gen, 130(3), 466-478.
- [2] Wolfe, J. M., & Horowitz, T. S. (2004). What attributes guide the deployment of visual attention and how do they do it? Nat Rev Neurosci, 5(6), 495-501. [3] Lovibond, P.F., Shanks, D.R., 2002. The role of awareness in Pavlovian conditioning: empirical evidence and theoretical implications. J. Exp. Psychol. Anim. Behav. Process 28, 3-26.