



Attachment State of Mind and complex traumatization in patients with Functional Motor Disorder (Motor Conversion Disorder)

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ABSTRACT

Introduction: Functional Motor Disorder (FMD) is characterized by motor neurological symptoms that cannot be explained by typical neurological diseases or other medical conditions. The role of psychological factors in the development, severity, and persistence of FMD remains unclear. We investigated the Attachment State of Mind (SoM) in FMD patients using the Adult Attachment Interview (AAI) and retrospectively examined the quality of their traumatic experiences, if any.

Methods: Thirty FMD patients and thirty healthy controls (HC) underwent the AAI and were classified according to both the three-way classification (Free/Secure, Dismissing or Entangled SoM) and the four-way classification (Unresolved SoM, indicating unelaborated traumatic events). Frequency and quality of adverse childhood experiences before the age of 14 were assessed via the Complex Trauma Questionnaire (ComplexTQ).

Results: Among HC, 53.3% exhibited a Free/Secure SoM, while 73.3% of FMD patients displayed an Insecure SoM (Entangled or, primarily, Dismissing). Individuals with Insecure SoM were three times more likely to manifest FMD. Unresolved Trauma was present in 26.7% of HC and 46.7% of FMD patients, with Unresolved Trauma leading to a fourfold increase in the likelihood of manifesting FMD. FMD patients reported significantly higher neglect from both parents, physical abuse from the mother, and parental loss compared to HC.

Discussion: Using a gold-standard instrument for evaluating Attachment SoM, we found that FMD patients had a significantly higher prevalence of Insecure SoM and childhood traumatic unresolved events compared to HC, supporting previous literature assessing FMD Attachment Styles through self-report questionnaires. We discuss the potential pathophysiological, neurobiological, and therapeutic implications of our findings.

1. Introduction

Functional Neurological Symptom Disorder (FND, also named Conversion Disorder) is characterized by symptoms of altered voluntary motor or sensory function that cannot be explained by typical neurological diseases or other medical conditions, but nevertheless authentic, determining clinically significant impairment in the patient's daily life

(American Psychiatric Association, 2021). Despite being a potentially reversible disorder, FND are a common source of disability in medicine, associated with high rates of comorbid mental health disorders (Carson et al., 2011) and often leading to loss of employment and need for disability benefit (Carson and Lehn, 2016), with a consequent high impact on national health services. The prevalence of the disorder is estimated to be around 5% (American Psychiatric Association, 2021);

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the most common onset is in adolescence or early adulthood, but it can also appear in childhood (Paleari et al., 2022) and in elder people (Geroïn et al., 2024). FND is more common in women than men, with a ratio ranging from 2:1 to 10:1 (McLoughlin et al., 2023) and has higher incidence in lower socioeconomic environment (American Psychiatric Association, 2021). One of the most common manifestations of FND is Functional Motor Disorders (FMD), which might encompass a broad spectrum of disturbances including weakness; hyperkinetic motor symptoms, such as tremor, myoclonus, jerks, tic, dystonia, paroxysmal dyskinesia or a combination thereof; hypokinetic motor symptoms, such as parkinsonism; and walking, balance and posture disorders.

Early investigations into FND pathophysiology, based on Freudian psychoanalytic theory, proposed that functional symptoms stemmed from repressed, often sexual, drives, converting psychic energy into physical symptoms – hence the term “Conversion Disorder”, a concept enduring into the DSM-5-TR (Levenson and Sharpe, 2016; Erro et al., 2016). In the last decades, new aetiopathological hypotheses integrating psychology and neurobiology have emerged, as consensus has been reached that this condition should be understood within a bio-psycho-social framework. The debate is still ongoing about how much psychological precipitating events contribute to the origin, exacerbation, severity, or maintenance of FND (Gelauff et al., 2014; Jalilianhasanpour et al., 2018; McKee et al., 2018). It was found that a history of “Adverse Life Events” (such as maltreatment, physical and sexual abuse, emotional neglect) is significantly more frequent in FND patients than in control subjects (Steffen et al., 2015; Ludwig et al., 2018; Pick et al., 2019), and that recalling these traumatic events during a structured clinical interview was associated with the manifestation of the functional symptoms experienced by the patient (Kanaan et al., 2007). In addition to the traditional focus on environmental and psychological factors in FND, the role of Attachment Styles (AS, in children) and Attachment States of Mind (SoM, in adults) is also under investigation (Brown et al., 2013; Green et al., 2017; Jalilianhasanpour et al., 2019; Williams et al., 2018; Gerhardt et al., 2020; Cuoco et al., 2021).

According to Attachment Theory, the main purpose of the Attachment System is for the child to receive security and protection by the caregiver in situations perceived as threatening. If the adult is responsive, the child will be inclined to develop a Secure Attachment, which promotes a sense of self-confidence in the child, progressively fostering autonomy. Otherwise, the child may develop an Insecure Attachment, which, depending on the quality of the response received, may be characterized by Avoidance (marked by a child’s apparent indifference towards the caregiver; they often do not seek much comfort or contact from the caregiver and may appear self-reliant, suppressing their emotional needs and avoiding intimacy or closeness), or Ambivalence (characterized by a child’s intense anxiety and uncertainty about the caregiver’s availability and responsiveness) (Ainsworth et al., 1978). These emotional bonds strongly influence the child’s ability to adapt to new experiences; they contribute to the development of multiple mental representations of self and others (Bowlby, 1958, 1969, 1979), of an enduring template for how they (and any possible Attachment figures) are supposed to behave in future relationships, and of emotional regulation skills, ultimately increasing vulnerability to adult psychopathology disturbance, in interaction with various life conditions (Sroufe, 1996; Bifulco et al., 2006). A severe lack of attunement between child and caregiver can lead to a chronic state of alarm in the child; in more extreme cases, where the caregivers themselves are perceived as a source of alarm due to being, for example, frightening, aggressive, or neglecting, children might manifest disorganized Attachment conducts: they simultaneously or rapidly exhibit contradictory behaviours, engage in stereotypes, display freezing behaviours, and appear stupefied when the caregiver leaves. Such Adverse Childhood Experiences (ACEs) (Felitti et al., 1998; Hamai et al., 2022) are considered traumatic as they lead to chronic dysregulation of emotional, behavioural, neurobiological and physiological arousal, ultimately affecting the individual’s mental (Fernandez et al., 2011) and physical (Mauder and Hunter,

2008, 2009; Mauder et al., 2019) health in adulthood. ACEs can be distinguished in major traumatic events that are typically life-threatening or severely distressing, such as natural disasters, violent assaults, or severe accidents (commonly referred to “Big T Trauma”), and not life-threatening distressing experiences (“small t trauma”) occurred repeatedly over time.

In adulthood, individuals categorized as Free/Secure/Autonomous (F), which partially overlaps with Secure AS in children, tend to have higher self-esteem, longer-term healthy relationships, and a better ability to trust others for social support. Dismissing (DS) individuals, partially mirroring Avoidant AS in children, tend to downplay the importance of vulnerability and Attachment in their early and adult lives. Consistent with Ambivalent AS, Entangled (E) individuals tend to be less aware of their own and others’ boundaries and have a strong need for emotional closeness and reassurance from others. Finally, individuals with Unresolved (U) Attachment SoM have a traumatic history in their childhood (e.g., abuse or loss) that they have not been able to effectively process and integrate.

The Adult Attachment Interview (AAI) is considered the gold standard to investigate adults’ SoM, being widely validated and characterized by a high inter-rater reliability (George et al., 1985). Individuals classified as U in the AAI also receive an underlying classification of F, DS, or E (i.e., U/F, U/DS, or U/E) and are associated, in a more complex etiological model, with those defined as fearful Attachments (Cassidy and Mohr, 2001; Lyons-Ruth et al., 2003), whereas the Cannot Classify (CC) category is used when a global breakdown in the organization and maintenance of a singular strategy is identified during the AAI (Hesse, 1996). The AAI transcripts of U individuals are characterized by chaotic narratives that show similar features of confusion, dissociation and incoherence as observed in disorganized behavior of children (George et al., 1985; Hesse and Main, 2000; Lyons-Ruth et al., 2005). The scientific literature shows that there is a strong association between a U SoM and increased levels of ACEs, particularly in clinical samples. Murphy et al. (2014) found that 84% of their clinical sample, composed by children in charge at the Center for Babies, Toddlers and Families (Albert Einstein College of Medicine, Bronx, NY) because of “concern regarding the parent’s ability to meet their child’s emotional needs” [40, p. 226] had 4 or more ACEs compared to 27% in the community sample, and 65% who were classified as U or globally disorganized (CC) had 4 or more ACEs compared to 9% of the community sample.

Insecure AS and SoM, particularly Avoidant and Dismissing, are more prevalent in individuals with alexithymia, characterized by the difficulties in understating one’s own feelings at the cognitive level (Scheidt et al., 1999). Similarly, it was observed that Insecure Attachment behaviours in adults correlate with heightened somatization and dysfunctional emotion regulation (Waldinger et al., 2006), anticipating some recent findings in patients with FND. Implementing different assessment techniques, the following findings emerged: (i) a Fearful AS was associated with greater severity of functional motor symptoms and various other conditions including depression, anxiety, dissociation, alexithymia, and dysfunctional coping (Williams et al., 2019); (ii) a Secure AS predicted improvement in functional symptoms, evaluated with a clinical follow-up after six months from the first assessment (Jalilianhasanpour et al., 2018); (iii) there was a lower incidence of Secure AS in patients with Functional Seizures (formerly referred to as psychogenic non-epileptic seizures, PNES) with respect to patients with epilepsy (Holman et al., 2008) and healthy controls (Gerhardt et al., 2020); (iv) on the other hand, no differences in terms of Attachment Styles between patients with Functional Seizures and patients with epilepsy (Brown et al., 2013; Green et al., 2017) were found. Our group (Cuoco et al., 2021) recently found that: (i) FND patients overall show higher values related to avoidant Attachment behaviours (evaluated through a self-report scale, the Experiences in Close Relationships-Revised (ECR-R) compared to patients with organic neurological disorders; (ii) in patients with FND, avoidance was an independent predictive factor of comorbid psychiatric symptoms; (iii),

that avoidance, the somatic component of depression (evaluated through the Beck Depression Inventory – II), and alexithymia were independent predictive factors of the presence of FND, suggesting that the co-occurrence of these three elements might trigger maladaptive responses leading to the emergence of functional neurological symptoms (Cuoco et al., 2021). However, all these studies are limited by the fact that they refer to different theoretical models of Adult Attachment, and consequently by the use of different tools for Attachment assessment; moreover, most of the studies used self-administered clinical scales, often deemed inadequate for capturing unconscious processes (Hesse et al., 1999).

1.1. Aims of the study

Aims of the present study were to: (i) investigate FMD patients' Attachment SoM by implementing the Adult Attachment Interview (AAI), (ii) assess whether the distributions of Attachment SoMs differ between FMD patients and a group of healthy controls (HC), and (iii) retrospectively study the quality of trauma in the group of FMD patients.

2. Methods

2.1. Participants

Thirty patients with FMD were recruited at the tertiary level neuropsychiatric clinic ASST Santi Paolo e Carlo, Presidio San Paolo, Milan, and at the neurology outpatient clinic of the Department of Medicine, Surgery and Dentistry of the University of Salerno. FMD diagnosis was made by an experienced neurologist (RE) and an experienced psychiatrist (BD) according to the DSM-5 and Gupta & Lang (Gupta and Lang, 2009) "clinically established" criteria. Thirty healthy controls subjects, matched for age and biological sex and whose health state was assessed through a detailed anamnestic interview, were enrolled in Turin. Exclusion criteria were as follows: (i) age below 18 years; (ii) inability to understand the instruction of the task; (iii) any other significant neurological or medical illnesses; (iv) comorbid psychotic disorders; (v) comorbid FND and other neurological disorders. The study was approved by the ethics committee of "Milano Area 1" ("Registro Sperimentazioni n.2020/ST/284", Protocol N0010811 March 02, 2022, and further amendments) and the Comitato Etico Territoriale (CET) of the Città della Salute e della Scienza (Protocol CS/218, June 09, 2014 and further amendments), and was conducted in accordance with the Declaration of Helsinki. Each participant signed an informed written consent and was free to withdraw from the experiment at any time without giving further explanation.

2.2. Procedure

First, participants underwent a detailed interview to collect their sociodemographic data. Second, they underwent the Adult Attachment Interview (AAI), a semi-structured interview which aims to evaluate the individual's current representational models of the self and Attachment figures; it consists of 20 open questions (along with additional follow-up questions if needed) and it typically takes about an hour to complete. Questions investigate autobiographical memories related to Attachment figures from early childhood; in particular, the interviewee is asked to provide five adjectives that describe the quality of their relationship with each parent, and to justify these adjectives with memories and experiences. This allows the interviewer to examine experiences of separation from caregivers, and potential bereavements and traumas experienced throughout the patient's life.

Each interview was recorded using a voice recorder, allowing it to be replayed and transcribed verbatim. Transcripts were analyzed by a certified coder blind to the diagnosis at the Department of Psychology of the University of Turin. Coders analyzed two main constructs: the Experience Scale, which investigates the experiences lived by the

interviewee during childhood in relation to caregivers, and the Mind Scale, which analyzes the subject's Attachment State of Mind. To each scale was assigned a score ranging from 1 (extreme of absence) to 9 (extreme of presence). As previously mentioned, according to the outcome of these scales, to each participant was assigned a specific SoM (F, Ds, E), and the presence or absence of Unresolved Trauma (U) (see introduction for further details) (George et al., 1985; Main and Goldwyn, 1998).

Subsequently, AAI transcripts were coded according to the Complex Trauma Questionnaire (ComplexTQ, (Maggiore Vergano et al., 2015), a 70-item instrument that measures the frequency and the quality of adverse childhood experiences (ACEs) occurred before the age of 14 years. Nine domains of interpersonal maltreatment categories have been operationalized: (i) Neglect: parents' failure to adopt behaviors that satisfy the child's needs, being them physical (food, medical care, clothing), emotional (demonstrating affection and support), or educational (such as monitoring the child's school activity or social relationships); (ii) Rejection: a cold or hostile caregiving, in which the parent seems to prefer the child's absence; (iii) Role Reversal: the caregiver seeks support, intimacy, and fulfilment of unmet needs (physical or psychological) from the child, who assumes the role of parent or spouse to reduce the caregiver's distress. (iv) Psychological Abuse: caregivers' behaviors aimed at causing pain, fear, or exerting strict control over the child (e.g. insults, threats, coercive attitudes, or invasive and disproportionate medical treatments); (v) Physical abuse: caregivers' physically aggressive behaviors that might result in injuries; this category also investigates the non-abusive parent's responses to the occurred maltreatment (e.g., defending and comforting the child); (vi) Sexual abuse: any sexual relationship involving physical contact or not. In the former case, it refers to inappropriate kissing, touching, and penetration; in the latter case, it refers to voyeurism, exposure to erotic language, and pornography; items on this scale also investigate whether the participant has been intimidated and threatened not to disclose the abuse, and, if the abuse was disclosed, if the other caregivers did or did not find the report credible, or if they were unable to comfort and protect the child from the abuse. (vii) Witnessing domestic violence: verbal and emotional abuses and aggressive behaviors that occur between parents in the presence of the child; (viii) separations: it is worth mentioning that abandonment, despite being less easily detectable and calculable compared to other types of abuse, constitutes one of the most frequent forms of maltreatment; (ix) significant losses (e.g., death of the caregiver). The raters assigned scores on a 4-point Likert scale (from 1 = never to 4 = often) reflecting the frequency with which such episodes occurred, except for the category related to significant losses which exclusively requires a yes/no response). A total score summarizing the cumulative trauma experience is provided. Importantly, the questionnaire distinguishes events occurred in the relationship with the maternal and paternal Attachment figures, as research suggests that the sex of the caregiver may be important for trauma outcomes (Briere and Rickards, 2007).

2.3. Statistical analysis

First, descriptive analysis for sociodemographic features was conducted. Second, the results from the AAI were analyzed by calculating the frequencies of the different SoM categories (Free/Secure, Dismissing, Entangled) and the presence of Unresolved Trauma (U). χ^2 analysis was performed to assess potential differences between the FMD and HC groups in the distribution of: (i) Free/Secure and Insecure SoM; (ii) Free/Secure, Dismissing, Entangled SoM; (iii) Unresolved SoM. Variables with statistically significant differences in distribution were then included as predictors into a Generalized Linear Model (binary logistic regression) with Group (FMD vs HC) as dependent variable, to assess the impact of having an Insecure and/or an Unresolved SoM on the likelihood of manifesting with FMD.

Finally, differences between the two groups at the ComplexTQ subscales were investigated via either *t*-test for independent sample (results

reported according to Levene's test for homogeneity of variances) and χ^2 analysis.

3. Discussion

The main aim of the present study was to investigate the Attachment SoM and the quality of traumatic events occurred during childhood of patients with FMD by implementing the Adult Attachment Interview (AAI) and the ComplexTQ. We further assessed whether the distribution of SoM and Unresolved Trauma differed between FMD patients and a group of sex- and age-matched HC.

First, we found that in patients with FMD, Insecure SoM was significantly more prevalent than in HC, in whom, instead, the most prevalent SoM was the Free/Secure/Autonomous. It is important to emphasize that Insecure SoM need not be considered pathological per se. However, the SoM significantly influences an individual's ability to cope with traumatic situations, and an Insecure SoM may predispose the person to react with certain difficulties under conditions of vulnerability. As a matter of fact, our findings indicate that participants with an Insecure Attachment were approximately three times more likely to manifest with FMD compared to those with a Free/Secure SoM. This result is consistent with the findings of Jalilianhasanpour and colleagues (Jalilianhasanpour et al., 2018), who found that a Free/Secure AS predicted improvement in functional symptoms, and of Williams et al. (2019), who found an association between a Fearful AS and the severity of functional motor symptoms. However, to the best of our knowledge, this is the first study finding an association between the presence of FMD and Attachment SoM, evaluated with the gold standard instrument such as the AAI. Specifically, most of our patients with FMD showed a Dismissing SoM, confirming the previous results of our group (Cuoco et al., 2021) where we found that FND patients overall showed more avoidant attachment behaviours with respect to both HC and patients with other neurological conditions.

Second, FMD patients had a higher incidence of Unresolved Trauma compared to HC. Again, this association was further confirmed by our finding that individuals with an Unresolved Trauma were approximately four times more likely to manifest with FMD compared to those without. When assessing the quality of traumatic events experienced by the participants, we found that FMD showed higher scores at the items pertaining to Neglect from both the mother's and the father's side, Physical Abuse from the mother, and loss of either the mother or the father (or both). Hence, both "small t" and "big T" traumas were over-represented, and not resolved, in the FMD population. At the AAI, Unresolved individuals implement an unusual use of language that indicates disorganization and disorientation, such as frequent lapsus verbae (i.e., so-called "slip of the tongue", where a person unintentionally says something different from what they meant to say) and apparent interruption of thoughts; they may show feelings of guilt, difficulties in believing that the traumatic events really happened, doubts that what happened could be their fault, or even doubts that the deceased person is in some way still alive and present. This is representative of errors in metacognitive monitoring, indicating transient alterations of the state of consciousness (which manifests itself in the use of emphatic or stereotypical words that are not dictated by personal emotional states, that are difficult to access) (Hesse and Main, 2000; Bakkum et al., 2023).

Common outcomes associated with parental neglect (which can include a lack of attention, affection, and adequate physical and emotional care) significantly influence brain development (particularly the proliferation and connection of neurons during the early years of life), emotional regulation abilities, perception of safety in the surrounding environment, and the child's cognitive and social skills (Glaser, 2000). Neglect can limit opportunities for social learning by reducing exposure to positive stimuli and appropriate behavior models. An unsupported environment can lead to heightened stress responses and compromised emotional regulation. It is also well known that

premature separation from the caregiver can have detrimental consequences on the child's life (Teicher et al., 2022; Strathearn et al., 2020).

It is not new that conversion symptoms might be interpreted as an extreme mechanism to handle traumatic events and thoughts (Levenson and Sharpe, 2016; Kanaan and Craig, 2019). As previously mentioned, psychoanalysis itself was born from the attempt to explain "conversion symptoms". The acknowledgment that FND should be understood within a biopsychosocial framework was reflected in the DSM-5 (American Psychiatric Association, 2013), where the requirement for a causative psychological triggering event was removed from the diagnostic criteria, instead considering it as a potential stressor. It is important to note that this change was driven by the recognition that not all patients disclose a potential traumatic event during the medical consultation when the diagnosis is made, taking further into consideration that they may be unaware of it at a conscious level. In other words, according to the DSM-5 (and DSM-5-TR), the diagnosis of FND should not be withheld if a precipitating psychological factor does not emerge during the clinical examination. However, several studies pointed out that the presence of potential Unresolved Traumatic events in the patient's history should not be disregarded (Pick et al., 2019), and our results further underscore this aspect.

4. Results

The groups were balanced for sex ($\chi^2(1) = 0.067$, $p = 0.796$, with the FMD group composed by 18 females and 15 males, and the HC group composed by 15 females and 15 males) and age ($t(56) = 0.85$, $p = 0.399$, with the mean age of the FMD group being 50.63 ± 16.1 years and the mean age of the HC group being 47.43 ± 12.2 years). Further socio-demographic variables are reported in Table 1.

The majority of the HC (16 out of 30, 53.3%) showed a Free/Secure SoM, while the majority of patients with FMD (22 out of 30, 73.3%)

Table 1
Sociodemographic information.

		FMD	HC
Age, mean (SD)		50.63 (16.1)	47.43 (12.2)
Sex (M/F)		12/18	15/15
Education, N(%)	Elementary School	3 (10)	0(0.0)
	Middle School	5 (16.7)	2 (6.7)
	High School Diploma	13 (43.3)	9 (30)
	Bachelor's Degree or above	5 (16.7)	17 (56.7)
Profession, N(%)	Undeclared	4 (13.3)	2 (6.7)
	Student	4 (13.3)	6 (20)
	Employed	10 (33.4)	20 (66.7)
	Unemployed	8 (26.6)	2 (6.7)
	Retired	7 (23.2)	0 (0.0)
	Undeclared	1 (3.3)	2 (6.7)
Civil state, N(%)	Single	10 (33.3)	17 (56.7)
	Married	15 (50)	9 (30)
	Divorced	2 (6.7)	1 (3.3)
	Undeclared	1 (3.3)	3 (10)
Psychiatric Familiarity, N(%)		8 (26.7)	0 (0)
Psychiatric Comorbidities, N (%)	Depression	7 (17.5)	0 (0)
	Anxiety	6 (15)	0 (0)
	Depression and anxiety	7 (17.5)	0 (0)
	OCD	3 (7.5)	0 (0)
	None	17 (42.5)	0 (0)
Psychopharmacologic treatment, N(%)	Antidepressants	12 (30)	1 (3.3)
	Tranquilizers	8 (20)	0 (0)
	Mood Stabilizer and/or Antipsychotics	3 (7.5)	0 (0)

Abbreviation: FMD = Functional Motor Disorders; HC = Healthy Controls; M/F = Males/Females; N = Numerosity; SD = Standard Deviation.

showed an Insecure SoM, resulting in a statistically significant different distribution between the two groups ($\chi^2(1) = 4.444$, $p = 0.035$). Specifically, in the HC group, 16 (53.3%) participants had a Free/Secure SoM, 6 (20%) had a Dismissing SoM, and 8 (26.7%) had an Entangled SoM; in the FMD group, 10 (33.3%) showed a Free/Secure SoM, 14 (46.7%) a Dismissing SoM, which resulted over-represented, and 6 (20%) an Entangled SoM ($\chi^2(2) = 4.870$, $p = 0.088$). Binary logistic regression showed that the odds ratio (OR) for an Insecure SoM was 3.143 (95% CI [1.091, 9.062], Wald $\chi^2(1) = 4.308$, $p = 0.038$), indicating that individuals with an Insecure SoM were approximately three times more likely to develop FMD compared to those with a Free/Secure SoM; the model was statistically significant (likelihood ratio $\chi^2(1) = 4.511$, $p = 0.034$) (Fig. 1).

The presence of Unresolved Trauma was different between groups ($\chi^2(1) = 6.239$, $p = 0.012$), with the HC group having 8 participants with Unresolved Trauma (of which one had a Free/Secure SoM, 3 had a Dismissing SoM, and 4 and Entangled SoM) and the FMD group having 14 patients with Unresolved Trauma (of which 5 had a Free/Secure SoM, 6 had a Dismissing SoM, and 3 and Entangled SoM). Binary logistic regression showed that the odds ratio (OR) for an Unresolved SoM was 4.375 (95% CI [1.091, 9.062], Wald $\chi^2(1) = 5.825$, $p = 0.016$), indicating that individuals with an Unresolved Trauma were approximately four times more likely to develop FMD compared to those without; the model was statistically significant (likelihood ratio $\chi^2(1) = 6.431$, $p = 0.011$) (Fig. 2).

At the ComplexTQ, patients with FMD showed higher scores at the items pertaining to Neglect from the mother's side ($t(41.3) = 5.1$, $p < 0.001$), Neglect from the father's side ($t(51.3) = 5.9$, $p < 0.001$) and Physical Abuse from the mother ($t(33.4) = 2.7$, $p = 0.011$). Moreover, they showed a significantly higher incidence of loss of both the mother (50% of patients, $\chi^2(1) = 16.705$, $p < 0.001$) and the father (53.3%, $\chi^2(1) = 21.818$, $p < 0.001$) with respect to HC. HC showed higher scores at the Role Reversing scale from the mother's side ($t(58) = -2.8$, $p = 0.007$). No other significant differences emerged. Further details are reported in Table 2.

4.1. Neurobiological considerations

It remains to be clarified how physical symptoms emerge as a psychological defense mechanism. Unresolved Trauma is a superordinate category that implies that an unprocessed, "frozen" traumatic memory can disrupt an organized SoM (whether Free/Secure or Insecure) when

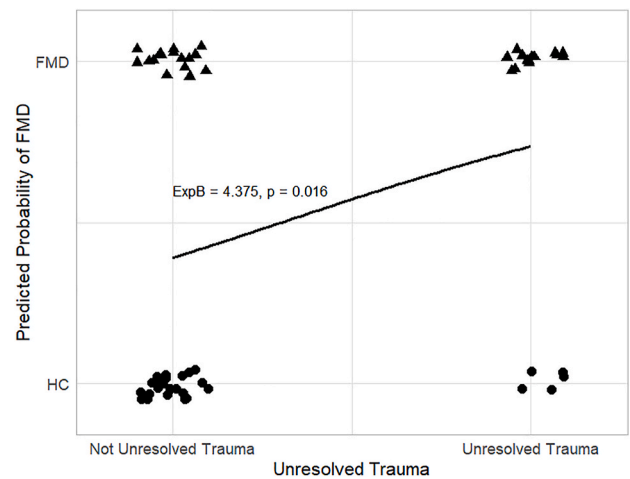


Fig. 2. Probability of manifesting with FMD according to the presence of Unresolved Trauma: individuals with an Unresolved Trauma resulted approximately four times more likely to develop FMD than those without. Triangles represent patients with Functional Motor Disorders, while dots represent Healthy Controls.

the individual encounters a stressful situation, thereby compromising their existing strategies to seek help. When humans face a stressful experience, such as Adverse Childhood Experiences themselves, the sympathetic nervous system and the hypothalamic-pituitary-adrenal (HPA) axis get activated, to prepare the body for a "fight or flight" response. Once the danger has passed, the body returns to balance through the allostatic mechanism. However, persistent stressful situations without protective factors (such as comfort from a parent) can lead a continuous activation of the aforementioned system, without returning to a normal homeostatic state, and ultimately causing long-term repercussions on the neurological, endocrine, and immune systems (Boullier and Blair, 2018). Several neurophysiological evidence support this hypothesis in FND. First, elevated autonomic arousal at baseline or during affective processing has been observed in adult patients with FND using various psychophysiological measures, including elevated salivary cortisol, heart rate, skin conductance levels and responses, lower Heart Rate Variability (Bakvis et al., 2011; Kozłowska et al., 2015; Pick et al., 2016, 2018), and potentiated startle responses (specifically in patients with FMD) (Seignourel et al., 2007). Second, neuroimaging findings (Aybek et al., 2014; Voon et al., 2010) consistent with alterations in the limbic and paralimbic areas (that primarily regulates emotions, memory, and motivation) and representative of neurobiological adaptations following early and prolonged psychosocial adversities have been demonstrated in FND patients. Increased activation in motor regions during affective processing has been commonly observed in FND [14, 64 for reviews], as well as increased limbic-motor circuit connectivity during affective processing tasks and at rest (Aybek et al., 2014; Voon et al., 2010; Charney et al., 2024). Similarly, alterations in functional connectivity between limbic areas and cortical areas related to the sense of body ownership and agency (respectively, the sense of being located within one's own body boundaries and being in control of one's own movement), namely the temporoparietal junction, have been found in patients with FMD (Demartini et al., 2021). Hence, Pick et al. (2019) suggested that enhanced limbic-motor coupling might mediate the influence of emotion on voluntary motor control in FND, possibly by contributing to the automatic activation or inhibition of motor sequences through the activity of the insula, the Anterior Cingulate Cortex, or the ventral striatum, which is a fundamental node of the Default Mode Network (Vuilleumier, 2014). Along this line, enhanced preconscious (implicit) processing of emotionally salient stimuli, associated with increased limbic and amygdalar reactivity, may trigger the initiation of basic affective/defensive responses. These affect-related brain areas may

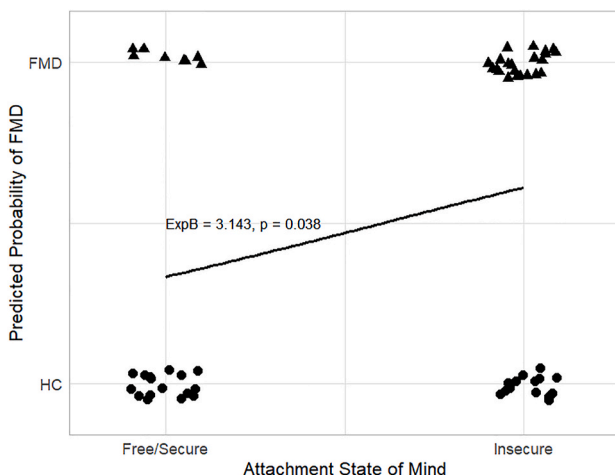


Fig. 1. Probability of manifesting with FMD according to the Attachment State of Mind: individuals with an Insecure SoM resulted approximately three times more likely to develop FMD compared to those with a Free/Secure SoM. Triangles represent patients with Functional Motor Disorders, while dots represent Healthy Controls.

Table 2
Results at the ComplexTQ.

	HC	FMD	t or χ (df)	p value	95% CI	Cohen's D
Neglect (Mother side), mean (SD)	1.27 (0.43)	2.21 (0.91)	-5.05 (41.28)	<0.001	[-1.31; -0.56]	0.71
Neglect (Father side), mean (SD)	1.36 (0.55)	2.41 (0.80)	-5.94 (51.32)	<0.001	[-1.41; -0.70]	0.69
Rejection (Mother side), mean (SD)	1.48 (0.62)	1.45 (0.66)	0.17 (58)	0.868	[-0.30; 0.36]	0.64
Rejection (Father side), mean (SD)	1.53 (0.82)	1.43 (0.57)	0.56 (58)	0.576	[-0.26; 0.47]	0.70
Role Reversal (Mother side), mean (SD)	1.35 (0.48)	1.04 (0.37)	2.79 (58)	0.007	[0.09; 0.53]	0.43
Role Reversal (Father side), mean (SD)	1.13 (0.34)	1.02 (0.43)	1.09 (58)	0.281	[-0.09; 0.31]	0.39
Psychological Abuse (Mother side), mean (SD)	1.17 (0.21)	1.15 (0.32)	0.21 (58)	0.837	[-0.12; 0.15]	0.27
Psychological Abuse (Father side), mean (SD)	1.17 (0.24)	1.18 (0.34)	-0.06 (58)	0.955	[-0.16; 0.15]	0.29
Physical abuse (Mother side), mean (SD)	1.10 (0.20)	1.46 (0.71)	-2.68 (33.38)	0.011	[-0.63; -0.09]	0.52
Physical abuse (Father side), mean (SD)	1.32 (0.54)	1.34 (0.59)	-0.12 (58)	0.902	[-0.31; 0.27]	0.56
Sexual abuse (Mother side), mean (SD)	1.00 (0.00)	1.05 (0.15)	-1.80 (29)	0.083	[-0.11; 0.01]	0.11
Sexual abuse (Father side), mean (SD)	1.01 (0.07)	1.02 (0.09)	-0.19 (58)	0.849	[-0.05; 0.04]	0.08
Domestic violence (Mother side), mean (SD)	1.26 (0.54)	1.08 (0.61)	1.17 (58)	0.247	[-0.12; 0.47]	0.58
Domestic violence (Father side), mean (SD)	1.32 (0.67)	1.16 (0.69)	0.93 (58)	0.356	[-0.19; 0.52]	0.68
Separation from the Mother, mean (SD)	1.07 (0.29)	1.22 (0.47)	-1.50 (48)	0.140	[-0.35; 0.05]	0.39
Separation from the Father, mean (SD)	1.33 (0.92)	1.13 (0.37)	1.10 (38.09)	0.277	[-0.17; 0.57]	0.70
Mother's death, Y/N	1/29	15/15	16.71 (1)	<0.001		
Father's death, Y/N	0/30	16/14	21.62 (1)	<0.001		

Abbreviation: Cohen's D = effect size measure; C.I. = Confidence Interval; df = degrees of freedom; FMD = Functional Motor Disorders; HC = Healthy Controls; M/F = Males/Females; SD = Standard Deviation; Y/N = Yes/No.

concomitantly negatively influence the circuitry involved in motor control (via hypothalamic and brainstem pathways, such as the periaqueductal grey) (Pick et al., 2019). Similarly, neurometabolic limbic alterations were found in adults with FMD (in particular, Glutamate + Glycine/Creatine ratio (Demartini et al., 2019)) and in children with FND (Charney et al., 2024); notably, in children with FND, who had a significantly higher rates of depression, anxiety, stress, and Adverse Childhood Experiences in their lifespan than to HC, neurometabolic alterations (specifically, lower N-acetyl aspartate/Creatine,

myo-inositol/Creatine, and GABA/Cr ratios) as measured by magnetic resonance spectroscopy were found also in the Supplementary Motor Area, which were associated with levels of stress and hyperarousal, giving further evidence to the link between alteration in emotional regulation and motor control in FND (Charney et al., 2024). Finally, Williams and colleagues (Williams et al., 2018) found an inverse relationship between Attachment dismissal, investigated with the Relationship Scales Questionnaire (Griffin and Bartholomew, 1994) and left parahippocampal cortical thickness in a group of women with FND. The parahippocampal gyrus connects the memory system of the medial temporal lobe and the cortical nodes of the Default Mode Network, a functional network known to be active at rest and associated with self-referential thoughts, daydreaming, and introspection (Williams et al., 2018). The authors hypothesized that the processing of past experiences could mix with self-awareness, and if self-awareness is fraught with Insecure Attachment, socio-behavioral consequences can follow, including a pervasive difficulty in trusting others and seeking support. Despite being limited by the evaluation of Attachment through a self-report questionnaire, this finding provides initial evidence of neurobiological alterations possibly underpinning dysfunctional Attachment profiles in FND. Further studies evaluating Attachment and potentially Unresolved Traumas with the AAI are needed to confirm this association.

4.2. Clinical and therapeutic considerations

On a clinical level, addressing Unresolved Attachment Trauma may be key to treating FMD, as numerous studies, beginning with classic ACEs research (Felitti et al., 1998), show that frozen traumatic memories can significantly impact an individual's psychobiological functioning. In FMD specifically, chronic post-traumatic responses are accompanied by cortico-limbic changes that make treatment challenging (Diez et al., 2021).

First, it is important to recognize that FMD patients often deny psychological distress and instead seek out neurobiological explanations for their symptoms, potentially leading to rejection of the FMD diagnosis. This pattern, frequently seen in alexithymic patients (who have difficulty identifying and describing emotions), reflects traits initially observed in psychosomatic disorders, where patients struggled to engage in insight-oriented psychotherapy (Sifneos, 1973). Despite this common characterization as "hard to reach" (Luyten and Fonagy, 2020), emphasize that many of these patients are, in fact, open to psychological treatment if their needs are carefully addressed. Stone and colleagues (Stone et al., 2016) recommend investing time to clearly explain the FMD diagnosis, as acceptance of its psychological aspects is essential for treatment engagement and a key factor in recovery.

Therapeutic interventions should be individually tailored (Roth and Fonagy), with techniques adapted to meet each patient's needs. It was proposed that patients who appear initially resistant to exploring emotional and interpersonal issues may not benefit from psychodynamic psychotherapy (historically the preferred approach for "conversion disorders"); instead, cognitive-behavioral techniques may be more suitable, offering practical symptom management strategies before addressing emotional and cognitive factors in FMD. Attachment-oriented psychotherapy may also help alleviate symptoms, particularly in cases involving Unresolved Attachment Trauma, which is recognized as a risk factor in FMD's etiopathogenesis. Understanding trauma's influence can guide effective strategies: for instance, avoidance strategies may offer temporary calm but often block emotional access during stress, leading to long-term issues like somatic symptoms and sleep disturbances (Mikulincer and Shaver, 2007). Hyperactivation strategies, on the other hand, amplify anxiety, create emotional chaos, and hinder emotional regulation, contributing to depression, anxiety, and potentially substance abuse. Knowledge of these mechanisms is thus fundamental in planning FMD treatment, and trying to effectively manage such a complex psychopathology with multiple manifestations

that still needs to be clarified. Understanding hyperactivation and deactivation (or avoidance) strategies forms the first core component of Luyten and Fonagy's dynamic interpersonal therapy (DIT) for Functional Somatic Disorders (Luyten and Fonagy, 2020). This approach also emphasizes: (i) embodied mentalizing, or the capacity to perceive and interpret bodily signals (interoception), helping patients reframe their view of their bodies, which may feel hostile over time due to chronic pain and fatigue (Schattner et al., 2008); and (ii) epistemic trust, the ability to regard others as reliable sources of knowledge about one's symptoms and the world (Luyten et al., 2013, 2016). Reduced epistemic trust is thought to be a key factor in FMD pathophysiology, as FMD patients often rely more on their own beliefs about their symptoms rather than external evidence (Hallett et al., 2022).

Overall, both Stone et al. (2016) and Luyten & Fonagy (Luyten and Fonagy, 2020) underscore that validating the reality of patients' suffering and symptoms is the first essential step in therapy. Without such validation, therapeutic interventions risk being iatrogenic, increasing patients' feelings of invalidation and epistemic distrust (Luyten and Abbass, 2013). However, when an approach begins by validating the patient's adaptation strategies, epistemic vigilance can decrease, opening the path to recovery. Even severely impaired patients can make significant therapeutic progress with this foundation.

It is essential that patients, psychotherapists, and all professionals involved in FMD management recognize that, despite its complexity, FMD is a potentially reversible condition. Effective treatment requires a shift in the patient's locus of control and sense of agency, making them an active participant in their recovery. Therapeutic efforts should balance validation of the patient's suffering with empowerment, emphasizing each patient's inherent resources and strengths.

4.3. Strength, limitations and conclusions

The strength of our study lays in having examined Attachment SoM and presence of Unresolved Traumatic events in FMD with two gold standard instruments, namely the AAI and the ComplexTQ. Our study is limited by the relatively small sample size, despite in line with other studies involving FMD patients. Moreover, in our statistical analysis, we did not control for pharmacological treatment and for the presence of comorbid psychiatric conditions, such as levels of anxiety and depression, that might have had an influence on our data.

In conclusion, by implementing the AAI, we found that in patients with FMD there was a higher incidence of Insecure SoM (specifically a Dismissing SoM) and Unresolved Trauma (specifically neglect, physical abuse, and loss of parents) than HC. Participants with an Insecure Attachment were three times more likely to manifest with FMD compared to those with a Free/Secure Attachment, and the ones with an Unresolved Trauma were approximately four times more likely to manifest with FMD compared to those without.

Future studies should investigate the neurobiological correlates associated with Attachment SoM by implementing more refined measures of Attachment. Finally, SoM in the FMD population should be compared with SoM of other clinical populations (suffering by either other functional, organic, and psychopathological conditions) to better understand if and how the trauma profile plays a role in specific clinical manifestations. Overall, exploring personality traits, psychopathological characteristics, Attachment SoM, and the presence of traumatic events and linking these to new neurobiological findings appears to be crucial to understanding and treating the pathophysiology of FMD and pave the way to efficacious treatment approaches.

CRedit authorship contribution statement

Cristina Civilotti: Writing – review & editing, Formal analysis, Data curation, Conceptualization. **Veronica Nisticò:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Roberta Tedesco:** Data curation. **Sofia Cuoco:**

Data curation. **Rossella Bisogno:** Data curation. **Paolo Barone:** Writing – review & editing. **Alessia Celeghin:** Data curation. **Giulia Di Fini:** Data curation. **Gabriella Gandino:** Data curation. **Roberto Erro:** Writing – review & editing, Conceptualization. **Benedetta Demartini:** Writing – review & editing, Supervision, Conceptualization.

Data availability statement

The data that support the findings of this study are not publicly available due to ethical restriction but are available from the corresponding author [VN] upon reasonable request.

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Declaration of competing interest

The authors report no conflict of interest.

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Data availability

Data will be made available on request.

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