Functional Neurological Disorders

CHAPTER 8

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Definition and aetiology

Functional neurological disorder (FND) is the paradigmatic mind-body disorder. Given both its high prevalence and high levels of resulting disability[1] it is central to neuropsychiatric practice. It is defined by neurological symptoms indicative of a disruption of voluntary motor control, speech, voice or language, diminished somatosensory function, vision or hearing, altered sensations of space and motion, or decreased cognitive abilities or awareness which can lead to it resembling almost all other neurological disorders. It can be differentiated from other conditions, and therefore reliably diagnosed, using 'positive clinical signs' which illustrate mechanistic features specific to FND such as motor function improving during automatic (subconscious) movement or sensory symptoms fitting internal representations of neurological dysfunction (illness models) rather than fitting known patterns of sensory nerve damage[2,3].

A number of aetiological risk factors have been identified, including any cause of neurological symptoms (e.g. pre-existing disorders or physical injuries[4–6]), psychiatric disorders (e.g. PTSD[7], anxiety[7] and autistic spectrum disorders[8,9]), hypermobility[10], and both recent and historical psychosocial stressors - especially childhood trauma, abuse & neglect[11].

Biopsychosocial models, informed by modern neuroscience, have replaced historical simplistic 'psychogenic' theories[3,12,13]. This has led to key changes in terminology with the historical term of hysteria, and more recent term of conversion disorder (referring to the Freudian notion of psychic stress converting into physical symptoms) being replaced by the more aetiologically neutral term of functional neurological disorder. This, combined with increases in shared care across neurology and psychiatry, has resulted in major improvements in patients' acceptance of the diagnosis and engagement; both of which are crucial to recovery[14,15].

Epidemiology

FND is common and disproportionately affects women with a ratio of around 2-3:1[16,17]. The most conservative estimates of FND prevalence as a whole lie at 80-140/100,000, meaning it is more common than multiple sclerosis, motor neurone disease and all CNS cancers combined[18]. Estimates for incidence range from 11-22/100,000 – although rates are higher in certain populations, including those in military service and forcibly displaced people groups[19,20].

FND makes up 9% of neurology admissions and is the second most common reason for referral to neurology outpatient clinic[21–24]. It is as disabling as multiple sclerosis and has a higher symptom burden, worse health-related quality of life and a comparable disease course to other neurological conditions at one year after diagnosis[1,25,26]. The healthcare associated costs related to FND rival those of demyelinating diseases, motor neurone disease and epilepsy[27].

Pathophysiology

The pathophysiology of FND is complex. Complementary neurobiological and psychosocial theories attempt to represent the multi-dimensional nature of FND at the cellular, network, personal and socio-cultural level, as well as encompass the heterogeneous features of the clinical syndromes under its diagnostic umbrella. Altered predictive processing, and its integration of 'feed-forward' and 'bottom-up' signals, is thought to be the mechanism by which involuntary symptoms are produced at the neurological level[12].

Optical illusions can be an intuitive example of how our predictive 'feed-forward' system works. In FND, 'bottom-up' sensory input and the predictive 'feed-forward' system are theorised to become dis-integrated, leading to persistent maladaptive models and therefore an altered experience of the world (Figure 1)[16]. This is a mechanism likely shared by the nocebo response[28]. Factors contributing to this dis-integration include chronic stress and arousal compromising inhibitory processes, and increased threat perception from cognitive processes such as catastrophisation and repetitive negative thinking[13,29,30].

Experiencing a symptom from any cause whether due to physical trauma, infection or another medical condition, especially neurological, can provide the 'scaffold' for a functional disorder to develop likely due to the perceived threat or state of bodily or health 'vigilance' becoming more salient than the objective severity of the precipitating cause of symptom[13,31]. Altered proprioception or interoception in those with hypermobility could potentially explain, at least in part, its increasingly recognised association with FND and related conditions[32]. Perpetuation of symptoms can ensue by maladaptively achieving a reduced arousal state in the case of functional seizures or leading to loss of agency in functional movement disorders for example[13,16]. Not only can FND occur co-morbidly with other neurological disease but in Parkinson's disease in particular it may represent a prodrome through early neurodegeneration causing dysfunction in the same predictive processing networks affected in FND[33].

Functional imaging (e.g. fMRI) studies have provided supportive evidence for the involuntary nature of FND[34]. Findings have included dysfunctions in brain networks related to self-agency, emotion processing, attention, homeostatic balance, interoception, multimodal integration, and cognitive/motor control. Specifically, the temporoparietal junction, key for integration of feedforward and sensory feedback, and the amygdala, important for both salience and emotion, have shown dysfunction in FND cohorts[3,16].

Briquet's, and then Freud and Breuer's, foundational descriptions identified stressful life events and traumas as important contributors to functional symptom development; ideas which now have support from clinical and mechanistic studies[35–37]. However, contrary to previous thought, stressful events or trauma are not present in a significant proportion of patients so are neither a necessary or sufficient cause and should be considered as just one of several risk factors – albeit a potentially potent one[11]. As such, stress or trauma should never be assumed to be present in a given patient and even when identified its aetiological relevance should be carefully and sensitively explored with patients as such life events are unfortunately common in the general population. Modern formulations may also identify unhelpful illness beliefs, cognitive processes and behaviours as well as interpersonal relations and other social factors which may contribute to symptom generation and/or propagation[38].

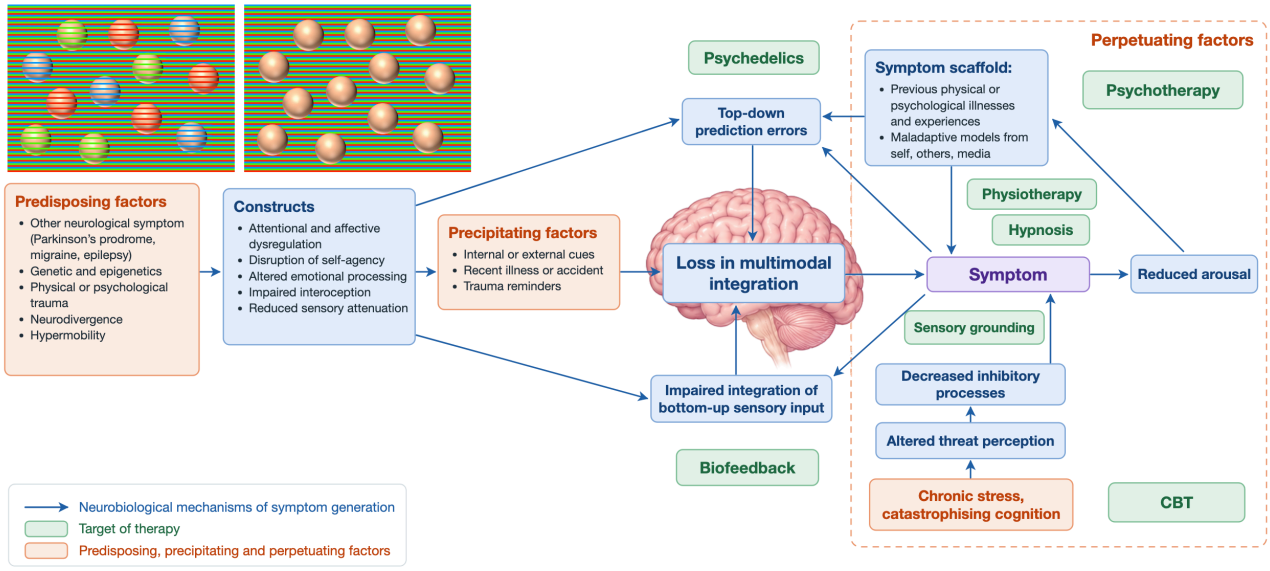


Figure 1 - A non-exhaustive depiction of the theorised pathophysiology of FND with speculative therapeutic target areas. Adapted from Hallett, *et al.*, Functional neurological disorder: new subtypes and shared mechanisms, *The Lancet Neurology*, 2022 and Brown and Reuber, Towards an integrative theory of psychogenic non-epileptic seizures (PNES), *Clinical Psychology Review*, 2016 and Drane *et al.* A Framework for Understanding the Pathophysiology of Functional Neurological Disorder, *CNS Spectrums*, 2021. Optical illusion courtesy of Professor David Novick, the University of Texas at El Paso.

Presentation and Course of Illness

FND usually fits into one or more clinical syndromes which, although influenced by personal and social history, are remarkably preserved across cultures[38–40]. It is important to mention that pain, fatigue and 'brain fog' frequently co-occur with FND and often have greater impacts on health-related quality of life than the primary functional symptom[41,42]. Misdiagnosis as FND remains rare at 4%, a figure comparable to other neurological and psychiatric conditions[16]. Below we have illustrated some of the more common functional syndromes seen across neurology and psychiatry. However, functional symptoms can present in any body system[43].

Functional / Dissociative Seizures (FDS)

This is the most common functional neurological presentation, representing around 30% of patients[18]. Around 20% of patients have co-morbid epilepsy, with FDS developing later in almost all cases[31,44]. Due to the ineffectiveness of antiseizure medication in FDS, protracted seizures can be misinterpreted as status epilepticus and erroneously treated; in the worst cases leading to iatrogenic respiratory arrest or intubation in intensive care[45,46].

FDS previously saw a consistent 7-year delay to diagnosis; more recent studies place this number at around a 5-year delay[44,47,48]. When a correct diagnosis was made, regular use of emergency departments dropped from 50% of patients at baseline to 16% at 12 months in one study and seizure-related medical costs dropped by 84% in another[49,50].

Characteristic features of FDS include eye closure (particularly resistance to passive eye opening), asynchronous movements (side-to-side head shaking or pelvic thrusting being specific) and hyperventilation[51]. Intra-ictal weeping is rare but specific for FDS, whereas lateral tongue biting is more

specific for an epileptic seizure. Re-orientation is usually rapid in FDS but there can be a waxing and waning course. Urinary incontinence is not specific to either FDS or epileptic seizures. A positive Babinski reflex post-ictally would point towards an epileptic seizure, whereas preserved pupillary light reflex would suggest FDS[52]. Caution should be taken to consider focal, particularly frontal, onset or absence seizures which can exhibit motor features more common to FDS[53]. Seizure duration of longer than 2 minutes usually suggests FDS, however status epilepticus is the most consequential differential to exclude[52]. Table 1 shows some important distinguishing factors between FDS and status epilepticus which can be remembered by the mnemonic MET A ROBR (a traumatic event!).

	FDS (specificity, sensitivity FDS vs epilepsy)	**Status epilepticus (specificity, sensitivity epilepsy vs FDS)**
Movements	Reduced or asynchronous movements (100%, 56%), head shaking (100%, 66%), pelvic thrusting (99%, 8%), opisthotonus	Stereotyped tonic-clonic
Eyes	Usually closed, often with resistance to passive eye opening (98%, 96%). Ictal crying (100%, 20%)	Usually open with no resistance to opening
Tongue Abrasions/Biting	Rare but if present usually tip of tongue, lip or buccal	Sometimes – lateral tongue bite most specific
Reflexes	Babinski negative, pupillary light reflex commonly retained but can be dilated due to autonomic arousal	Babinski sometimes positive post-ictally, pupillary light reflex absent
Orientation	Rapid recovery (85%, 73%), no confusion post ictally. Waxing and waning course (96%, 69%). Often awareness during and memory of event (90%, 82.5%)	Slow, post-ictal confusion. Rarely awareness or memory of event
Blood tests	Usually normal but prolonged FDS can cause raised lactate	Prolactin will be raised within 20 minutes of a tonic-clonic seizure (99.1% 67.3.%) with creatinine kinase rising over two days
Respiration	Variable but can exhibit hyperventilation (100%, 14%)	Stertorous (100%, 76%)

Table 1 - Features of FDS versus status epilepticus with specificity and sensitivities. Adapted from Avbersek, A. & Sisodiya, S. Does the primary literature provide support for clinical signs used to distinguish psychogenic nonepileptic seizures from epileptic seizures? *Journal of Neurology, Neurosurgery & Psychiatry*, 2010 and Eilon, T. *et al.* The A to F of functional status in the acute setting: A scoping review. *Seizure: European Journal of Epilepsy*, 2022 and Wang *et al.* Prolactin levels as a criterion to differentiate between psychogenic non-epileptic seizures and epileptic seizures: A systematic review. *Epilepsy Research*, 2021.

Video EEG is the gold standard for diagnosis. When this is not available, a clinician may use ambulatory EEG or smartphone video of the seizure episodes, if available, in combination with history and semiology to make the diagnosis. EEG during an event should be used to rule out epilepsy; semiology should be used to rule in FDS[54]. The International League Against Epilepsy (ILAE) provides the criteria for diagnostic levels of certainty shown in Table 2. Serum markers are another useful adjunct; raised prolactin within 20 minutes has a sensitivity of 93% and negative predictive value of 100% for a tonic-clonic epileptic seizure[53]. Lactic acidosis is expected in tonic-clonic

seizure but can also be produced by imitating seizure-like movements and raised creatinine kinase has been found 48 hours post tonic-clonic seizure but not FDS[53,55]. However, none of these markers are regularly used in clinical practice where the history and semiology (features of the seizure from patient and witness accounts and ideally video recordings of the seizure, often taken on mobile phones) remain the cornerstones of diagnosis.

Diagnostic level	History	Witnessed event	EEG
Possible	Consistent with FDS	By witness or self-report	No epileptiform activity on routine or sleep-deprived EEG
Probable	Consistent with FDS	By clinician reviewing video or in person showing semiology consistent with FDS	No epileptiform activity on routine or sleep-deprived EEG
Clinically established	Consistent with FDS	By clinician experienced in diagnosis of seizure disorders (on video or in person) showing semiology typical or FDS while not on EEG	No epileptiform activity in routine or ambulatory ictal EEG during typical ictus where epileptiform activity would be expected in epilepsy
Documented	Consistent with FDS	By clinician experienced in diagnosis of seizure disorders (on video or in person) showing semiology typical or FDS while on EEG	No epileptiform activity captured before, during or after ictus captured on video EEG with FDS semiology

Table 2 - ILAE Criteria for levels of diagnostic certainty in FDS. *Epilepsia* 2013.

The CODES trial was the largest randomised control trial to examine treatment of FDS[56]. While cognitive behavioural therapy (CBT) didn't improve seizure frequency compared to controls, patients reported higher overall quality of life, seizures to be less bothersome, and lower levels of psychological distress. Epidemiological factors could tailor care provision going forward as patients were most often female, unemployed and living in high deprivation areas. Removal of unnecessary anti-seizure medication is safe and may help to reduce unnecessary healthcare utilisation even in those with dual diagnosis of epilepsy and FDS[44,57,58].

Functional movement disorders (FMD)

FMD is characterised by abnormal movements; most commonly dystonia, myoclonus and gait disorders. Less common are parkinsonism, tics, stereotypy, facial movements and chorea[2]. Functional paresis and paralysis also fit into this category. Often there is a mixed phenotype with multiple abnormal movements[5].

Symptoms can develop suddenly, leading to erroneous diagnosis and inappropriate treatment as stroke[59]. Positive identification of clinical signs as a 'rule-in' diagnosis is of paramount importance, with common features such as distractibility and variability of the symptoms described[60]. No single sign is diagnostic of FMD, however all
can aid in both diagnosis and communication of the diagnosis to the patient. Table 3 and Figure 2 illustrates common signs and how to elicit a selection of them.

Area	Signs
Gait	Monoplegic leg dragging, falling towards support, excessive slowness or effort (huffing and puffing sign), hesitation/caution, knee buckling, non-economic posture
Limbs	Discordance (Hoover's sign lower limb, flex/ext sign upper limb), give way weakness (initial power good then 'gives way'), drift without pronation, co-contraction of agonist and antagonist
Tremor	Variable amplitude which increases when weight added, entrainment (matching frequency to tapping motion), tremor moves to another body part when affected area immobilised (whack-a-mole sign)
Face	In functional hemifacial spasm: Long tonic contraction (>3s), bilateral hemispasm (alternating sides), lip pulling, lack of "other Babinski sign" (eyebrow elevation on side of spasm, platysma contraction In functional vs tardive dyskinesia look for: purely lingual movements, lack of chewing or self-biting, affected speech
Trunk	Weak head rotation towards weak limb (asymmetry of sternocleidomastoid), strongly positive Romberg's without falling and improvement with distraction (functional Romberg's)
Tics	Inability to supress the movement, lack of premonitory urge

Table 3 - Signs in FMD with instructions. Adapted from: Aybek S, Perez D L. Diagnosis and management of functional neurological disorder. *BMJ*, 2022.

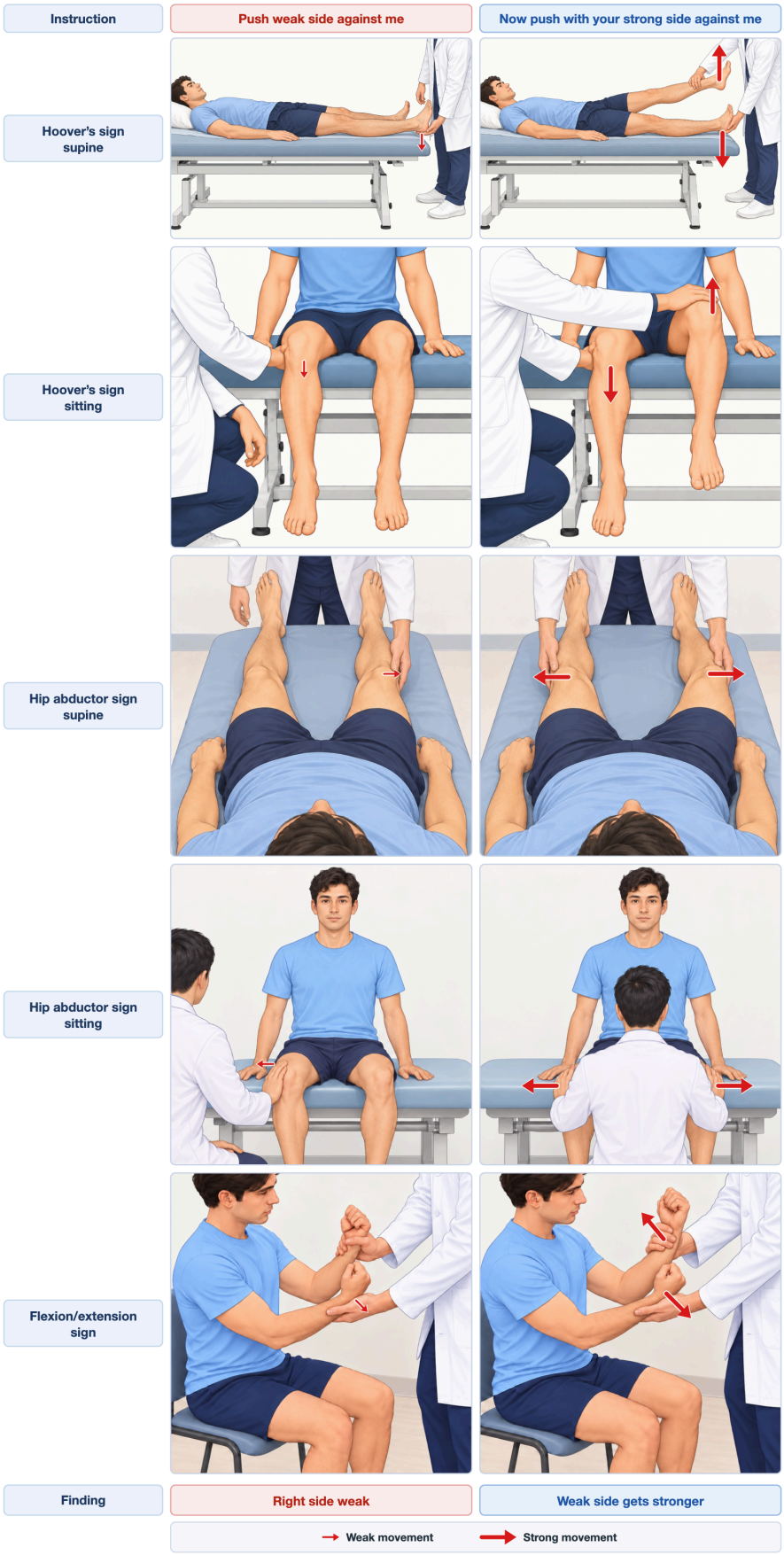


Figure 2 - How to elicit Hoover's in supine and sitting, Hip abductor and Flexion/extension signs. The arrows show the strength of the force pushing against the examiner. Adapted from: Aybek S, Perez D L. Diagnosis and management of functional neurological disorder. *BMJ*, 2022.

Electrophysiological investigations can strengthen the confidence in a diagnosis in clinically challenging cases. Functional tremor is usually in the range of 6-11Hz. Variability of >2Hz suggests a functional diagnosis, and entrainment can be measured by matching to a known frequency using a metronome or by tapping a steady beat. Entrainment is, however, only present in a third of those with functional tremor[61].

In the case of weakness, delayed motor evoked potential latency using transcranial magnetic stimulation would suggest a structural rather than functional cause[61]. Time locked back averaging of EMG-EEG for jerks demonstrates a bereitschaftspotential in functional jerk or tic compared to myoclonus in 63-86% of cases[61].

Specialised physiotherapy focusing on goal-directed movement is the mainstay of treatment, showing improvements in self-rated measures of motor symptoms[62]. Botulinum toxin, therapeutic sedation, hypnosis and biofeedback are other management adjuncts that have shown some utility and there is emerging evidence for the potential use of transcranial magnetic stimulation (TMS), tactile induced catalepsy and brain-computer interfaces (BCI)[42,63,64].

Functional Sensory Symptoms

Paraesthesia, anaesthesia, hearing loss, visual loss (or other disturbances such as diplopia) and pharyngeal 'globus' (the sensation of something being stuck in the throat and difficulty swallowing) are all possible sensory
manifestations of FND[65]. These symptoms often present as a syndrome alongside other functional symptoms, however little evidence exists on optimal management[42,66].

Functional visual loss may present with tubular visual fields, where distance does not widen the field of view as would be expected due to the laws of optics, or spiralling on perimetry, where the field of vision shrinks during testing, which are incongruent with structural damage[67]. Inconsistencies often exist and so psychoeducation and use of diagnostic visual tests can be used to encourage that vision may be better than first believed[68].

Sensory loss showing non-anatomical distribution or precise midline splitting of vibration suggests a functional diagnosis as bilateral innervation exists for at least 1-2cm across the sternum[69]. MRI head would exclude a thalamic lesion which would exhibit similar signs[16]. Transcranial magnetic stimulation (TMS) to the occipital lobes, creating phosphenes (flashes of perceived light), may facilitate improvement in a sub-set of patients with functional sensory loss[70]. Globus requires direct pharyngeal visualisation to rule out structural causes before a functional diagnosis can be made. Treatment includes speech therapy, trial of a proton pump inhibitor and avoidance of causative foods[42].

Functional Cognitive Disorder (FCD)

FCD is defined by impaired cognitive functioning causing distress or impairment but with evidence of internal inconsistency[71]. It is not related to systemic or neurodegenerative disease[72]. Subclinical examples include forgetting why you have walked into a room or being unable to recall the name of someone you know well in a pressured social situation. Such cognitive failures happen to us all transiently from time to time but can become longer lasting, more frequent and

therefore distressing and impairing through a spiral of increased attention and monitoring of cognitive performance progressing to the level of a disorder[65,73].

Distinguishing features of FCD from neurodegenerative disorders include patients being able to attend clinic alone, answer questions independently (in contrast to 'head-turn sign' to a partner in dementia), describe detailed examples of memory losses and loss of remote autobiographical memories, commonly preserved in dementia, as well as loss of recent memories[71]. Patients with FCD tend to be more worried about their memory than family and friends are and memory gaps may be present only at certain times of day or exhibit more marked variability[71].

A positive diagnosis and psychoeducation are the most important aspects of therapy in FCD however consensus is lacking on the utility of further options. Acceptance and commitment therapy (ACT), CBT and computer based training aimed at improving metacognition are therapies that require further investigation[74,75].

Persistent Postural Perceptual Dizziness (PPPD)

Functional dizziness is termed Persistent Postural Perceptual Dizziness (PPPD) and defined by the Barany society as[76]:

- Dizziness, unsteadiness or non-spinning vertigo for a prolonged period most days for 3 months or more,
- Being exacerbated by upright posture, active or passive motion, and exposure to moving visual stimuli or complex visual patterns,
- Triggered by an organic vertiginous or dizziness causing event where symptoms fails to settle,
- Symptoms causing significant distress or functional impairment,
- Symptoms are not better accounted for by another disease.

PPPD is responsible for 20% of vestibular presentations[77]. Symptoms are thought to develop from excessive body vigilance leading to heightened sensitivity to motion, stiffened postural control as a result, and preference for visual cues leading to excessive postural sway[78]. Treatment with vestibular rehabilitation, use of SSRIs and psychotherapy in the form of CBT have shown robust improvements in self-reported measures of dizziness[78].

Neuropsychiatric aspects of managing all FND subtypes

Clear and sensitive communication aids in patient acceptance of a diagnosis. Acceptance has been shown to be a positive prognostic factor in FND and can even lead to the cessation of symptoms in a subset of patients[60,79,80]. Many communication strategies are available, whether through utilizing a specific framework or the use of metaphor. It is a worthy test of your clinical acumen to tailor your explanation to each individual patient and relate it to their specific functional symptoms. Specific pointers that might be useful are listed below (Table 4).

Do	Don't
Take the problem seriously and ask for an exhaustive symptom list including dissociative symptoms such as derealisation and depersonalisation. Validating additional related symptoms such as poor sleep, fatigue and pain as part of the same disorder can improve engagement	Use negative test results rather than positive signs to explain
Label the diagnosis as FND rather than as 'you don't have… x'	Focus on psychiatric co-morbidity or preciptiously produce a psychological formulation to explain aetiology
Explain the rationale for the diagnosis using the positive signs relevant to the patient and why these are compatible with FND and not other disorders	Assume all symptoms (new or old) are functional once a diagnosis is made. Functional symptoms commonly arise as a pro-drome or co-morbidity to structural disease
Tackle common misconceptions or concerns (e.g. FND means symptoms are not real, voluntary, 'all in the head', 'just due to stress/trauma') directly and early in consultations if suspected. Unhelpful or incorrect other explanation or diagnoses patients may have been told or read about may also need to be tackled sensitively once trust has been built	
Discuss the mechanism in a way that the patient can understand and relate to using pre-disposing, precipitating and perpetuating factors relevant to their symptoms	
Convey potential for reversibility (referring back to positive signs you have elicited which can clearly demonstrate this) and that significant and sometimes full recovery is possible even if it's hard to predict in whom; check understanding and re-explain more simply if needed	
Provide authoritative written and/or online information (e.g. information sheets, neurosymptoms.org and FND charity websites) and follow up as indicated when possible	

Table 4 - Tips for communicating a diagnosis of FND. Adapted from Carson *et al.* Explaining functional disorders in the neurology clinic: a photo story. *Practical Neurology*, 2016 and Hall-Patch, L. *et al.* Acceptability and effectiveness of a strategy for the communication of the diagnosis of psychogenic nonepileptic seizures. *Epilepsia*, 2010 and Stone *et al.* Recognising and explaining functional neurological disorder. *BMJ* 2020.

Psychological therapies for FND have shown mixed results and there may be no 'one size fits all'. CBT alone improves patient reported measures of disease severity and the addition of motivational interviewing seems to decrease seizure frequency in FDS[56,81]. Psychodynamic approaches, particularly using interpersonal techniques, have shown benefit but may be more suitable for those with trauma histories[65,82]. Eye-movement desensitisation therapy and hypnosis are other treatment options that show promise[83,84]. Novel pharmacological approaches being developed and tested include the use of ketamine and classical psychedelics, such as psilocybin, with or without concurrent psychological or physiotherapy[85,86]. Psychiatric co-morbidity is high in FND and should be managed as usual whether pharmacologically or otherwise.

Other key aspect of management

Multidisciplinary working involving neurologists, psychiatrists, physiotherapists, occupational therapists, speech and language therapists and psychotherapists among others has repeatedly led to robust improvements for patients[16,87–90]. Therapeutic interventions may take the form of outpatient, intensive day hospital or inpatient programmes[87,91,92]. Consensus guidelines exist for individual therapists treating FND but the optimal interplay of each requires further large trial data[93–95].

Unfortunately patients still experience stigma and discrimination from healthcare professionals and the wider public ignorant to FND as well as internalised stigma which is associated with shame and social withdrawal[96]. Educating colleagues on the wards and in our personal lives can help foster a supportive and therapeutic environment for patients to recover.

Chapter Summary

- FND is a common, often chronically disabling, disorder for which neuropsychiatrists have a key role in managing.
- Common subtypes include seizures, movement disorders, sensory symptoms, cognitive dysfunction and dizziness.
- Patients often experience multiple symptoms either concurrently or sequentially and FND is often comorbid with other psychiatric and medical conditions.
- Dysfunction in the brain's 'predictive processing' is considered a potentially unifying pathophysiological mechanism across subtypes, which may be precipitated and/or perpetuated by a range of physiological and psychosocial factors relevant to an individual's management.
- Diagnosis is based on eliciting positive clinical signs.
- Communication of a diagnosis and ensuring patient understanding are the first steps to treatment.
- Some aspects of management are specific to the FND subtype and may include psychotherapy, physiotherapy, and/or occupational therapy. Common themes include helping patients down-regulate threat processing, regain sense of agency, manage pain and fatigue, increase daily activity levels, and tolerate uncertainty during recovery and management of FND.

References

1. Moss, R. S. L. *et al.* Disability, distress and delayed access to care in functional neurological disorder: cross-sectional study from an Australian tertiary clinic. *BJPsych open* **12**, e128 (2026).
2. Hallett, M. *et al.* Functional Neurological Disorder: New Phenotypes, Common Mechanisms. *Lancet Neurol* **21**, 537–550 (2022).
3. Drane, D. L. *et al.* A Framework for Understanding the Pathophysiology of Functional Neurological Disorder. *CNS Spectr* **26**, 555–561 (2021).
4. Stone, J., Warlow, C., Deary, I. & Sharpe, M. Predisposing Risk Factors for Functional Limb Weakness: A Case-Control Study. *JNP* **32**, 50–57 (2020).
5. Tinazzi, M. *et al.* Clinical Correlates of Functional Motor Disorders: An Italian Multicenter Study. *Mov Disord Clin Pract* **7**, 920–929 (2020).

6. Liampas, A., Markoula, S., Zis, P. & Reuber, M. Psychogenic non-epileptic seizures (PNES) in the context of concurrent epilepsy – making the right diagnosis. *Acta Epileptologica* **3**, 23 (2021).

7. Patron, V. G., Rustomji, Y., Yip, C. & Jenkins, L. M. Psychiatric Comorbidities in Functional Neurologic Symptom Disorder. *Pract Neurol (Fort Wash Pa)* **21**, 71–75 (2022).

8. Cole, R. H., Smythe, L., Edwards, M. J., Happé, F. & Nicholson, T. R. Exploring the autism and functional neurological disorder association: Considerations from biopsychosocial, neuropsychological and computational models. *Autism* **30**, 269–284 (2026).

9. Cole, R. H., Elmalem, M. S. & Petrochilos, P. Prevalence of autistic traits in functional neurological disorder and relationship to alexithymia and psychiatric comorbidity. *Journal of the Neurological Sciences* **446**, 120585 (2023).

10. Chen, G., Castro-de-Araujo, L. F. S., Olver, J. S. & Kanaan, R. A. Joint hypermobility in functional neurological disorder: A cross-sectional study. *Journal of Psychosomatic Research* **182**, 111807 (2024).

11. Ludwig, L. *et al.* Stressful life events and maltreatment in conversion (functional neurological) disorder: systematic review and meta-analysis of case-control studies. *The Lancet Psychiatry* **5**, 307–320 (2018).

12. Edwards, M. J., Adams, R. A., Brown, H., Pareés, I. & Friston, K. J. A Bayesian account of 'hysteria'. *Brain* **135**, 3495–3512 (2012).

13. Brown, R. J. & Reuber, M. Towards an integrative theory of psychogenic non-epileptic seizures (PNES). *Clinical Psychology Review* **47**, 55–70 (2016).

14. Silva, A. F. & Silva, B. Diagnostic communication in functional neurological disorder: A systematic review and meta-analysis of patient acceptance and clinical outcomes. *Patient Education and Counseling* **152**, 109826 (2026).

15. Wardrope, A. *et al.* How to do things with words: Two seminars on the naming of functional (psychogenic, non-epileptic, dissociative, conversion, …) seizures. *Seizure* **93**, 102–110 (2021).

16. Espay, A. J. *et al.* Current Concepts in Diagnosis and Treatment of Functional Neurological Disorders. *JAMA Neurol* **75**, 1132–1141 (2018).

17. Kulikov, V. & Maurer, C. Longitudinal Epidemiological Trends in Functional Neurological Disorder (P10-5.016). *Neurology* **104**, 343 (2025).

18. Finkelstein, S. A., Diamond, C., Carson, A. & Stone, J. Incidence and prevalence of functional neurological disorder: a systematic review. *J Neurol Neurosurg Psychiatry* **96**, 383–395 (2025).

19. Ar, G., Sd, H. & S, S. Epidemiology of functional neurological disorder, active component, U.S. Armed Forces, 2000-2018. *MSMR* **(7):16-22**, (2020).

20. Hallab, A. & Sen, A. Epilepsy and psychogenic non-epileptic seizures in forcibly displaced people: A scoping review. *Seizure* **92**, 128–148 (2021).

21. Stone, J. *et al.* Who is referred to neurology clinics?—The diagnoses made in 3781 new patients. *Clinical Neurology and Neurosurgery* **112**, 747–751 (2010).

22. Lempert, T., Dieterich, M., Huppert, D. & Brandt, T. Psychogenic disorders in neurology: frequency and clinical spectrum. *Acta Neurologica Scandinavica* **82**, 335–340 (2009).

23. Beharry, J. *et al.* Functional neurological disorders presenting as emergencies to secondary care. *Euro J of Neurology* **28**, 1441–1445 (2021).

24. Watila, M. M., Duncan, C. & Mackay, G. Evaluation of telemedicine for new outpatient neurological consultations. *BMJ Neurol Open* **4**, e000260 (2022).

25. Asan, L. *et al.* Comorbidities and Outcomes in People With Functional Neurological Disorder. *JAMA Neurol* **83**, 709–711 (2026).

26. Shipston-Sharman, O., Popkirov, S., Hansen, C. H., Stone, J. & Carson, A. Prognosis in functional and recognised pathophysiological neurological disorders - a shared basis. *Journal of Psychosomatic Research* **152**, 110681 (2022).

27. Stephen, C. D., Fung, V., Lungu, C. I. & Espay, A. J. Assessment of Emergency Department and Inpatient Use and Costs in Adult and Pediatric Functional Neurological Disorders. *JAMA Neurol* **78**, 1–14 (2021).

28. Fiorio, M. *et al.* Functional neurological disorder and placebo and nocebo effects: shared mechanisms. *Nature Reviews Neurology* **18**, 624–635 (2022).

29. Whitfield, A., Walsh, S., Levita, L. & Reuber, M. Catastrophising and repetitive negative thinking tendencies in patients with psychogenic non-epileptic seizures or epilepsy. *Seizure* **83**, 57–62 (2020).

30. Bakvis, P. *et al.* Trauma, stress, and preconscious threat processing in patients with psychogenic nonepileptic seizures. *Epilepsia* **50**, 1001–1011 (2009).

31. Kutlubaev, M. A., Xu, Y., Hackett, M. L. & Stone, J. Dual diagnosis of epilepsy and psychogenic nonepileptic seizures: Systematic review and meta-analysis of frequency, correlates, and outcomes. *Epilepsy & Behavior* **89**, 70–78 (2018).

32. Akaras, E., Deniz, G., Eymir, M. & Sönmez, M. The effects of joint hypermobility on strength, proprioception, and functional performance. *Sci Rep* **15**, 40529 (2025).

33. Matar, E., Tinazzi, M., Edwards, M. J. & Bhatia, K. P. Functional Movement Disorder as a Prodromal Symptom of Parkinson's Disease—Clinical and Pathophysiological Insights. *Movement Disorders* **39**, 1952–1959 (2024).

34. Cojan, Y., Waber, L., Carruzzo, A. & Vuilleumier, P. Motor inhibition in hysterical conversion paralysis. *NeuroImage* **47**, 1026–1037 (2009).

35. Keynejad, R. C. *et al.* Stress and functional neurological disorders: mechanistic insights. *J Neurol Neurosurg Psychiatry* **90**, 813–821 (2019).

36. P. Briquet. *Traité Clinique et Theŕapeutique de l'hysteŕie*. (1859).

37. Breuer J, Freud S. *Studies on Hysteria*. (Avon Books, New York, 1966).

38. Carson, A., Ludwig, L. & Welch, K. Chapter 10 - Psychologic theories in functional neurologic disorders. in *Functional Neurologic Disorders* (eds Hallett, M., Stone, J. & Carson, A.) vol. 139 105–120 (Elsevier, 2016).

39. LaFrance Jr., W. C., Baker, G. A., Duncan, R., Goldstein, L. H. & Reuber, M. Minimum requirements for the diagnosis of psychogenic nonepileptic seizures: A staged approach. *Epilepsia* **54**, 2005–2018 (2013).

40. Cubo, E. *et al.* Transcultural comparison of psychogenic movement disorders. *Movement Disorders* **20**, 1343–1345 (2005).

41. Věchetová, G. *et al.* The impact of non-motor symptoms on the health-related quality of life in patients with functional movement disorders. *Journal of Psychosomatic Research* **115**, 32–37 (2018).

42. Gilmour, G. S. *et al.* Management of functional neurological disorder. *J Neurol* **267**, 2164–2172 (2020).

43. Benbadis, S., Ledford, R., Sawchuk, T. & Dworetzky, B. A broader perspective: Functional symptoms beyond Neurology. *Epilepsy Behav Rep* **18**, 100506 (2021).

44. Whitfield, A., Leighton, E., Boagey, H. & Oto, M. Dual diagnosis of epilepsy and dissociative seizures: Prescription patterns, feasibility and safety of rationalising antiseizure medication. *Epilepsy & Behavior* **152**, 109661 (2024).

45. Mcloughlin, C., Lee, W. H., Carson, A. & Stone, J. Iatrogenic harm in functional neurological disorder. *Brain* **148**, 27–38 (2025).

46. Viarasilpa, T. *et al.* Intubation for Psychogenic Non-Epileptic Attacks: Frequency, Risk Factors, and Impact on Outcome. *Seizure* **76**, 17–21 (2020).

47. Reuber, M., Fernández, G., Bauer, J., Helmstaedter, C. & Elger, C. E. Diagnostic delay in psychogenic nonepileptic seizures. *Neurology* **58**, 493–495 (2002).

48. Oto, M., Espie, C. A. & Duncan, R. An exploratory randomized controlled trial of immediate versus delayed withdrawal of antiepileptic drugs in patients with psychogenic nonepileptic attacks (PNEAs). *Epilepsia* **51**, 1994–1999 (2010).

49. McKenzie, P., Oto, M., Russell, A., Pelosi, A. & Duncan, R. Early outcomes and predictors in 260 patients with psychogenic nonepileptic attacks. *Neurology* **74**, 64–69 (2010).

50. Martin, R. C., Gilliam, F. G., Kilgore, M., Faught, E. & Kuzniecky, R. Improved health care resource utilization following video-eeg-confirmed diagnosis of nonepileptic psychogenic seizures. *Seizure* **7**, 385–390 (1998).

51. Stone, J., Burton, C. & Carson, A. Recognising and explaining functional neurological disorder. *BMJ* m3745 (2020) doi:10.1136/bmj.m3745.

52. Avbersek, A. & Sisodiya, S. Does the primary literature provide support for clinical signs used to distinguish psychogenic nonepileptic seizures from epileptic seizures? *Journal of Neurology, Neurosurgery & Psychiatry* **81**, 719–725 (2010).

53. Eilon, T. *et al.* The A to F of functional status in the acute setting: A scoping review. *Seizure: European Journal of Epilepsy* **102**, 61–73 (2022).

54. Tolchin, B. *et al.* Management of Functional Seizures Practice Guideline Executive Summary: Report of the AAN Guidelines Subcommittee. *Neurology* **106**, e214466 (2026).

55. Lou Isenberg, A., Jensen, M. E. & Lindelof, M. Plasma-lactate levels in simulated seizures – An observational study. *Seizure* **76**, 47–49 (2020).

56. Goldstein, L. H. *et al.* Cognitive behavioural therapy for adults with dissociative seizures (CODES): a pragmatic, multicentre, randomised controlled trial. *Lancet Psychiatry* **7**, 491–505 (2020).

57. Liu, J., Chen, D., Xu, Y., Zhang, Y. & Liu, L. Safety and efficacy of rapid withdrawal of antiseizure medication during long-term video-EEG monitoring. *Front Neurol* **14**, 1196078 (2023).

58. Kumar, S. *et al.* Randomized controlled study comparing the efficacy of rapid and slow withdrawal of antiepileptic drugs during long-term video-EEG monitoring. *Epilepsia* **59**, 460–467 (2018).

59. Gargalas, S. *et al.* Incidence and outcome of functional stroke mimics admitted to a hyperacute stroke unit. *J Neurol Neurosurg Psychiatry* **88**, 2–6 (2017).

60. Aybek, S. & Perez, D. L. Diagnosis and management of functional neurological disorder. *BMJ* o64 (2022) doi:10.1136/bmj.o64.

61. Edwards, M. J. *et al.* Clinical neurophysiology of functional motor disorders: IFCN Handbook Chapter. *Clin Neurophysiol Pract* **9**, 69–77 (2024).

62. Nielsen, G. *et al.* Specialist physiotherapy for functional motor disorder in England and Scotland (Physio4FMD): a pragmatic, multicentre, phase 3 randomised controlled trial. *The Lancet Neurology* **23**, 675–686 (2024).

63. Oriuwa, C. *et al.* Neuromodulation for the treatment of functional neurological disorder and somatic symptom disorder: a systematic review. *J Neurol Neurosurg Psychiatry* **93**, 280–290 (2022).

64. Morrin, H. *et al.* Closed-Loop Brain-Computer Interface for Rehabilitation in Functional Neurological Disorder: A Case Report and Theoretical Overview. *Brain Stimulation* **18**, 1305–1306 (2025).

65. Bennett, K. *et al.* A practical review of functional neurological disorder (FND) for the general physician. *Clin Med (Lond)* **21**, 28–36 (2021).

66. Stone, J., Sharpe, M., Rothwell, P. & Warlow, C. The 12 year prognosis of unilateral functional weakness and sensory disturbance. *J Neurol Neurosurg Psychiatry* **74**, 591–596 (2003).

67. Stone, J., Burton, C. & Carson, A. Recognising and explaining functional neurological disorder. https://doi.org/10.1136/bmj.m3745 (2020) doi:10.1136/bmj.m3745.

68. Ramsay, N., McKee, J., Al-Ani, G. & Stone, J. How do I manage functional visual loss. *Eye* **38**, 2257–2266 (2024).

69. FutureLearn. Sensory symptoms - Functional Neurological Disorder: A Healthcare Professional's Guide - City St George's, University of London (formerly St George's). *FutureLearn* https://www.futurelearn.com/courses/functional-neurological-disorder-a-healthcare-professionals-guide/1/steps/1477174.

70. Parain, D. & Chastan, N. Large-field repetitive transcranial magnetic stimulation with circular coil in the treatment of functional neurological symptoms. *Neurophysiologie Clinique/Clinical Neurophysiology* **44**, 425–431 (2014).

71. McWhirter, L., Ritchie, C., Stone, J. & Carson, A. Functional cognitive disorders: a systematic review. *The Lancet Psychiatry* **7**, 191–207 (2020).

72. Pennington, C., Newson, M., Hayre, A. & Coulthard, E. Functional cognitive disorder: what is it and what to do about it? *Pract Neurol* **15**, 436–444 (2015).

73. Palmer, D. D. G., Edwards, M. J. & Mattingley, J. B. Functional neurological symptoms occur commonly in healthy adults: implications for the pathophysiology of FND. *CNS Spectr.* **31**, e13 (2026).

74. Cabreira, V., McWhirter, L. & Carson, A. Functional Cognitive Disorder: Diagnosis, Treatment, and Differentiation from Secondary Causes of Cognitive Difficulties. *Neurologic Clinics* **41**, 619–633 (2023).

75. Poole, N. *et al.* Randomised controlled feasibility trial of online group acceptance and commitment therapy for functional cognitive disorder. *BJPsych Open* **11**, e91 (2025).

76. Staab, J. P. *et al.* Diagnostic criteria for persistent postural-perceptual dizziness (PPPD): Consensus document of the committee for the Classification of Vestibular Disorders of the Bárány Society. *J Vestib Res* **27**, 191–208.

77. Adamec, I. *et al.* Persistent postural-perceptual dizziness: Clinical and neurophysiological study. *Journal of Clinical Neuroscience* **72**, 26–30 (2020).

78. Staab, J. P. Persistent Postural-Perceptual Dizziness. *Neurologic Clinics* **41**, 647–664 (2023).

79. Silva, A. F. & Silva, B. Diagnostic Communication in Functional Neurological Disorder: A Systematic Review and Meta-Analysis of Patient Acceptance and Clinical Outcomes. *Patient Education and Counseling* 109826 (2026) doi:10.1016/j.pec.2026.109826.

80. Stone, J. Functional neurological disorders: the neurological assessment as treatment. *Pract Neurol* **16**, 7–17 (2016).

81. Tolchin, B. *et al.* Randomized controlled trial of motivational interviewing for psychogenic nonepileptic seizures. *Epilepsia* **60**, 986–995 (2019).

82. Reuber, M., Burness, C., Howlett, S., Brazier, J. & Grünewald, R. Tailored psychotherapy for patients with functional neurological symptoms: A pilot study. *Journal of Psychosomatic Research* **63**, 625–632 (2007).

83. Moene, F. C., Spinhoven, P., Hoogduin, K. A. L. & Dyck, R. V. A Randomized Controlled Clinical Trial of a Hypnosis-Based Treatment for Patients with Conversion Disorder, Motor Type. *International Journal of Clinical and Experimental Hypnosis* **51**, 29–50 (2003).

84. Cope, S. R. *et al.* Randomised feasibility study evaluating eye movement desensitisation and reprocessing therapy for functional neurological disorder (MODIFI). *J Neurol* **272**, 493 (2025).

85. Bryson, A. *et al.* Psilocybin-assisted Physiotherapy for Refractory Motor Functional Neurological Disorder: A Randomized Dose-comparison Pilot Study (P7-17.001). *Neurology* **106**, 440 (2026).

86. Tamilson, B. *et al.* (Es)ketamine in functional neurological disorder: a systematic review. *Front Psychiatry* **17**, 1872389.

87. Demartini, B. *et al.* Multidisciplinary treatment for functional neurological symptoms: a prospective study. *J Neurol* **261**, 2370–2377 (2014).

88. Guy, L. *et al.* Routine outcomes and evaluation of an 8-week outpatient multidisciplinary rehabilitative therapy program for functional neurological disorder. *Journal of Neurology* **271**, 1873–1884 (2023).

89. Schmidt, T. *et al.* Evaluation of Individualized Multi-Disciplinary Inpatient Treatment for Functional Movement Disorders. *Mov Disord Clin Pract* **8**, 911–918 (2021).

90. Anne, S. *et al.* Outcomes and Cost-Effectiveness of an Interdisciplinary Clinic for Functional Neurologic Disorders. *Neur Clin Pract* **16**, e200638 (2026).

91. Frucht, L. *et al.* Functional Dystonia: Differentiation From Primary Dystonia and Multidisciplinary Treatments. *Front Neurol* **11**, 605262 (2021).

92. Jacob, A. E., Kaelin, D. L., Roach, A. R., Ziegler, C. H. & LaFaver, K. Motor Retraining (MoRe) for Functional Movement Disorders: Outcomes From a 1-Week Multidisciplinary Rehabilitation Program. *PM&R* **10**, 1164–1172 (2018).

93. Nicholson, C. *et al.* Occupational therapy consensus recommendations for functional neurological disorder. *J Neurol Neurosurg Psychiatry* **91**, 1037–1045 (2020).

94. Baker, J. *et al.* Management of functional communication, swallowing, cough and related disorders: consensus recommendations for speech and language therapy. *J Neurol Neurosurg Psychiatry* **92**, 1112–1125 (2021).

95. Nielsen, G. *et al.* Physiotherapy for functional motor disorders: a consensus recommendation. *J Neurol Neurosurg Psychiatry* **86**, 1113–1119 (2015).

96. Bailey, C. *et al.* Illness perceptions, experiences of stigma and engagement in functional neurological disorder (FND): exploring the role of multidisciplinary group education sessions. *BMJ Neurol Open* **6**, e000633 (2024).