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The Effect of Individualized Sensory Retraining on the Rehabilitation of Adults with Functional Neurological Disorders: An Unexplored Field in Physical Therapy Practice

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Abstract---*The purpose of this article is to introduce a new integrated model of physical therapy in managing adults with Functional Neurological Disorder (FND), which is a disabling, common health issue with no form of standardized treatment. The approach includes integrating incongruent lines of evidence through adopting a complete synthesis of the qualitative research of the lived experience of the patient, neurobiological research on sensory perception, and clinical research regarding physical and mental therapy. The primary results of this synthesis argument led to a paradigm shift towards the participatory model of sensory retraining that rejects pure motor-based rehabilitation. This model is constructed based on co-creation, in which the patient-narrative*

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construction and subjective state are the central sequences in creating a treatment alliance and the improvement of treatment compliance. The main ones are the introduction of affordably individualized classical sensory retraining focused on retraining the central nervous system-interpretation, the use of a personalized dental or sensory diet to enhance self-regulation, and the introduction of what we call the sensory mindfulness to uncouple painful sensations with maladaptive/ unresponsive movements/dissociation reactions. It is concluded that such a unitary mechanism-centered model explicitly targets the root of core pathophysiology, psychosocial mechanisms of FND dynamics, sensory gating dysfunction, disrupted predictive coding, and, most critically, the extensive influence on symptom production of relational contexts. The proposed framework addresses important gaps in the available literature and supports a sound theoretical framework for formal investigation in the future to define its effectiveness in enhancing functional independence and quality of life among persons with FND.
Keywords---*FND (Functional Neurological Disorder), physical therapy model, neurological symptoms.*

1. Introduction: The Enigma of Functional Neurological Disorder

Defining FND: A Paradigm Shift from Mind to Brain Function

Functional Neurological Disorder (FND) is a multifaceted condition in which neurological issues are opposed to established illnesses (American Psychiatric Association, 2022; Annam, 2020). These are involuntary symptoms that create distress and impairments to the greatest degree (National Institute of Neurological Disorders and Stroke, 2023; Stone et al., 2021; Ali et al., 2023; Gnanavel, 2024). Historically, the term was conversion disorder based on a Freudian psychoanalysis, which implied that a conflict within the psyche was translated into a physical symptom (American Psychiatric Association, 2022; Annam, 2020). The FND term adopted in DSM-5 corresponds to a transition to a neurobiologically based approach (American Psychiatric Association, 2022; Ali et al., 2023; Espay et al., 2020). These clinical signs and symptoms are not a structural disease, and thus FND is a disorder of nervous system functioning- an issue with the way the brain sends and receives signals (National Institute of Neurological Disorders and Stroke, 2023; Stone et al., 2021). Such a reframe is a therapeutic intervention in itself, as it minimizes stigma, contributes to a therapeutic alliance that is required to engage in treatment, by clarifying that FND is a network brain issue that can be treated (LaFaver et al., 2021; Ricciardi et al., 2020).

The Heterogeneous Clinical Presentation

There is a vast range of symptoms of FND, which may resemble practically any neurological illness (Szasz et al., 2025; NHS, n.d.). These include:

- **Motor Symptoms:** Weakness of function in the limbs, tremor, dystonia, myoclonus, and disturbances with the gait (National Institute of Neurological Disorders and Stroke, 2023; NHS, n.d.; Brigham & Women, 2019; Gore et al., 2024).
- **Sensory Symptoms:** numbness, tingling, or the inability to feel in non-anatomical patterns (NHS, n.d.; FND Hope, n.d.).
- **Paroxysmal Symptoms:** Functional or Dissociative Seizures (previously Psychogenic Non-epileptic Seizures, or PNES), which have similar signs of the epileptic seizure but these are not related to any unusual electrical activity in the brain (National Institute of Neurological Disorders and Stroke, 2023; Gnanavel, 2024; Szasz et al., 2025).
- **Additional Co-Symptoms:** Constant aches, exhaustion, sleep problems, and thinking difficulties ("brain fog") (Ali et al., 2023; NHS, n.d.; Lumsden et al., 2024; NHS Grampian, n.d.; Schwarz et al., 2022).

Diagnostics and Pathophysiology

Diagnosing has shifted away from negative exclusion to the presence of positive rule-in clinical features that show internal inconsistency, including the Hoover sign of functional leg weakness (National Institute of Neurological Disorders and Stroke, 2023; Espay et al., 2020; LaFrance et al., 2022; Hallett et al., 2022). This enables a surer and sooner diagnosis to take place (LaFaver et al., 2021; Brigham & Women's Hospital, 2019). It is believed that pathophysiology involves dysfunction of the brain network, specifically disruptive predictive coding, attention, and agency (Szasz et al., 2025; Hallett et al., 2022).

The brain may have abnormal predictive modeling of the sensory input, and voluntary movement may be accompanied by too much attention on internal processes, thus the symptoms can become locked into place because they are no longer about agency as a person thinks he or she is making a voluntary movement but it feels involuntary (Hallett et al., 2022; Finkelstein et al., 2025; Nielsen et al., 2015; American Psychiatric Association, 2022).

The Problem Statement: A Common Disorder with Unstandardized Rehabilitation

FND is widespread and a relevant disability generator (Ali et al., 2023; Brigham & Women, 2019; Schwarz et al., 2022). Although physical therapy is a first-line and evidence-based intervention, there is a major gap in standardized evidence-based guidelines of its provision (Ali et al., 2023; LaFrance et al., 2022; Nielsen et al., 2015; Maggio et al., 2023). Other neurological diseases that exhibit such a lack of standardization include multiple sclerosis (Savio et al., 2025; University of Oulu, 2025). In this article, the authors present the integrated physical therapy model of FND based on the lived experience of the patient and focusing on correcting the underlying sensory processing aberrations.

2. The Patient's Voice: Why the "Lived Experience" is Central to Rehabilitation

Thematic Analysis of the FND Experience

To build effective rehabilitation, the subjective experience of living with FND is necessary. Qualitative systematic reviews of narratives relating to mood disorders, conducted by Szasz et al., found eight predominant themes: feeling lost, body-mind dualism, antecedent stressful events, relatedness, stigma, the battle or fight, the burden and the losses of the illness, and trust versus mistrust (Szasz et al., 2025). They entail tedious accounts of a very long process of receiving a diagnosis, sometimes punctuated by being brushed aside by medical personnel (Lumsden et al., 2024; Zickert et al., 2024; Korner & McLean, 2025).

The Great Theme: Relationally Regulated Selves

Based on these themes, Szasz et al. (2025) came to a general idea, a so-called relationally regulated self (Szasz et al., 2025). This assumes that an experience of the FND is the process of self-reacting to stressful situations in life and is done in a relational setting. The ability to self-regulate is closely interconnected with the interpersonal environment of the person. Recovery, thus, stops being a matter of correcting problematic brain signals and becomes a matter of healing in a nurturing and affirming relational setting, with the therapeutic relationship becoming a major instrument of change (Szasz et al., 2025).

Lived Experience to Treatment Adherence

Treatment engagement and outcome are determined directly by the lived experience of the patient. Experiences of poor interaction with the healthcare system, such as denial and stigma, are important impediments to care, relating to poor treatment adherence and a more adverse clinical outcome (LaFaver et al., 2021; Lumsden et al., 2024; Zickert et al., 2024; Perez et al., 2017). On the other hand, active participation needs a validating, non-judgmental, and collaborative style of care to develop trust, facilitating the process (LaFaver et al., 2021; Maggio et al., 2023; Nielsen et al., 2015). In this way, the patient saves the mental and emotional resources that could be spent in the great battle to support our knowledge, and thus frees their energies to tackle the challenging task of healing (Schwarz et al., 2022; Nielsen et al., 2015).

The qualitative research findings support the idea that a holistic, biopsychosocial approach should be used, which incorporates co-designing patterns of recovery, with the patient presented as the first partner in the healing experience (Szasz et al., 2025; Kim et al., 2022; Korner & McLean, 2025; McBain et al., 2022; McBain et al., 2024).

3. A New Therapeutic Target: Sensory Processing and Modulation in FND

Beyond Motor Symptoms: The Sensory Dimension of FND

Although it is characterized by motor symptoms, FND is also coming to be regarded as an issue of abnormal sensory processing (Boon et al., 2023; Perez et al., 2020). Typically, patients complain about added sensory things that cause

their symptoms, including the presence of bright lighting or loud sounds (FND Hope, n.d.; Perez et al., 2021). This renders the sensory system as a major therapeutic target.

Definition of Sensory Processing Difficulties

Patients with FND report the specific sensory processing patterns as the use of the tools such as the Adolescent/Adult Sensory Profile (AASP) revealed **Low Registration** (not reading stimuli), **Sensory Sensitivity** (easily overwhelmed by the stimuli), and **Sensation Avoiding** (proactively limiting exposure to sensations) (Ranford et al., 2020; Perez et al., 2021; Maclean et al., 2024). The concomitance of these patterns indicates that there may exist a basic malfunction of sensory gating, the regulation and filtering of the sensory information input into the brain (Finkelstein et al., 2025; Nudo et al., 2017). The desired therapeutic effect is thus not desensitization but modulation: training the patient to retain some conscious control of his or her sensory input.

Neurophysiological Foundations: Change of Perception and Action

Neurophysiological research reflects these behavioral results. Research indicates that FND is associated with impaired perception-action coupling, or hyperbinding, wherein movements are hardly able to be restructured in reaction to sensory triggers (Boon et al., 2023). In addition, one of the mechanisms depends on decreased sensory attenuation (SA), which is a factor whereby brain accesses the sensory feedback to self-generated actions (Finkelstein et al., 2025). The described failure of SA offers an excellent insight on how the sense of agency in FND might change and suggests an idea of why involuntary movements are perceived as voluntary (Finkelstein et al., 2025). The combination of these findings is the most convincing argument in turning sensory processing into the core of FND rehabilitation, which is virtually unrepresented in the physical therapy practice (Perez et al., 2021; Maclean et al., 2024; Baslet et al., 2023).

4. Bridging the Gap: A Proposed Model for Participatory Sensory Retraining in Physical Therapy

The experience is indicative of a novel therapy approach to physical therapy in FND: **Participatory Sensory Retraining**. This method transforms transferable rehabilitation strategies to the specific pathophysiology of FND and integrates them with a patient-centered, co-created process of treatment.

A. Core Principles: Modification of Sensory Retraining to FND
Sensory retraining is well-established in the fields of peripheral nerve injuries and stroke, where it works by repetitively stimulating the nerve to induce neuroplastic changes in the somatosensory cortex (Rosen, 2011; Schabrun & Hillier, 2019). The issue in FND is not peripheral rather central; hence, the aim is to **retrain the broken predictive models as well as the attentional networks of the brain** (Rosen, 2011).
These networks may be recalibrated through structured activities, including learning to distinguish between the various forms of touch (Rosen, 2011; Arya, 2021).
B. The Participatory Framework: The Lived Experience
To be successful, this intervention should be implemented in a participatory framework. It includes a function-based goal setting that is co-created (e.g., "I want to be able to garden again") and a good therapeutic alliance that is promoted by validating, non-judging language and clear education (Robson et al., 2020; neurosymptoms.org, n.d.; Gore et al., 2024; LaFaver et al., 2021; Nielsen et al., 2015).
C. The Implementation of the Intervention: Sensory Diet and Sensory Mindfulness
Therapists can borrow the concepts applied in other areas to implement these principles.

- **The Sensory Diet:** This is adopted and is used in occupational therapy where it entails a personal plan of exercises based on unique sensations daily such as booked sensory meals and prompt sensory snacks (e.g. the use of a weighted lap pad or TENS unit) to empower the patient to be proactive and reactive in understanding and controlling symptoms of their nervous system (Maclean et al., 2024; Reactive Physical Therapy, 2024; The Neuro Collaborative, 2023).
- **Sensory Mindfulness:** This aspect combines mindfulness and specific sensory seeing/listening/touching. There is evidence that mindfulness-based interventions (MBIs) lead to remission in functional seizures (PNES) (Baslet et al., 2015; Baslet et al., 2020; Baslet et al., 2022). This is used in sensory mindfulness to help the patient notice bodily sensations in an objective rather than fearful manner, attempting to decouple the primitive sensory input and the adaptive motor and dissociative behavior (Baslet et al., 2020; Toljan et al.,

2020).

The following table provides a structured framework for this proposed clinical model

Component	Principle	Clinical Application Example	Supporting Evidence
Education & Alliance	Co-create understanding of FND as a reversible brain network disorder.	Use non-judgmental language ("allow your leg to move" vs. "move your leg"); explain how attention affects symptoms.	(LaFaver et al., 2021; Nielsen et al., 2015)
Participatory Goal Setting	Goals are patient-led, functional, and flexible, reflecting their meaningful activities.	Use a "goal ladder" approach for returning to a hobby like gardening, starting with tolerating the texture of soil.	(Gore et al., 2024; Robson et al., 2020)
Sensory Profile Assessment	Identify individual patterns of sensory sensitivity, avoidance, and registration.	Conduct a detailed sensory history interview alongside a standardized tool like the AASP to understand triggers and soothers.	(Ranford et al., 2020; Maclean et al., 2024)
Sensory Retraining	Re-educate the interpretation of sensory input to drive neuroplasticity and rebuild the body map.	Graded exposure to textures (e.g., different fabrics on a limb with sensory loss), temperatures, and proprioceptive tasks with eyes closed.	(Rosen, 2011; Arya, 2021)
Sensory Modulation	Develop a personalized "sensory diet" for proactive and reactive self-regulation.	Co-design a toolkit of "sensory snacks" (e.g., using a TENS unit for non-painful stimulation, wearing a compression vest, listening to binaural beats) to manage arousal before difficult tasks.	(National Institute of Neurological Disorders and Stroke, 2023; Reactive Physical Therapy, 2024)
Sensory Mindfulness	Cultivate non-judgmental, present-moment awareness of bodily sensations to uncouple them from maladaptive responses.	Guided practice in noticing the premonitory sensations of a functional seizure or tremor without reacting, instead focusing on grounding techniques (e.g., feeling feet on the floor).	(NHS Grampian, n.d.; Baslet et al., 2020)
Functional Integration	Apply sensory strategies during functional movement retraining to promote automaticity.	Use rhythmic, externally-focused tasks (e.g., walking to a metronome, dancing, throwing and catching a ball) while simultaneously using a "sensory snack" to prevent hyper-focus on the body.	(Schwarz et al., 2022; Nielsen et al., 2015)

5. Investigating the Hypotheses: Potential Outcomes and Measures

The model suggested will allow testing multiple hypotheses. Outcome measuring should be multifaceted, appreciating both objective functional and subjective experience of the patient, which can be a rather direct signal of the therapeutic transformation (Pick et al., 2020; van der Sar et al., 2024).

Hypothesis 1: Participatory sensory retraining improves functional independence in patients with FND

The model is theorized to enhance functional independence based on attention to sensory processing deficits, as well as motivation and self-efficacy through emphasis on personally aligned meaningful goals (Kim et al., 2022; Nudo et al., 2017; Schabrun & Hillier, 2019; Gore et al., 2024; neurosymptoms.org, n.d.; Cramer et al., 2013). The

opportunity to measure should be based on clinician-rated functional measures (e.g., 6-Minute Walk Test) and, most importantly, on patient-reported outcome measures (PROMs) that cover disability, quality of life, and participation (Robson et al., 2020; Pick et al., 2020; van der Sar et al., 2024; Hadas et al., 2022).

Hypothesis 2: The integration of "lived experience" in physiotherapy interventions enhances patient adherence

Ineffective adherence to treatment is one of the biggest challenges in FND, and it is frequently caused by the experiences of stigma and dismissal in patients (LaFaver et al., 2021; Perez et al., 2017). These barriers are directly addressed by the participatory model in two ways through the establishment of trust and a therapeutic alliance, which are essential elements of patient engagement and adherence (LaFaver et al., 2021; Szasz et al., 2025; Brigham & Women's Hospital, 2019; Perez et al., 2017). Patient adherence can be quantitatively assessed, including the number of sessions (e.g., session attendance) and qualitatively, including interviews addressing the experience of the patient in respect to the therapeutic relationship (Perez et al., 2017).

Hypothesis 3: Sensory mindfulness is associated with a reduction in the frequency of "pseudo-epileptic" episodes

The strength of this hypothesis is confirmed by powerful evidence supporting the study of mindfulness-based intervention (MBIs) in the treatment of psychogenic non-epileptic seizures (PNES), which demonstrates a substantial amount of seizure frequency reduction (Baslet et al., 2020; Baslet et al., 2022). The suggested mechanism is that mindfulness increases levels of attentional self-control and leads to non-judgmental acceptance of unwanted acute inner states (Baslet et al., 2020; Toljan et al., 2020). "Sensory mindfulness" uses this by training patients to recognize premonitory sensations without involving the fearful response that may cause a dissociative event. The prevalent measure of the outcome would be the frequency of seizures studied through patient diaries (Nielsen et al., 2015; Baslet et al., 2019).

6. Conclusion and Future Directions

Adult rehabilitation with FND needs to be developed as a generic rehabilitation; motor exercise fails to fit the needed rehabilitation, which should focus on the underlying problems of the disorder. This paper has **presented participatory sensory** retraining, which is a framework that combines lived experience with knowledge of the patient with a neurobiologically informed intervention shaping sensory processing. The model directly fills essential scientific gaps, such as focusing on the experience of the lived reality, which is essentially a co-construction-based approach, and has a systematic structure of sensory retraining.

This model urgently needs to be exposed to a stiff empirical study. It is suggested that a staged research program should be implemented, starting with feasibility and pilot trials, followed by large-scale randomized controlled trials (RCTs). This type of research will be an important step in revolutionizing the quality of care and providing real hope of healing to the millions of people living with this demanding and hopefully reversible condition.

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