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Functional neurological symptoms modulate processing of emotionally salient stimuli

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ABSTRACT

Objective: Dysfunctional emotion processing has been discussed as a contributing factor to functional neurological symptoms (FNS) in the context of conversion disorder, and refers to blunted recognition and the expression of one's own feelings. However, the emotion processing components characteristic for FNS and/or relevant for conversion remain to be specified. With this goal, the present study targeted the initial, automatic discrimination of emotionally salient stimuli.
Methods: The magnetoencephalogram (MEG) was monitored in 21 patients with functional weakness and/or sensory disturbance subtypes of FNS and 21 healthy comparison participants (HC) while they passively watched 600 emotionally arousing, pleasant, unpleasant or neutral stimuli in a rapid serial visual presentation (RSVP) design. Neuromagnetic activity was analyzed 110–330 ms following picture onset in source space for prior defined posterior and central regions of interest.
Results: As early as 110 ms and across presentation interval, posterior neural activity modulation by picture category was similar in both groups, despite smaller initial (110–150 ms) overall and posterior power in patients with FNS. The initial activity modulation by picture category was also evident in the left sensorimotor area in patients with FNS, but not significant in HC.
Conclusions: Similar activity modulation by emotional picture category in patients with FNS and HC suggests that the fast, automatic detection of emotional salience is unchanged in patients with FNS, but involves an emotion-processing network spanning posterior and sensorimotor areas.

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1. Introduction

Altered emotion processing has been discussed as a factor that potentially contributes to the generation of functional neurological symptoms (FNS) ever since FNS have been conceptualized in the context of conversion or dissociative disorders [cf. 1,2–7]: Breuer and Freud linked FNS to a conversion of intrapsychic distress into physical symptoms [2], and Janet linked psychoform and somatoform symptoms (like FNS) to the dissociation of psychobiological systems (thoughts, sensations, and behavior) consequent upon psychological trauma and individual predispositions [1,3–5,8]. Pavlov connected emotion processing and FNS when proposing that excessive cortical inhibitory control over (subcortically generated) emotional activities (centered in subcortical areas) flooded other neurological pathways, thereby causing FNS-like paralysis or anesthesia [cf. 7,9,10].

Within the framework of psychological emotion processing theories, emotion processing is defined by distinct processes such as the initial, automatic detection of emotional and salient "ecologically important" [11,p. 773] stimuli and/or controlled processing, the conscious processing of one's own emotional responses or their regulation. Evaluating dysfunctional emotion processing in individuals with FNS indicated a different initial detection of emotional stimulus category: in an incidental affective task, patients with FNS responded with a greater amygdala activity to unpleasant stimuli (measured by functional magnetic resonance imaging, fMRI) and also showed less activity habituation across trials compared to healthy control participants [12]. Moreover, patients with FNS exhibited less modulation of amygdala activation by stimulus valence (unpleasant–pleasant) than HC [13]. Aybek et al. [12] further showed that emotionally salient stimuli prompted greater activation in the supplementary motor area (SMA) in patients with FNS than in controls, and a greater functional connectedness between amygdala

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and SMA [13,14], thus, between brain areas associated with emotion processing and movement preparation.

Referring to emotion regulation, we [15,this journal] found less frontocortical but more sensorimotor neuromagnetic activity in patients with FNS than in healthy control participants, when subjects activated trained strategies of cognitive reappraisal upon presentation of unpleasant pictures [16]. When subjects passively watched the unpleasant and neutral pictures in a second condition within the same design, patients and controls displayed similar activity in posterior areas. While the latter activity was associated with the processing of the emotional salience of visual stimuli [11,17,18], sensorimotor activity was discussed as an indication of the close association of emotion and sensorimotor processing in patients with (dominant sensory and motor) FNS.

Complementing these findings, the present study scrutinized the initial, automatic discrimination of emotionally salient stimuli using a rapid serial visual presentation (RSVP) design to enforce automatic detection and high-resolution magnetoencephalography (MEG) to depict the fast cortical processing. The RSVP design has been shown to prompt greater posterior activity to arousing pleasant and unpleasant compared to neutral stimuli as early as 150 ms after stimulus onset [17,19–21] and has been used to study dysfunctional emotion processing in patients with posttraumatic stress disorder (PTSD), major depression disorder (MDD) or stress-related syndromes [20–22]. In the present study, neuromagnetic activity modulation by picture category was compared between patients with FNS and healthy comparison participants (HC) with the hypotheses that:

(1) patients with FNS show enhanced processing of emotionally salient relative to neutral stimuli (referring to evidence from fMRI studies [12,13]) in posterior areas associated with a visual emotional processing network [e.g. 17]); and that
(2) patients with FNS display greater activity in sensorimotor areas than HC (referring to evidence of simultaneous activity in emotion- and movement-related areas in emotion recognition [12, 13] and emotion regulation [15] tasks).

2. Methods

2.1. Participants

The study involved 21 patients with FNS and 21 healthy comparison participants (HC). Samples overlapped with those reported in Fiess et al. [15; this journal]. Patients with an ICD diagnosis of conversion disorder (ICD-10 codes F44.4, F44.6, F44.7) were recruited from the local rehabilitation center (Kliniken Schmieder) where they were following comprehensive treatment protocols involving individual and group psychotherapy, physiotherapy and occupational therapy. Diagnoses were given by two or more experienced psychiatrists and neurologists following standardized ICD-10 guidelines, with at least one core negative somatoform dissociative symptom (e.g., motor disorders, hypesthesia) required for a diagnosis of conversion disorder. Symptom duration varied between 7 and 41.5 months (interquartile range) around the median of 12 months. Dominant symptoms were motor weakness and/or sensory disturbances on the left and/or right side of the body (see Table 1A).

HC were recruited from the local community through flyers and verbal advertising in order to be demographically comparable to the patient sample. HC were screened using the Mini International Neuropsychiatric Interview [MINI; 23] to exclude any psychiatric disorders. From $n = 24$ individuals screened with the MINI, $n = 3$ were excluded because of a hypomanic episode in the past, a current major depressive episode, and alcohol abuse, respectively. Recruitment was continued until the control group consisted of $n = 21$ participants. As evident from Table 1B, groups did not differ with respect to mean age, gender distribution or years of school education. Patients with FNS and HC with central nervous lesions (e.g., degenerative disorders, tumors) were not included. For patients with FNS, this screening was accomplished upon admission following a standard protocol that included screening for neuropathology, clinical structural MRI and electromyography as clinically indicated. All participants had normal or corrected-to-normal vision. The Fisher-Freeman-Halton test (an extension of the Fisher exact test for r × c contingency tables) confirmed that groups did not differ significantly in handedness, as assessed using the Edinburgh Handedness Inventory [24; see Table 1B].

Table 1A
Dominant symptoms in patients with FNS ($n = 21$).

	Left-sided	Right-sided	Both sides	None
Motor weakness (n)	6	1	12	2
Sensory disturbances (n)	5	3	9	4

2.2. Setting

The study protocol was approved by the ethics committee of the University of Konstanz. Participants were informed about the design and procedures and provided their written informed consent. Thereafter, demographic and self-report data (see below) were assessed. A separate session comprised the rapid serial visual presentation (RSVP) protocol [17] while the MEG was being monitored.

2.3. Stimulus material

For the RSVP, highly arousing pleasant ($n = 100$), unpleasant ($n = 100$) and neutral pictures ($n = 100$) were chosen from the International Affective Picture System [IAPS; 25] on the basis of their normative ratings. Brightness, contrast and color spectra of the stimuli were matched across picture categories. Each stimulus was presented once within each of two series of 300 pictures (total 600 stimuli) without a perceivable gap for 333 ms each (3 Hz, 60 Hz refresh rate) in a pseudorandom sequence. The two picture series were presented without a break, the presentation time was approximately 4 min. Participants were instructed to maintain their focus on a small, centrally located fixation cross overlaying each picture and to watch the sequence of pictures without any specific task.

Table 1B
Sociodemographic and clinical information of study samples.

	Patients with FNS	HC	Patients with FNS vs. HC
n	21	21	
Gender (f/m)	13/8	11/10	*n. s.*
Age ($M \pm$ SD)	*42* ± 13.4	*48* ± 14.3	*n. s.*
Years schooling ($M \pm$ SD)	*11* ± 3.2	*11* ± 1.6	*n. s.*
SDQ-20 (median *(range)*)	33 *(28–40)*	21 *(20–22.5)*	$U = 26, z = -4.9$; $p < 0.001, r = 0.76$
SCL-90-R (median *(range)*)			
Depression	1.4 *(0.3–1.9)*	0.1 *(0–0.3)*	$U = 82.5, z = -3.5$; $p < 0.001, r = 0.54$
PSSI (median *(range)*)	8 *(0.5–24)*	0 *(0–4)*	$U = 108, z = -2.9$; $p < 0.01, r = 0.45$
ETI (median *(range)*)	213 *(15–585)*	34 *(8–75.5)*	$U = 78, z = -2.6$; $p < 0.01, r = 0.39$
Handedness (n)			
Right-handed	18	20	*n. s.*
Left-handed	1	1	
Ambidextrous	2	0	

Note. FNS = patients with functional neurological symptoms; HC = healthy control participants; SDQ-20 = Somatoform Dissociation Questionnaire (scores range from 20 to 100); SCL-90-*R* = 90-item Symptom Checklist (scores range from 0 to 4); PSSI = Posttraumatic Stress Scale-Interview severity score (scores range from 0 to 86); ETI = Early Trauma Inventory.

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