



The impact of adverse childhood experience on symptom severity in patients with functional neurological symptom disorder (FNSD)

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ARTICLE INFO

Keywords:

Functional neurological symptoms
Childhood neglect
Abuse
Conversion
Alexithymia

ABSTRACT

Theoretical background: Adverse childhood experiences (ACE), especially traumatic ACE have been assumed to play a particular role for patients with functional neurological symptoms (FNS): Emotional responses to traumata hypothetically affect (or ‘convert’ into) bodily symptoms. The present study examined this hypothesis scrutinizing the specific impact of (1) traumatic experiences compared to other adversities such as neglect, (2) early childhood compared to adolescent adverse experiences, (3) on FNS compared to psychological symptoms such as depressive and trauma-related symptoms.

Methods: Neglect and abuse experiences during childhood and adolescence were assessed in 82 patients diagnosed with functional neurological symptom disorder (FNSD) and 82 healthy comparison participants (HC) together with self-rated FNS (indexed by somatoform dissociative symptoms, SDQ-20), depressive (BDI) and posttraumatic stress symptoms (PDS). Emotion processing was assessed with the TAS-26, which captures the ability to identify and describe one's own emotions (described as alexithymia).

Results: Patients reported more ACE than HC independent of type and age period, more severe functional neurological symptoms and more alexithymia. Alexithymia mediated not only the relationship between ACE and FNS, but also the relationship between ACE and depressive and ACE and trauma-related symptom severity in cases and controls.

Conclusion: Results emphasize the impact of neglect and abuse on FNSD, and strengthen the proposed ACE influence on affect regulation with its mediating role for symptom expression in support of the conversion concept. The similar impact of ACE on FNS, depressive and trauma-related symptoms suggest a sensitizing impact of childhood adversities on mental health.

1. Introduction

An influence of adverse experiences early in life on the development of (altered emotion processing and) medically unexplained, thus, functional neurological symptoms (FNS), has been considered ever since Breuer and Freud introduced the concept of ‘conversion’ to describe the shift of painful emotional experience to physical symptoms (cf. e.g., Kozłowska, 2005; Vuilleumier, 2014). FNS are mainly characterized by somatoform symptoms in current diagnostic manuals (DSM-5 or ICD-10), related to somatoform dissociation² (ICD-10). Diagnostic criteria include emotional stress and/or trauma as antecedents, and etiological hypotheses propose the conversion of stress-induced,

painful emotion into bodily symptoms. Hypotheses are grounded in evidence aggregated from studies that distinctly scrutinized the relationship between functional neurological symptoms (FNS³) and sexual trauma, physical abuse, but also neglect; recent traumata, as well as adverse experiences during childhood (cf. Draijer & Langeland, 1999; Ludwig et al., 2018; Nicholson et al., 2016; Roelofs, Spinhoven, Sandijck, Moene, & Hoogduin, 2005; Steffen, Fiess, Schmidt, & Rockstroh, 2015). Distinct evidence, though, raises the question, whether conversion is prompted (mainly or predominantly) by severe or traumatic abuse or by adverse childhood experiences (ACE) in general (Roelofs, Keijsers, Hoogduin, Näring, & Moene, 2002).

The concept of conversion further implies a shift towards bodily

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² For discussion of terms and definitions see van der Kruijs et al., 2014; Stone, 2005

³ the term FNS, as used in the present report, includes somatoform dissociative symptoms

symptoms as a way to avoid permanent intolerable emotional pain (cf. e.g., Kozłowska, 2005; Vuilleumier, 2014). In adults suffering from FNS such conversion might be manifest in reduced expression and / or perception of negative emotion, a feature described as alexithymia (e.g., Demartini et al., 2014; Fiess, Rockstroh, Schmidt, & Steffen, 2015; Steffen et al., 2015; Terock et al., 2016). This assumption implies a mediating effect of alexithymia in the relationship between early adverse experiences and adult FNS. Yet, frequent reports of comorbid symptoms of depression and anxiety (e.g., Sar, Akyüz, Kundakci, Kiziltan, & Dogan, 2004) suggest that the link between ACE, long-term affect regulation (for instance manifest in alexithymia) and mental health in adulthood is not restricted to FNS and/or somatoform dissociative disorders.

With the aim to further clarify conversion in patients with FNS the present study addressed the question of (a) specificity of stress and trauma early in life, (b) consequences of specific experiences on FNS severity (compared to psychological symptoms like depression and symptoms of Posttraumatic Stress Disorder (PTSD)), and (c) the role of altered affect regulation in mediating the relationship between adverse childhood experiences and adult FNS expression by comparing different types of ACE (abuse, neglect), their prominence in early childhood or adolescence, and their relationship with severity of symptoms in $n = 82$ patients diagnosed with FNSD and $n = 82$ healthy comparison participants (HC).

Literature on conversion disorders and FNS (cf. Draijer & Langeland, 1999; Nicholson et al., 2016; Roelofs et al., 2005; Steffen et al., 2015; Vuilleumier, 2014) suggested the following specific hypotheses:

- (1) Patients with FNSD report a higher number of overall ACE, particularly more abuse than HC. Group differences are expected to be larger for adverse experiences in childhood than in adolescence.
- (2) In addition to the (expected) higher severity of FNS, patients with FNSD report more alexithymia, depressive, and PTSD symptoms than HC, with symptom severity varying with ACE load.
- (3) Alexithymia mediates the relationship between ACE and FNS, less so between ACE and depression or PTSD, and particularly in FNSD patients compared to HC.

2. Methods

2.1. Participants

$N = 82$ adult inpatients with ICD-10 diagnoses of functional neurological symptom disorder (FNSD; ICD-10 codes F44.4 ($n = 20$, F44.6 ($n = 1$), F44.7 ($n = 52$)) were recruited at the local neurological rehabilitation centre (Kliniken Schmieder Konstanz and Gailingen). Based on the diagnostics of at least two experienced psychiatrists and neurologists, patients were included, if they presented at least one core negative (e.g., paralysis or hypoesthesia) but no positive FNS (such as seizures), and no central nervous lesions. The FNSD sample was compared to a sample of $n = 82$ HC, who were recruited from the local community by flyers and oral advertisement. Exclusion criteria were current or lifetime mental disorders (assessed by the German version of the MINI international Neuropsychiatric Interview, Ackenheil, Stotz, Dietz-Bauer, & Vossen, 1998) and / or neurological disorders. HC were comparable to the patient samples with respect to age and gender distribution, and educational level (see Table 1).

2.2. Material and methods

2.2.1. Study design and measures

The study design was reviewed and approved by the Institutional Review Board (Ethics Committee) of the University of Konstanz and the boards of the neurological rehabilitation center Kliniken Schmieder. Prior to the assessment, each participant was informed about the study objectives and procedures and provided written informed consent. ACE

Table 1
Sociodemographic information of participants.

	FNSD patients	HC	FNSD patients vs. HC
N	82	82	164
Gender (number of f/m)	60/22	59/23	$\chi^2 = 0.03$, $p = .86$
Age in years (M \pm SD)	41.63 \pm 13.92	45.94 \pm 15.26	$t(162) = 1.89$, $p = .06$
Number of school years (M \pm SD)	13.82 \pm 4.35	14.78 \pm 2.55	$t(162) = 1.72$, $p = .09$

Note. FNSD functional neurological symptom disorder; HC = healthy comparison participants; f = female; m = male. M \pm SD: Means \pm Standard deviation

were assessed by standardized semi-structured interviews. Severity of FNS, alexithymia, depressive and trauma-related symptoms was determined by self-report questionnaires. Data assessment lasted about 2–3 h per participant.

The German version of the Maltreatment and Abuse Chronology of Exposure Scale (MACE, Teicher & Parigger, 2011; German 'Kindheitserfahrungen, KERF, Isele et al., 2014) includes 70 items covering the ten domains parental verbal abuse, parental non-verbal emotional abuse, parental physical abuse, emotional neglect, physical neglect, familial and non-familial sexual abuse, witnessed physical violence towards parents, witnessed violence towards siblings, peer emotional and peer physical violence. Experiences per domain are scored together with the age of onset and duration of the respective experience between the ages of 4 to 18 yrs. Convergent validity of the MACE was verified by correlation with the Childhood Trauma Questionnaire (Wingenfeld et al., 2010) and good test-retest reliability has been established ($r_{tt} = 0.91$ at 10 weeks; Isele et al., 2014). The present analyses considered the overall severity of exposure to childhood adversities (MACE sum), which, varied between 0 (no childhood adversities at all) and 75, 42 in the present sample (of maximal 180, if exposure to all types of childhood adversities). For group comparison and regression analyses, sum-scores of the 10 subscales (each providing scores between 0 and 100) were collapsed to the categories (abuse and neglect) and time (ages 4–9 yrs defined as childhood, 10–15 yrs covering early adolescence). Each of the four categories represents the mean score of the respective subscale (see Table 2 for definition and means \pm SD for types (neglect, abuse) and time windows (4–9 yrs, 10–15 yrs)).

FNS severity was evaluated by the Somatoform Dissociation Questionnaire (SDQ-20; German Version: Mueller-Pfeiffer et al., 2010), which shows good internal consistency and reliability (SDQ-20, Mueller-Pfeiffer et al., 2010: $\alpha = 0.91$, $r_{tt} = 0.89$).

Alexithymia was assessed with the Toronto Alexithymia Scale (TAS-26; Bagby, Parker, & Taylor, 1994a,b; German version: Kupfer, Brosig, & Brähler, 2001). Moreover, the Beck Depression Inventory (BDI-2) was employed for the screening of depressive symptoms, and trauma-related symptoms were measured with the Posttraumatic Stress Diagnostic Scale (PDS; Foa, Cashman, Jaycox, & Perry, 1997; German version: Ehlers, Steil, Winter, & Foa, 1996), which shows good internal consistency ($\alpha = 0.94$) and validity (Griesel, Wessa, & Flor, 2006). Comorbid diagnoses of MDD and PTSD in the patient sample are reported in supplementary Table 1.

2.3. Statistical analyses

Group differences in ACE and symptom expression were evaluated by Mann–Whitney U-tests (Tables 2 and 3, respectively). Effect sizes

⁴ Experiences reported at age 4 years and later were considered as reliable (cf. e.g. Bauer, 2014).

Table 2
Median, range and group comparisons of adverse childhood experiences, ACE.

	FNSD patients median (IQR)	HC median (IQR)	FNSD patients vs. HC
Overall ACE	31.69 (8.23–68.68) n = 82	7.94 (1.44–26.55) n = 82	$U = 1871.5, z = -4.72^{***}, r = -0.37$
ACE sum 4–9 yrs,	0.89 (0.28–2.17) n = 82	0.25 (0.02–0.85) n = 82	$U = 2084, z = -4.21^{***}, r = -0.33$
ACE sum 10–15 yrs,	1.18 (0.4–2.8) n = 82	0.26 (0.03–0.89) n = 82	$U = 1888, z = -4.86^{***}, r = -0.38$
Sum Abuse	11.67 (2.73–30.84) n = 81	2.69 (0.25–8.61) n = 82	$U = 1855, z = -4.87^{***}, r = -0.38$
Abuse 4–9 yrs	0.5 (0.05–1.35) n = 82	0.16 (0–0.51) n = 82	$U = 2296.5, z = -3.54^{***}, r = -0.28$
Abuse 10–15 yrs	1.07 (0.21–2.38) n = 82	0.25 (0–0.61) n = 82	$U = 1918, z = -4.77^{***}, r = -0.37$
Sum neglect	19.50 (0.25–43.50) n = 82	4 (0–15.63) n = 82	$U = 2197, z = -3.80^{***}, r = -0.30$
Neglect 4–9 yrs	1.17 (0–3) n = 82	0.25 (0–1) n = 82	$U = 2266.5, z = -3.68^{***}, r = -0.29$
Neglect 10–15 yrs	1.13 (0–3.1) n = 82	0 (0–1.02) n = 82	$U = 2171.5, z = -4.07^{***}, r = -0.32$

Note. ACE: Adverse Childhood Experiences Abuse: emotional and physical abuse during childhood, including parental verbal abuse, parental non-verbal emotional abuse, parental physical abuse, witnessed physical violence towards parents, witnessed violence towards siblings, peer emotional violence, peer physical violence, familial and non-familial sexual abuse; Neglect = emotional and physical neglect. Overall ACE = sum of experiences across all 10 domains and age 4–18 yrs; Sum Abuse, Sum Neglect: experiences per type summed up for entire age range 4–18 yrs: ACE sum 4–9 yrs: ACE sum 10–15 yrs, sum of abuse and neglect per age range. Comparison between Abuse and Neglect was possible, because each score was divided by the number of its subdomains (i.e., 8 subdomains for Abuse, 2 subdomains for Neglect). FNSD patients = patients with functional neurological symptom disorder; HC = healthy comparison participants; IQR = interquartile range; asterisks indicate significance of $^{***} p < .001$.

Table 3
Median, range and group comparisons of symptom severity and alexithymia.

	FNSD patients n = 82 median (IQR)	HC n = 82 median (IQR)	FNSD patients vs. HC
Symptom severity			
FNS	30 (27–36)	21 (20–22)	$U = 429.5, z = -9.71^{***}, r = -0.76$
PTSD symptoms	8.5 (0–23.25)	0 (0–1)	$U = 1527.5, z = -6.5^{***}, r = -0.51$
Depressive symptoms	14 (7–22.25)	1 (0–4)	$U = 592.50, z = -9.2^{***}, r = -0.51$
Alexithymia score	2.67 (2.31–2.94)	2.08 (1.81–2.35)	$U = 1300, z = -6.79^{***}, r = -0.72$

Note. FNSD = functional neurological symptom disorder; HC = healthy comparison participants; IQR = interquartile range; PTSD = posttraumatic stress disorder. Asterisks indicate significance of $^{***} p < .001$.

FNS: Functional neurological /Somatoform dissociative symptoms per SDQ-20; PTSD symptoms per PSSI; depressive symptoms per BDI. Alexithymia per TAS-26 (see Methods section for assessment instruments).

were calculated using the estimate “ r ” described by Rosenthal (1991). Deviation from normality within subgroups required non-parametric testing. Moreover, a particular impact of the type of ACE on FNS severity was tested using Spearman correlations (abuse and neglect; Tables 4). The Holm–Bonferroni method corrected for multiple testing (Gaetano, 2013). Group differences between correlation coefficients were tested following the algorithm proposed by Eid, Gollwitzer, and Schmitt (2011) implemented in the freeware by Lenhard and Lenhard (2014).

Forced-entry multiple regression analysis evaluated the contribution of overall ACE severity (MACE sum) and alexithymia on FNS severity, testing hypothesis (3). A mediation analysis evaluated the impact of alexithymia on the relationship between overall ACE severity and FNS. Using a non-parametric resampling approach suggested by Hayes and Rockwood (2017) path coefficients were estimated in a multiple mediator model and bias-corrected bootstrap confidence intervals for both total and specific indirect effects were generated. Due to small sample size, 95% bootstrap confidence intervals based on 10,000 bootstrap samples were obtained. All statistical analyses were computed with an alpha level set to 5%. One-sided hypotheses were tested one-tailed. Similar regression models evaluated the impact of alexithymia on the severity of other psychological symptoms (i.e., depression, PTSD).

3. Results

In support of hypothesis (1), FNSD patients reported more abuse and neglect experiences in childhood than HC. Whereas a Wilcoxon Signed-Rank Test indicated that FNSD patients reported more neglect than abuse experiences ($Z = -3.05, p = .00$), group differences were similar for abuse and neglect experiences (compare Fig. 1). Whereas 81.7% of HC reported at least one ACE (18.3% none, 19.5% no abuse, 16.6% no neglect experience), 95.1% reported more than one ACE in the FNSD-sample (6.1% had not experienced abuse, 23.2% no neglect). Also in support of hypothesis (1) FNSD patients reported more overall adverse experiences than HC during childhood (4–9 yrs) as well as during adolescence (10–15 yrs), while median values (Table 2) did not indicate higher ACE load in early childhood than in early adolescence.

As expected, patients reported more FNS, alexithymia, depression, and PTSD symptoms than HC (Table 3). FNSD patients also showed higher depressive, and posttraumatic symptoms. As summarized in Table 4B, symptom-intercorrelations in FNSD patients indicated comorbidity of FNS, depression and PTSD in somatoform symptom disorders.

The hypothesized influence of ACE on symptom severity was confirmed for the entire sample (see Table 4A), whereas correlations did

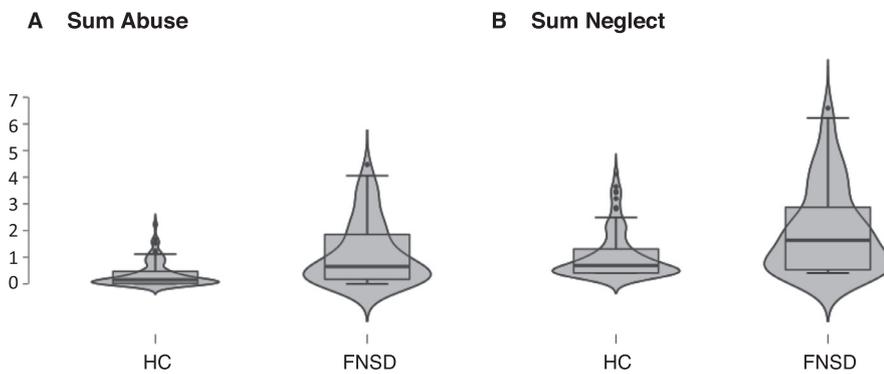


Fig. 1. Abuse and Neglect in childhood and adolescence. Box plots illustrating means, standard deviations maxima and minima, and single-participant distributions for each group

A the sum of abuse and

B the sum of neglect in childhood and adolescence.

Comparison between Abuse and Neglect is possible, because each sum score was divided by the number of its subdomains (i.e., the 8 subdomains for Abuse: emotional and physical abuse during childhood, including parental verbal abuse, parental non-verbal emotional abuse, parental physical abuse, witnessed physical violence towards parents, witnessed violence towards siblings, peer emotional violence, peer physical violence, familial and non-familial sexual abuse; and the 2 subdomains for

Neglect: emotional and physical neglect). FNSD patients = patients with functional neurological symptom disorder; HC = healthy comparison participants. For (non-parametric) statistical comparisons see Table 2.

not reach significance for subsamples (FNSD, HC), and ACE types (Table 4B). For the entire sample, Table 4B also illustrates relationships between ACE and depression and PTSD symptoms. Yet, only the correlation between PTSD symptoms and FNSD symptoms showed a significant difference (PTSD und FNS after Bonferroni–Holm correction ($z = 3.16, p = .018$)).

Hypothesis (3) addressed the potential mediating impact of alexithymia on the relationship between ACE and symptom severity. Table 5 summarizes the correlations between alexithymia and ACE, and between alexithymia and symptom severities for the entire sample and for each subsample. While moderate correlation coefficients for the entire sample indicate higher alexithymia in individuals with higher ACE load (abuse and neglect), significant associations could not be confirmed for subsamples (probably as a result of lower power).

The relationship was further examined by multiple regression analysis (including the entire sample): additive effects of overall ACE and alexithymia on FNS severity were supported by $\beta_{MACE\ sum} = 0.31, p < .001$, and $\beta_{TAS-26} = 0.33, p < .05$ (adjusted $R^2 = 0.26; p < .001$). The mediation analysis (see Fig. 2A) confirmed the positive total effect of overall ACE severity on FNS: while the direct effect of overall ACE severity on FNS severity remained significant after adjusting for alexithymia, a bootstrapping procedure revealed a positive total indirect effect of overall ACE severity on FNS severity through alexithymia (bias-corrected $CI_{0.95} = 0.03, 0.76$).

The mediating effect of alexithymia on the relationship between ACE and indices of mental illness was not restricted to FNS: As reported above, ACE was also related to the intensity of depressive and post-traumatic stress symptoms (see Table 4A and Fig. 2). A similar mediating impact of alexithymia on the relationship between ACE and symptoms of depression and PTSD in cases and controls is illustrated in Figure 2B and C (additive effects of overall ACE and alexithymia on depressive symptom severity were supported by $\beta_{MACE\ sum} = 0.36, p < 0.001$, and alexithymia ($\beta_{TAS-26} = 0.43, p < .001$, adjusted

$R^2 = 0.41; p < .001$) and posttraumatic stress symptoms (additive effects of overall ACE and alexithymia on posttraumatic stress symptom severity were supported by $\beta_{MACE\ sum} = 0.38, p < .001$, and alexithymia ($\beta_{TAS-26} = 0.26, p < .001$, adjusted $R^2 = 0.27; p < .001$)).

4. Discussion

The emergence of medically unexplained, thus, functional neurological symptoms in somatic symptom disorders is often explained in the framework of ‘conversion’. Conversion implies an impact of (presumably early traumatic) experiences on later symptom development, presumably mediated by changes in affect regulation consequent upon the traumatic experience. Conversion has been paraphrased as warding off painful emotions activated by stress or stimuli associated with the earlier traumatic experiences by accentuating the (emotional) arousal response as bodily symptoms instead. The present study empirically addressed distinct assertions of this conversion hypothesis, scrutinizing the kind of early emotionally arousing experiences and a mediating role of altered affect regulation, indexed by alexithymia. Results confirmed higher prevalence of childhood adversities in a sample of 82 FNSD patients compared to a sample of healthy comparison participants, whereas a dominance of severe, sexual trauma in FNSD was not verified. Rather, neglect was more prevalent than abuse experiences in both samples. A recent meta-analysis that aggregated data from 34 studies with 1405 FNSD patients (Ludwig et al., 2018) confirmed a higher rate for emotional neglect in childhood (odds ratio (OR) 5.6) compared with sexual abuse (OR 3.3) or physical abuse (OR 3.9) in patients than in healthy control participants. The population attribution fraction (PAF) was highest for physical abuse in childhood (16.9%; 14.6% in adulthood), followed by emotional neglect (15.1% in childhood and 11.0% in adulthood), and sexual abuse (8.7% in childhood and 4.8% in adulthood). However, given that many patients with FNSD did not report any life events, the relevance of life events for FNSD

Table 4A
Association between ACE and symptom severities (FNS, depressive and PTSD symptoms).

	FNS			Depressive symptoms			PTSD symptoms		
	Entire sample	FNSD patients	HC	Entire sample	FNSD patients	HC	Entire sample	FNSD patients	HC
Overall ACE	0.46	0.26	0.30	0.48	0.34	0.28	0.37	0.39	−0.03
	$p < .001$	$p = .064$	$p = .036$	$p < .001$	$p = .001$	$p = .054$	$p < .001$	$p < .001$	$p = 1$
	$n = 163$	$n = 81$	$n = 82$	$n = 163$	$n = 81$	$n = 82$	$n = 163$	$n = 81$	$n = 82$
Abuse	0.44	0.30	0.23	0.43	0.27	0.17	0.39	0.41	−0.02
	$p < .001$	$p = .044$	$p = .100$	$p < .001$	$p = .064$	$p = .264$	$p < .001$	$p < .001$	$p = 1$
	$n = 163$	$n = 81$	$n = 82$	$n = 163$	$n = 81$	$n = 82$	$n = 163$	$n = 81$	$n = 82$
Neglect	0.43	0.26	0.38	0.46	0.38	0.29	0.36	0.38	0.02
	$p < .001$	$p = .064$	$p < .001$	$p < .001$	$p < .001$	$p = .044$	$p < .001$	$p < .001$	$p = 1$
	$n = 163$	$n = 81$	$n = 82$	$n = 163$	$n = 81$	$n = 82$	$n = 163$	$n = 81$	$n = 82$

Note. ACE = adverse childhood experiences; FNSD = functional neurological symptom disorder; HC = healthy comparison participants; PTSD = posttraumatic stress disorder. Coefficients with $p < .05$ (Bonferroni–Holm corrected) are marked by bold letters.

Table 4B
Association between symptom severities (FNS, depressive and PTSD symptoms).

	FNS			Depressive symptoms			PTSD symptoms		
	Entire sample	FNSD patients	HC	Entire sample	FNSD patients	HC	Entire sample	FNSD patients	HC
Depressive symptoms	0.70	0.44	0.19				0.55	0.49	0.01
	<i>p</i> < .001	<i>p</i> < .001	<i>p</i> = .123				<i>p</i> < .001	<i>p</i> < .001	<i>p</i> = .384
	<i>n</i> = 164	<i>n</i> = 82	<i>n</i> = 82				<i>n</i> = 164	<i>n</i> = 82	<i>n</i> = 82
PTSD symptoms	0.51	0.39	−0.09	0.55	0.49	0.01			
	<i>p</i> < .001	<i>p</i> < .001	<i>p</i> = .384	<i>p</i> < .001	<i>p</i> < .001	<i>p</i> = .384			
	<i>n</i> = 164	<i>n</i> = 82	<i>n</i> = 82	<i>n</i> = 164	<i>n</i> = 82	<i>n</i> = 82			

Note. FNSD = functional neurological symptom disorder; HC = healthy comparison participants; PTSD = posttraumatic stress disorder. FNS: Functional neurological /Somatoform dissociative symptoms per SDQ-20; PTSD symptoms per PSSI; depressive symptoms per BDI; alexithymia score per TAS-26. Bold text indicates correlations with a *p*-value less than 0.05 (Bonferroni–Holm corrected).

Table 5
Association between alexithymia and ACE and alexithymia and symptom severities (per (sub-) sample).

	Alexithymia score		
	Entire sample	FNSD patients	HC
Overall ACE	0.32	0.14	0.18
	<i>p</i> < .001	<i>p</i> = .600	<i>p</i> = .406
	<i>n</i> = 163	<i>n</i> = 81	<i>n</i> = 82
Abuse	0.32	0.112	0.18
	<i>p</i> < .001	<i>p</i> = .745	<i>p</i> = .392
	<i>n</i> = 163	<i>n</i> = 81	<i>n</i> = 82
Neglect	0.32	0.27	0.11
	<i>p</i> < .001	<i>p</i> = .070	<i>p</i> = .745
	<i>n</i> = 163	<i>n</i> = 81	<i>n</i> = 82
FNS	0.49	0.27	−0.04
	<i>p</i> < .001	<i>p</i> = .070	<i>p</i> = .745
	<i>n</i> = 164	<i>n</i> = 81	<i>n</i> = 82
Depressive symptoms	0.57	0.40	0.09
	<i>p</i> < .001	<i>p</i> < .001	<i>p</i> = .745
	<i>n</i> = 164	<i>n</i> = 82	<i>n</i> = 82
PTSD symptoms	0.42	0.28	0.12
	<i>p</i> < .001	<i>p</i> = .066	<i>p</i> = .745
	<i>n</i> = 164	<i>n</i> = 82	<i>n</i> = 82

Note. ACE = adverse childhood experiences; functional neurological symptoms; FNSD = functional neurological symptom disorder; HC = healthy comparison participants; PTSD = posttraumatic stress disorder. FNS: Functional neurological /Somatoform dissociative symptoms per SDQ-20; PTSD symptoms per PSSI; depressive symptoms per BDI; alexithymia score per TAS-26. Bold text indicates correlations with a *p*-values less than .05 (Bonferroni–Holm corrected).

diagnosis remains to be clarified (see Ludwig et al., 2018 and Roelofs & Pasman, 2016 for an overview on the ongoing discussion). To conclude, the present findings of augmented experiences of abuse and neglect are not sufficient to disprove the hypothesized specific impact of sexual

abuse in FNSD, but emphasize the role of overall load ACE in the emergence of FNS.

Present FNSD patients were characterized by FNS and comorbid psychological symptoms of depression and posttraumatic stress. This is in accordance with reports of depression (Sar et al., 2004) and PTSD (e.g., Sar et al., 2003) as frequent comorbid diagnoses in individuals diagnosed with dissociative disorders. Moreover, frequent ACE have been reported in patients diagnosed with different psychiatric disorders (including PTSD, depression, BPD and schizophrenia) and relationships between ACE and depressive, dissociative, and posttraumatic symptoms have been reported across diagnoses (e.g., Bick & Nelson, 2016; Fiess et al., 2015; Kienle et al., 2017; Matz, Pietrek, & Rockstroh, 2010; Schalinski et al., 2016). The present result of similar relationships in FNSD patients suggest that adverse experiences during critical periods of brain and stress system development operate as nonspecific moderators of the vulnerability for psychopathological development and promote a more severe course of the respective mental illness. Only by comparing different diagnostic groups, this role of ACE as general stressor (see Ludwig et al., 2018; Roelofs & Pasman, 2016) sensitizing for psychopathological development can be distinguished from specific effects of specific types of ACE on FNS.

The present study addressed assumed altered affect perception and expression (as a consequence of early emotionally painful experiences) through alexithymia. Indeed, alexithymia was influenced by ACE in the present sample, and mediated the relationship between ACE and symptom severity. Of note, these relationships were not confirmed as significant for FNSD patients in particular (which may be partly attributable to reduced power). Whereas a relationship between alexithymia and FNS, psychological trauma, affective and anxiety symptoms has frequently been reported (e.g., Jalilianhasanpour et al., 2018; Kienle et al., 2017; Li, Zhang, Guo, & Zhang, 2015; Myers, Matzner, Lancman, Perrine, & Lancman, 2013; Terock et al., 2016, for patients diagnosed with non-epileptic seizures; see also Kienle et al., 2017,

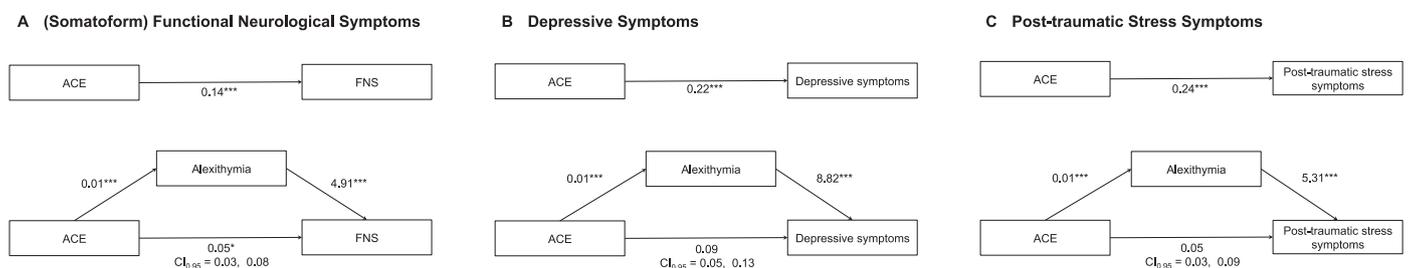


Fig. 2. The relationship between adverse childhood experiences (ACE) and symptom severities – and its mediation via alexithymia for...
A (Somatoform) Functional Neurological Symptoms. *Upper part:* Association between emotional ACE (per MACE sum score), and FNS severity (per SDQ-20 score). *Lower part:* Association between ACE and FNS severity through alexithymia (per TAS-26).
B Depressive Symptoms. *Upper part:* Association between emotional ACE (per MACE sum score), and depressive symptom severity (per BDI score). *Lower part:* Association between ACE and depressive symptom severity through alexithymia (per TAS-26).
C Posttraumatic Stress Symptoms. *Upper part:* Association between emotional ACE (per MACE sum score), and posttraumatic stress symptom severity (per PDS score). *Lower part:* Association between ACE and posttraumatic stress symptom severity through alexithymia (per TAS-26). Unstandardized beta coefficients are shown for each path. Asterisks indicate significance of * *p* ≤ 0.05, ** *p* < .01, *** *p* < .001. Data from the entire sample was used for calculations.

Steffen et al., 2015), a mediating effect of alexithymia in the sense of conversion has not been reported. Alexithymia may not be the suitable index of conversion-relevant change in emotion processing: For instance, Demartini et al. (2014) describe alexithymia as cognitive aspect of affect regulation rather than manifestation of warded-off painful emotions in the aftermath of trauma-related emotions. Yet, the present results emphasize the significance of ACE on abnormal development of affect regulation, which may be manifest in depression, PTSD, and FNS.

Conclusions are further limited by the used and available instruments for measuring FNS and alexithymia: whereas the SDQ-20 seems to be the only available, adequately validated instrument for the assessment of somatoform dissociative symptoms / FNS to date, some items address more than pure (motor and/or sensory) FNS. Yet, test criteria such as internal consistency and reliability refer to the entire questionnaire. Thus, present identification of FNSD by SDQ-20 might lack definition clarity. Moreover, TAS-26 assessed alexithymia overlaps with features of depression and neglect experience, which resulted in intercorrelation of these three factors. Further validation of the conversion hypothesis requires the integration of objective evidence on stressors, their impact on emotion processing, and consideration of the individual life/learning history that bridges the gap between the experience of emotional childhood traumata, psychological and biological consequences, and their establishment as bodily symptoms in adult patients.

4.1. Conclusion

Taken together, present results confirm a broad range of negative consequences of childhood adversities, manifest in somatoform dissociation (FNS), depression, emotion perception, expression and regulation, and anxious narrowing of attention to body sensations. Considering the spectrum of abnormalities and similar prevalence of ACE in patients with other diagnoses than FNSD suggest a nonspecific sensitizing role of ACE in the development of psychopathology. The evident role of altered emotion processing in this development may prompt the discussion as to what extent the concept of conversion applies to psychopathology in general (Kozłowska, 2005; Vuilleumier, 2014). Complementary, specifying the roles of abuse, emotion processing, and their relation to FNS implied by the conversion concept requires comparison of diagnostic groups and individual learning histories.

Conflict of interest statement

The authors declare no competing interests, for further details please see the respective uploaded declaration.

Funding

Research was supported by the German Research Council (Deutsche Forschungsgemeinschaft; grant to one of the first authors, project number STE 2263/2-1) and the University of Konstanz.

Acknowledgments

We thank the physicians and psychologists of the Psychotherapeutic Neurology section, Kliniken Schmieder Konstanz and Gailingen for patient recruitment and the Lurija Institute of the Schmieder Foundation for support of the study.

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