

# Functional Seizures analyzed by the Symptom Amplification Model of Neurolog: a distinguished group in Functional Neurological Disorders? A pilot study

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## Abstract

Functional Seizures (FS) are non-epileptic seizures, of which the underlying neuropsychopathology remains unclear. FS can be regarded as symptoms of Functional Neurological Disorder and are therefore included in the Symptom Amplification Model (SAM) of Neurolog [1]. As in other psychobiosocial conditions, functional seizures are often linked to psychological trauma, problems with sensory integration, and cognitive dysfunction [2,3]. According to Asadi-Pooya and Sperling (2015), FS is one of the most common Functional Neurological Disorders (FND), with a prevalence of 1.4-4.9 per 100.000 and three times as many females as males [4]. Neurolog is a digital platform that uses the Symptom Amplification Model (SAM) to analyze transdiagnostic factors that affect symptom severity across biopsychosocial conditions [1]. Neurolog examined continuous, anonymized data analysis of patients with FS logs, providing new insights into the transdiagnostic factors and underlying mechanisms of this specific symptomatology.

In this pilot study, Neurolog compared ecological log analyses of functional seizures (FS) with those of other FND presentations. The results strongly support FS as a separable, sensory-linked, paroxysmal subtype with distinct emotional and temporal dynamics.

**Keywords:** Functional Seizures, Non-Epileptic Seizures, Symptom Amplification Model, Psychobiosocial Conditions, Neurolog

## Introduction

NeuroLog is an innovative digital platform that harnesses the power of the Symptom Amplification Model (SAM) to provide a comprehensive analysis of the intricate interplay among emotional, biological, and societal influences that contribute to symptom severity in biopsychosocial conditions [1]. This cutting-edge tool empowers patients to meticulously track their physical and emotional experiences, rating them on an intuitive scale from 1 to 10. By documenting relevant triggers, users provide a wealth of real-time, anonymized data that sheds light on their overall well-being. All of this is accomplished with a steadfast commitment to privacy and GDPR compliance, ensuring that sensitive information remains secure while unlocking valuable insights into health management.

## Objective

The researchers utilized Neurolog to investigate whether Functional Seizures (FS) can be identified as a distinct subgroup within Functional Neurological Disorders (FND). Four hypotheses

were formulated for this pilot study.

The first objective was to determine if FS differs from other presentations of FND in terms of emotional complexity, independent of symptom severity. It was hypothesized that FS logs would show greater emotional complexity than non-FN logs at matched severity levels.

The second objective was to assess whether FS logs exhibit a distinct affective profile.

The third goal was to determine whether FS logs demonstrate higher within-person variance, consistent with episodic threshold-breach dynamics.

Finally, the fourth research question aimed to test the hypothesis that sensory overload triggers predict emotional flooding more strongly than symptom severity.

## Study Design

The study involved users of the Neurolog platform who provided written informed consent for anonymized data analysis and submitted at least five logs. We analyzed 2,782 patient logs from 186 users of this digital symptom-tracking platform. Users were

classified into two groups: an FS group (n=75) and a non-FS FND group (n=111), based on their symptom presentation.

The primary outcome of our analysis was the emotions reported in each log. Secondary outcomes included the proportion of high-arousal emotions (activation of emotion) and the proportion of low-arousal or dissociative emotions (shutdown of emotion). We used self-reported symptom severity per log and sensory overload triggers as predictors in our analysis.

The patient logs contained information on symptom severity (rated from 0 to 10), identified triggers, and multi-label emotion tags. Free-text notes were also provided; however, they were not analyzed in this study.

## Data analysis

In this study, the researchers conducted severity-stratified

comparisons and used multilevel mixed-effects modeling with variance decomposition. First, they compared the emotional responses of individuals with functional seizures (FS) and those with non-functional seizures (non-FS), focusing on participants with moderate-to-high severity ratings (6-7 on a scale of 10).

Additionally, the researchers compared the mean emotional complexity and the proportions of activation and shutdown responses. Since the emotional data were nested within individual users, they fitted mixed-effects models with random intercepts for user identity. The analysis decomposed the variance into within-user and between-user components, and they computed intraclass correlation coefficients (ICC) to assess reliability.

Table 1 presents the emotional profiles categorized by severity level and group.

Severity Bin	Group	N Logs	N Users	Mean Severity	Mean Emotions/ Log	SD	% Calm	% Activation	% Shutdown
Severe (8-10)	FS	188	61	8.7	<b>4.54</b>	3.53	16.00%	<b>52.70%</b>	13.30%
	Other FND	663	193	8.54	<b>4.26</b>	5.54	14.30%	<b>43.70%</b>	18.60%
	<b>Diff.</b>			0.16	<b>0.28</b>		1.70%	<b>9.00%</b>	-5.30%
Moderate-High (6-7)	FS	188	62	6.6	<b>3.76</b>	2.69	<b>28.20%</b>	<b>50.50%</b>	<b>33.50%</b>
	Other FND	965	354	6.58	<b>3.29</b>	3.81	<b>18.40%</b>	<b>31.80%</b>	<b>14.50%</b>
	<b>Diff.</b>			0.02	<b>0.47</b>		<b>9.80%</b>	<b>18.70%</b>	<b>19.00%</b>

**Table 1:** Emotional profiles categorized by severity level and group

## Results

When Neurog indicated a moderate-to-high severity level (6-7/10), we observed significant differences between patients with Functional Symptoms (FS) and those without. Patients with FS exhibited greater emotional complexity (3.76 vs. 3.29 emotions per log; +14.3%) than those without FS. Additionally, the FS group showed a distinct emotional profile, with greater emotion activation (50.5% vs. 31.8%) and a higher incidence of shutdown emotions (33.5% vs. 14.5%) than the non-FS Functional Neurological Disorder (FND) group. These findings suggest a co-occurrence of high- and low-arousal emotional states, highlighting the need for tailored emotion and symptom regulation strategies.

In the mixed-effects modeling, FS participants demonstrated a 35% increase in emotional complexity per log compared to non-FS participants (3.75 vs. 2.77; Cohen's  $d = 0.73$ ;  $p < 0.001$ ), regardless of severity. The effect size ( $d = 0.73$ ) is considered substantial and clinically significant.

Variance decomposition indicated a 5.4-fold increase in within-user variance for FS (15.31 vs. 2.85), which is consistent with paroxysmal episodic dynamics. Notably, sensory overload

triggers predicted emotional flooding more strongly than severity ( $r = 0.381$  vs.  $r = 0.170$ ).

## Conclusions

The researchers formulated four hypotheses regarding considering Functional Seizures as a distinguishable group within the population of patients with Functional Neurological Disorders. The study formulated four hypotheses regarding the consideration of Functional Seizures as a distinguishable group within the population of patients with Functional Neurological Disorders. The survey results show that we can maintain all hypotheses. First of all, the results suggest that FS exhibit a separable sensory-linked affective phenotype, marked by heightened emotional complexity. Besides, FS presents an autonomous-style mixture that is significantly different from that of the FND group. In the FS patient logs, we found disproportionately high within-person fluctuation, supporting further investigation of sensory-arousal threshold processes in FS patients and across the broader FNS spectrum.

The coexistence of activation and shutdown states at the same severity level suggests that FS may involve state switching or an autonomic-style instability, potentially reflecting rapid

transitions between high arousal and dissociative protection during episodes. The strong sensory-trigger linkage implies a sensory-arousal coupling whereby environmental load precipitates abrupt emotional escalation and control disruption.

## Discussion

In this section, based on the pilot study that was assumed as the first pilot study to assess FS emotion symptom regulation using the Symptom Amplification Model of Neurolog, the findings are significant and clinically relevant. The results support subtype-specific care pathways for patients with FS and advocate for interventions and self-regulation tools that prioritize sensory load management (W.A.R.A. and FFH) and generally influence arousal regulation and promote secure attachment, such as ReAttach [5,6,7].

## Limitations

The deployment of the data platform likely revealed a range of confounding variables that Neurolog may not have fully considered, including medication use and comorbidities. With only limited descriptive data at our disposal, we are unable to unravel the intricate influences of age, gender, and other underlying health conditions on these findings. The complexity of these interactions leaves us in the dark, unable to clearly discern their potential impact on the results.

## Future Directions

The initial findings are intriguing enough to warrant a thorough exploration of Functional Somatic Syndromes (FS) as a unique category in assessing the effectiveness of psychobiosocial interventions, such as ReAttach. With this compelling evidence in mind, we have embarked on creating a specialized ReAttach Protocol designed explicitly for individuals grappling with FS. This endeavor is a vital component of our expansive project that delves into the realms of ReAttach, Sensory-Affective Modulation (SAM), and various psychobiosocial conditions, aiming to unravel the complexities of these interconnected experiences [8,9,10,11].

## Declaration of interest

Steven Painter is a visionary in neuroscience, known for creating the Neurolog Platform, which aims to transform our understanding of brain health. The researcher also developed the Symptom Amplification Model, enhancing our understanding of how symptoms can be intensified. These contributions underscore Painter's dedication to advancing neuroscience and supporting those with neurological conditions..



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