A Review and Expert Opinion on the Neuropsychiatric Assessment of Motor Functional Neurological Disorders

David L. Perez, M.D., M.M.Sc., Selma Aybek, M.D., Stoyan Popkirov, M.D., Kasia Kozlowska, M.B.B.S., Ph.D., Christopher D. Stephen, M.B.Ch.B., M.R.C.P., Jordan Anderson, D.O., Robert Shura, Psy.D., A.B.P.P., Simon Ducharme, M.D., M.Sc., Alan Carson, M.D., Ph.D., Mark Hallett, M.D., Timothy R. Nicholson, M.D., Ph.D., Jon Stone, Ph.D., F.R.C.P., W. Curt LaFrance, Jr., M.D., M.P.H., Valerie Voon, M.D., Ph.D.
(On behalf of the American Neuropsychiatric Association Committee for Research)

Functional neurological (conversion) disorder (FND) is a prevalent and disabling condition at the intersection of neurology and psychiatry. Advances have been made in elucidating an emerging pathophysiology for motor FND, as well as in identifying evidenced-based physiotherapy and psychotherapy treatments. Despite these gains, important elements of the initial neuropsychiatric assessment of functional movement disorders (FND-movt) and functional limb weakness/paresis (FND-par) have yet to be established. This is an important gap from both diagnostic and treatment planning perspectives. In this article, the authors performed a narrative review to characterize clinically relevant variables across FND-movt and FND-par cohorts, including time course and symptom evolution, precipitating factors, medical and family histories, psychiatric comorbidities, psychosocial factors, physical examination signs, and adjunctive diagnostic tests. Thereafter, the authors propose a preliminary set of clinical content that should be assessed during early-phase patient encounters, in addition to identifying physical signs informing diagnosis and potential use of adjunctive tests for challenging cases. Although clinical history should not be used to make a FND diagnosis, characteristics such as acute onset, precipitating events (e.g., injury and surgery), and a waxing and waning course (including spontaneous remissions) are commonly reported. Active psychiatric symptoms (e.g., depression and anxiety) and ongoing psychosocial stressors also warrant evaluation. Positive physical examination signs (e.g., Hoover's sign and tremor entrainment) are key findings, as one of the DSM-5 diagnostic criteria. The neuropsychiatric assessment proposed emphasizes diagnosing FND by using "rule-in" physical signs while also considering psychiatric and psychosocial factors to aid in the development of a patient-centered treatment plan.

J Neuropsychiatry Clin Neurosci 2021; 33:14–26;
doi: 10.1176/appi.neuropsych.19120357

Functional neurological disorder (FND), also known as conversion disorder, greatly interested early leaders in neurology and psychiatry. Although largely neglected for much of the 20th century, FND is among the most common conditions encountered by neurologists and neuropsychiatrists and incurs considerable morbidity (1). Renewed interest in FND has been promoted through neuroscience advancements aiding the understanding of the brain-mind interface (2). In parallel, a renewed clinical interest in FND led to a greater emphasis on physical examination signs guiding diagnosis, as well as to a growing repertoire of evidence-based treatments, including physiotherapy and psychotherapy (3–6). Given that neurologists, psychiatrists, and allied clinicians often report feeling ill-equipped to assess and manage FND, there is a need to work toward optimizing the neuropsychiatric assessment of individuals with FND for both diagnostic and initial treatment planning purposes. The present review focuses on motor FND, which includes functional movement disorders (hyper- and hypokinetic), hereafter referred to as FND-movt, and functional limb weakness/paresis, hereafter referred to as FND-par (7). For further details on this topic, see a separate article on psychogenic nonepileptic (dissociative) seizures (PNES), sponsored by the American Neuropsychiatric Association (ANPA) Committee on Research (8).

The biopsychosocial model identifying predisposing vulnerabilities, acute precipitants, and perpetuating factors is a prevailing conceptual formulation for FND (7) (see also reference S1 in the online supplement). Although all nuanced aspects of a patient's history do not need to be fully elucidated for diagnosis and initial treatment planning, factors with prognostic and treatment implications should be

Online supplemental materials can be found by selecting "View Options" (located above the Abstract when accessing article on computer or tablet) or "About" (located above the title when accessing on smartphone).

assessed (1, 9). These factors include comorbid pain and fatigue, psychiatric comorbidities, active psychosocial stressors, unhelpful behavioral strategies, and illness beliefs, among other factors. To date, there is no established initial approach to the neuropsychiatric assessment of motor FND.

We performed a narrative review detailing the clinical history and diagnostic evaluation for FND-movt and FND-par, including time course, precipitating factors, symptom evolution, medical and family histories, psychosocial factors, psychiatric comorbidities, personality characteristics, physical examination signs, and adjunctive diagnostic tests. We have provided suggestions regarding the core elements of the neuropsychiatric assessment, integrating neurological and psychiatric aspects, that should be performed in the early phases of clinical care based on expert opinion from ANPA's Committee on Research and a select panel of international FND leaders. We aimed to help promote a uniform, practical neuropsychiatric interview and physical examination that can be used clinically to both guide diagnosis and the development of a patient-centered treatment plan.

APPROACH

We sought to identify published cohort studies on FND-movt and FND-par written in English. We searched articles in the following databases from their inception through August 2019: PubMed, PsycINFO, and Cochrane Library. The following search terms were used: "functional neurological disorder" OR "conversion disorder" OR "functional neurological symptom disorder" OR "functional movement disorder(s)" OR "psychogenic movement disorder(s)" OR "functional gait" OR "psychogenic gait" OR "astasia-abasia" OR "astasia abasia" OR "functional tremor" OR "psychogenic tremor" OR "functional dystonia" OR "psychogenic dystonia" OR "fixed dystonia" OR "psychogenic tic" OR "psychogenic jerk" OR "psychogenic myoclonus" OR "functional limb weakness" OR "psychogenic limb weakness" OR "psychogenic weakness" OR "functional weakness" OR "psychogenic paralysis" OR "functional paralysis" OR "hysterical weakness" OR "hysterical tremor" OR "hysterical gait" OR "hysterical dystonia" OR "hysterical jerk" OR "hysterical tic" OR "hysterical myoclonus." Exclusion criteria were review articles and studies on isolated PNES, sensory forms of FND, and functional speech and voice disorders. Additionally, articles investigating the pathophysiology of FND (e.g., functional neuroimaging and autonomic/neuroendocrine studies) were excluded. After reviewing the available evidence, core elements of the neuropsychiatric assessment for FND-movt and FND-par were proposed and agreed upon by all coauthors (see the Discussion section).

REVIEW: STATE OF THE EVIDENCE

The content below is organized to provide evidence supporting elements of the clinical interview, physical examination, and adjunctive tests that can be considered in the early assessment of patients suspected of having FND-movt and/or FND-par.

CLINICAL INTERVIEW

Illness Onset

Demographic characteristics. FND-movt and FND-par usually begin in middle adulthood but can affect children (documented as early as age 6) (10) and the elderly (11) (see also reference S2 in the online supplement). The common age at presentation is between 39 and 49 years old (11–14) (see also references S3 and S4 in the online supplement). A bimodal age distribution was reported in one study (11), with a low average of 35.5 years (N=118; female, 89%) and a high average of 63.5 years (N=33; male, 76%). In some phenotypes, age at onset can help refine the differential diagnosis, such as when Tourette's syndrome (onset typically between ages 3 and 9) or Parkinson's disease (onset usually >50 years old) is suspected (15) (see also reference S5 in the online supplement). A female predominance was identified across FND-movt and FND-par, including in pediatric populations (16) (see also references S6 and S7 in the online supplement), with a range of 63%−89% in studies with ≥80 subjects (11–14) (see also references S3 and S4 in the online supplement).

Tempo. The onset of FND-movt and FND-par is often sudden, including in pediatric populations (17) (see also references S7–S9 in the online supplement). One study found that 97% of FND-movt patients (N=147/151) had an "abrupt onset" (11), while a smaller study found that 50% of patients (N=15/28) had such an onset (see reference S10 in the online supplement). In terms of timescale, in an FND-movt cohort (N=50), 54% of patients reported sudden onset within seconds to minutes, while 36% developed symptoms over the course of hours to one day (18). In an FND-par cohort (N=107), 46% of patients reported sudden onset while awake, and another 15% first experienced symptoms on waking from sleep or general anesthesia (19). In a predominantly pediatric cohort, all 70 patients had abrupt or rapidly progressive onset (see reference S2 in the online supplement). FND-movt and FND-par (in older patients) are common disorders that mimic stroke (11, 12, 20), with a meta-analysis reporting that FND comprises 13%−18% of all stroke mimics (21).

In FND-movt semiologies, an abrupt onset occurred in functional tremor (67%−73%) (see references S11 and S12 in the online supplement), parkinsonism (71%) (see reference S5 in the online supplement), dystonia (50%) (see reference S13 in the online supplement), and myoclonus (52%−61%) (22) (see also reference S14 in the online supplement). Less frequently encountered subtypes, such as functional stereotypies (23), tics (15), and facial movements (24), also showed high rates of abrupt onset (80%−100%).

Precipitating factors. Precipitants occur in two broad categories: physical/medical events (25) and emotional stressors (at times intertwined). A few studies have noted the scale of proximity, which has generally ranged from minutes to within 3 months (18, 26). For emotionally relevant events (11,

27–30) (see also references S3, S10, and S15–S19 in the online supplement), these instances have been described using terms such as "emotional/life event," "adjustment problem," "severe life event," "high escape stress," or simply "stress" (11, 26, 31) (see also references S3, S10, S15, S17, and 20–22 in the online supplement).

Studies on FND-movt have reported precipitating factors in 48%−80% of cases (11, 18) (see also references S10 and S23 in the online supplement). In three studies comprising a total of 229 case subjects, the prevailing trigger was injury of the affected limb in one-fourth of the cases (11, 18) (see also reference S10 in the online supplement). In a FND-movt cohort (N=50), triggering events included injury (22%), infections (18%), another neurological condition (16%), and a drug reaction (6%) (18); in this cohort, 70% of patients also reported physical panic symptoms at onset. Among 49 patients in this same cohort, 87% reported psychological precipitants, such as death of a relative, marital problems, poverty, and unemployment (see reference S23 in the online supplement). Studies on FND-movt subtypes have generally shown the same trend. In an analysis of functional tremor, 51% of patients (N=70) identified a trigger, most commonly physical injury (see reference S12 in the online supplement). In an analysis of functional dystonia, physical triggers, such as injury or surgery, were common (63%−78%) (see reference S13 in the online supplement), consistent with the overlap with complex regional pain syndrome (32) (see also reference S24 in the online supplement). Precipitating factors for other functional subtypes, such as parkinsonism (see reference S5 in the online supplement), myoclonus (27) (see also reference S14 in the online supplement), tics (see reference S25 in the online supplement), paroxysmal FND-movt (28), hemifacial spasm (31), and other facial movement abnormalities (24), have been reported to occur at rates of 37%−88%, with injuries and accidents predominating.

In a study of adults with FND-par, 81% (N=107) of participants reported a precipitant, commonly panic attacks (34%), dissociative symptoms (25%), pain (21%), and migraine headaches (10%). In this same cohort, physical injury was reported in 20% of cases with abrupt onset (19). In a systematic review, 162 out of 397 individuals with FND-par reported a physical trigger, commonly motor vehicle accidents and limb injury (25).

In pediatric FND, stressful life events—often cumulative—are commonly reported (47%−81%) (10, 16, 33) (see also references S6–S8 in the online supplement), although reports are less likely in acute care settings (34) and more frequent when evaluated as part of longitudinal care (35) (see also reference S9 in the online supplement). Physical stressors, including injury, illness, and medical procedures, are common (40%−64%) (35, 36) (see also references S8 and S9 in the online supplement). Psychological stressors may include family conflict, bullying, separation from a family member, death of a friend or family member, family illness, and school/learning stressors (16, 35, 36) (see also references S6 and S7 in the online supplement).

Illness Course and Clinical Presentation

For adults with FND-movt, the average illness duration at diagnosis is reported to be between 2 and 10 years in most studies (11, 18, 23, 24, 27, 37, 38) (see also references S5, S10–S14, S22–S24, and S26 in the online supplement). Illness duration at diagnosis for FND-par is variable across studies (14, 19, 39) (see also reference S2 in the online supplement).

The illness course is often variable in intensity, and symptoms may evolve or wax and wane considerably. The clinical course of functional tremor can be static, progressive, fluctuating, and/or show spontaneous improvements (see reference S12 in the online supplement). Functional dystonia spreads to other body parts in about half of cases (see reference S24 in the online supplement) and generalizes in 22%−31% of cases (see references S13 and S24 in the online supplement). In a study of paroxysmal FND-movt, seven of 26 patients had varied presentations across attacks (28). Symptom self-report can also diverge from objective data. One study found a mismatch between subjective and objective occurrence of functional tremor (38), although these observations were not replicated in another study (40).

Although mixed functional symptoms are common in adults (one in four individuals had mixed features of FND-movt, FND-par, and/or PNES in one cohort, N=100 [39]), multiple motor symptoms are particularly common in children (50%−75%) (see references S7–S9 in the online supplement), as are comorbid functional sensory symptoms and PNES (36%−69%) (16, 35) (see also reference S6 in the online supplement).

Phenotype-specific characteristics of movement disorders should also be considered (41). Phenotype-specific characteristics can be especially important in paroxysmal disorders when direct neurological examination of the dysfunction is limited. For example, in contrast to primary ("organic") tic disorders, functional tics are usually not preceded by premonitory urges (15). Similarly, while children with Tourette's syndrome can often temporarily suppress their tics voluntarily, this is rarely reported in functional tics (15).

Medical and Family Histories

FND-movt and FND-par can predate or accompany other neurological disorders (e.g., migraine) (42, 43) (see also reference S27 in the online supplement) and/or coexist with pain disorders, fatigue, sleep disturbances, urinary complaints, cognitive symptoms, headache, and the presence of other functional somatic disorders (e.g., fibromyalgia and irritable bowel syndrome) (14, 37, 39, 44, 45). Studies in FND-movt have reported 17%−25% co-occurrence with other movement disorders (28) (see also references S10 and S12 in the online supplement). Crucially, FND does not preclude the diagnosis of a comorbid neurological condition and vice versa (including FND predating or coexisting with Parkinson's disease [42]). Additionally, increased rates of surgical procedures (e.g., appendectomies, hysterectomies, and sterilization) have been described in analyses of individuals with

FND-par compared with neurological control subjects (45). In pediatric FND, pain is the most common comorbidity and is present in approximately two-thirds of cases (56%−77%) (16) (see also references S6 and S28 in the online supplement). Fatigue, dizziness, nausea, and gastrointestinal concerns are present in approximately one-third of cases (17, 35) (see also reference S7 in the online supplement); medical comorbidities may be less common in children (5%−12%) (see references S6, S7, and S28 in the online supplement).

In one study, family history of neurological disorders was present in 55% of patients with FND-movt (N=29) (see reference S29 in the online supplement). Interestingly, FND-movt can occur across family members, although no clear inheritance pattern has been identified. Social (environmental) interactions are also likely important (46) (see also reference S30 in the online supplement). Diagnostically, the absence of a family history of Tourette's syndrome or another motor tic disorder may help support a functional tic diagnosis (15). A family history of psychiatric comorbidities is also common and was reported in 36%−68% of individuals with motor FND across two retrospective cohorts (39) (see also reference S16 in the online supplement). In pediatric FND, a family history of mental health concerns is often reported (26%–48%), with maternal depression and anxiety being the most common (16, 35, 36) (see also reference S6 in the online supplement).

Other Psychosocial Factors

Among adult patients, unemployment rates vary, with reports between 23% and 84% (13, 39, 47) (see also references S16, S18, and S21 in the online supplement). The reported percentage of patients who are receiving or seeking medical disability has ranged from 24% to 55% (14, 39, 47) (see also references S16 and S29 in the online supplement). Studies have reported college graduation rates between 41% and 85% (13, 39) (see also reference S16 in the online supplement) and marriage rates between 53% and 77% (13, 14, 47) (see also the online supplement). However, studies have not shown convincing differences in these variables among patients compared with control subjects.

Past Maltreatment and Other Stressors

Psychosocial histories have commonly identified childhood maltreatment and other adverse life events (48). A history of abuse, often during childhood, is identified among some patients with motor FND and includes sexual, physical, and verbal/emotional subtypes (31, 39, 45, 47) (see also references S15, S16, and S20 in the online supplement). When childhood maltreatment and/or other adverse life events are present, it is important to note that these events may or may not have some etiological relevance. Sexual abuse among patients has been reported in many studies, with rates ranging between 3% and 37% (31, 39, 45) (see also references S15, S16, and S20 in the online supplement). Notably, incidence of sexual abuse among women in the general population is approximately 18% (see reference S31 in the online supplement). Physical abuse has been identified within a range of 18%−37%, although in fewer studies (39, 45) (see also reference S16 in the online supplement). Other experiences include neglect (see reference S32 in the online supplement) and parental divorce (see references S15 and S21 in the online supplement). Compared with control subjects, patients with FND (excluding PNES) in a meta-analysis were found to be 3.5 times more likely to report lifetime stressors (48). Other psychosocial factors can include worker's compensation, disability claims, unemployment benefits, and pending litigation (see references S3 and S10 in the online supplement). In pediatric populations, maltreatment (i.e., sexual abuse, physical abuse, or neglect) is reported somewhat less frequently (6%−36%) (49) (see also reference S7 in the online supplement). Stressful family dynamics, including excessively high parental expectations for scholastic achievement, are other variables reported in the pediatric literature (10) (see also reference S33 in the online supplement).

Categorical Psychiatric Comorbidities and Dimensional Characteristics

Several studies used the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I) to evaluate psychiatric comorbidities in adults with FND-movt and FND-par (14, 47, 50–53) (see also reference S34 in the online supplement). Lifetime comorbidities included major depression (35%−42%), generalized anxiety disorder (7%−23%), panic disorder (3%−36%), posttraumatic stress disorder (PTSD) (0%−24%), somatization disorder (22%−27%), and dissociative disorders (approximately 26%) (14, 47, 50–52) (see also references S34 and S35 in the online supplement). In pediatric FND, anxiety disorders (18%−100%) (10, 16, 54) (see also references S6 and S36 in the online supplement) and mood disorders (9%−16%) (16, 54) (see also reference S6 in the online supplement) are common.

In adults, self-report questionnaires can complement categorical diagnoses. One study showed that group-level differences in the frequency of psychiatric diagnoses were not appreciated in FND-movt versus focal hand dystonia using SCID-I diagnoses; however, depression and anxiety self-reported scores were elevated among patients with FND-movt compared with focal hand dystonia (47). In FND-movt, depression scores have been reported to be positively correlated with symptom severity (55). One study showed that 34.5% of individuals with FND-movt were reported to have alexithymia (difficulty putting emotions into words), with associations found between alexithymia and obsessive-compulsive personality disorder identified in this cohort (53).

On dissociation scales, psychological dissociation rates among patients were similar to those for healthy control subjects in one study (47), but another study (56) reported a positive correlation between FND severity and dissociation. Elevated dissociation correlated with childhood abuse burden in 60 patients with mixed FND (55% with FND-par) (57). Studies have shown conflicting results regarding whether dissociation tendencies differ across motor FND and psychiatric populations (see references S37–S40 in the

online supplement). Hypnotic suggestion rates have been inconsistent (see references S41–S43 in the online supplement).

Increased harm avoidance and impulsivity, decreased novelty seeking, self-directedness and active problem-solving, and external rather than internal locus of control have all been described in motor FND (58–60) (see also references S44–S46 in the online supplement). By contrast, in a recent study on FND-movt, patients reported higher general and health-specific internal locus of control compared with neurological control subjects (61). In mixed motor FND, fearful attachment has been shown to be positively correlated with alexithymia and depression scores (62). In pediatric FND, increased questionnaire scores for emotional difficulties, peer problems and social skills difficulties, somatic symptoms, anxiety, depression, stress, internalizing and externalizing, and negativity bias were found (63). In addition, pediatric FND studies have found high rates of insecure attachment and unresolved trauma/loss (35).

Illness Perceptions

Illness perceptions have been characterized in FND-par (14, 64, 65), with patients with FND-par and neurological control subjects having similar illness perceptions in most domains. Compared with other neurological conditions, however, individuals with FND-par were more likely to believe that their illness was a mystery and less likely to agree that stress was etiological (14). Furthermore, compared with individuals with PNES, individuals with FND-par more strongly rejected psychological mechanisms (64).

Suicidality and Self-Harm

Some patients with motor FND report prior suicidal ideation or suicide attempts (39, 66) (see also references S3, S10, and S18 in the online supplement), self-injurious behaviors (14), and psychiatric hospitalizations (39). Elevated dissociation, alexithymia, depression, and anxiety scores were observed for individuals with mixed FND with prior suicidality compared with mixed FND patients without suicidality (60).

Personality Disorders and Dimensional Assessments

In one cohort study (N=31), one in three FND-movt patients met criteria for a personality disorder (50); a similar observation was noted for a separate cohort (67). Associations between FND-movt, obsessive-compulsive personality disorder (53), and dependent personality disorder (see reference S47 in the online supplement) have been reported. In one study utilizing a self-report measure, no differences in personality disorders were identified between FND-movt patients (N=51), neurological control subjects (N=34), and healthy subjects (N=52) (56). Among 20 individuals with FND-par, 50% met SCID-II criteria for a personality disorder, 7% with borderline personality disorder(see reference S21 in the online supplement). In a FND-par cohort (N=30), 50% of patients had a personality disorder (five with histrionic personality disorder) (see reference S48 in the online supplement). Associations between FND and avoidant personality disorder have also been described (see reference S35 in the online supplement).

Multiscale instruments, such as the Minnesota Multiphasic Personality Inventory (MMPI), have also been used for personality assessments. For the MMPI, when clinical scales 1 (for hypochondriasis) and 3 (for hysteria) are the highest elevations and are above scale 2 (for depression), the resulting profile is the "conversion V" pattern. Although well characterized in PNES, the conversion V profile has only been identified in some FND-movt patients compared with normative data (see references S49 and S50 in the online supplement). More research is needed to determine the utility of the MMPI in the assessment of motor FND.

Dimensionally, the Big Five personality traits include neuroticism, extraversion, openness to experience, conscientiousness, and agreeableness. One study found that individuals with FND-movt did not differ from healthy control subjects on personality scores (52). Elevated neuroticism and lower openness scores were observed among patients with FND-par compared with neurological control subjects (45). Another study found lower extraversion and openness scores among patients with functional dystonia compared with control subjects (68); extraversion positively correlated with self-reported adaptive stress coping (resilience) in a mixed-motor FND cohort (69). In pediatric FND, elevated neuroticism scores have also been appreciated (63). Overall, while elevated neuroticism has been identified in some FND cohorts, characterization of the Big Five personality traits remains only a research topic at the present time.

In summary, while some patients report adverse life events, many do not. Additionally, the above-described developmental history and medical, neurologic, and psychiatric comorbidities, as well as other psychosocial factors, can contribute to predisposing, precipitating, and perpetuating FND (Table 1).

NEUROLOGICAL EXAMINATION: RULE-IN SIGNS

A major DSM-5 update for FND was the inclusion of a new criteria, where certain examination features can be used as positive signs (4, 5). This transitioned FND from a "rule-out" disorder to a "rule-in" diagnosis (Table 2).

Signs used to differentiate FND-movt and FND-par from other neurological conditions have been identified since at least the time of Babinski and Charcot. Only some of these widely used signs have been validated, and problems remain with respect to unblinding and diagnostic suspicion bias (4, 70). The plethora of available signs contrasts with the limited evidence on interrater reliability and available specificities and sensitivities. Eighteen controlled studies (14, 23, 31, 70–77) (see also references S51–S57 in the online supplement) reported on 41 bedside clinical tests for motor FND. All studies had small sample sizes (10–50 patients), and only three reported interrater reliability (70, 72, 73). Most signs were investigated in a single study; only the Hoover's sign was validated in five studies (14, 70, 74) (see also

TABLE 1. Clinical history variables commonly found (yet nonspecific) in motor functional neurological disorders (FNDs)

Variable	Description
Age at onset (years)	Symptom onset usually occurs between 39 and 49 years old (mean range), with a female predominance. It also can occur in pediatric and geriatric populations.
Tempo of onset	Sudden onset occurs in a majority of cases (>50%).
Precipitating factors	A precipitating factor occurring in close temporal proximity with symptom onset can often be identified (48%–80%), such as injuries, accidents, surgeries, other medical procedures, and emotionally valenced events.
Associated functional neurological symptoms	Mixed functional motor symptoms are common in adults and especially in children (50%–75%).
Other associated physical symptoms	Comorbid pain, fatigue, dizziness, gastrointestinal complaints, sleep difficulties, and cognitive symptoms are common.
Illness course	The illness course can show waxing and waning patterns, including periods of spontaneous remissions.
Medical comorbidities	In adults, FND can coexist with other medical and neurological conditions, including, for example, another movement disorder (17%–25%). Medical comorbidities are less common among children.
Family history	Neurological and/or psychiatric disorders can be found in the family. A maternal history of depression and/or anxiety is common in pediatric populations.
Psychosocial history	Childhood maltreatment (abuse and neglect) is commonly identified but not universally present. Stressful family dynamics or scholastic challenges are relevant themes in pediatric FND.
Psychiatric comorbidities	In adults, comorbid psychiatric conditions are frequently present (major depression [35%–42%], generalized anxiety disorder [7%–23%], panic disorder [3%–36%], posttraumatic stress disorder [0%–24%], somatization disorder [22%–27%], and personality disorders [20%–30%]). In children, mood disorders (9%–16%) and anxiety disorders (18%–100%) are common.

references S54 and S55 in the online supplement). The specificities of validated signs was very high (64%−100%), with 37 out of 41 signs having a specificity over 90%. The sensitivities were variable (9%−100%).

General functional motor signs include distractibility during another task (motor or cognitive), variability (contrasts between what may be observed in the waiting room and during examination or history taking), and expressive/suffering-type effortful expression during examination (70) or gait (73).

Positive signs for functional gait include dragging monoplegic gait, huffing and puffing, falling toward support, excessive slowness, hesitation, noneconomic posture, and knee buckling (70, 73, 78). Asking a patient with gait disorder to propel a chair while sitting can aid in the assessment of improvement in functional gait (see reference S58 in the online supplement).

Positive signs for functional tremor include distractibility, entrainment (abnormal movements that take on the frequency of volitional movements performed elsewhere), and increase in amplitude with weight load (75). An additional sign is the observation that movement suppression of one body part (e.g., holding an individual's wrist) is followed by immediate re-emergence of movement in another body part (the so-called whack-a-mole sign) (79).

Positive signs for functional jerks include variability and distractibility. The localization can help diagnostically, because functional jerks are often axial when other types of myoclonus occur in the limbs. Arrhythmic jerks of the trunk, hips, and knees, classically recognized as propriospinal myoclonus, can also be functional when functional signs are present (distractibility, variability) (22), as well as electrophysiological evidence (see below).

Positive signs for functional parkinsonism include a triad of excessive slowness of movement without decrement (loss of amplitude), increased tone as a result of gegenhalten, and functional tremor (see above) (4, 42, 80, 81) (see also reference S59 in the online supplement).

Positive signs for dystonia include typical fixed postures and dramatic changes with interventions (such as placebo or low-dose botulinum toxin or physiotherapy) (4), as well as lack of sensory tricks (82).

Positive signs for tics include inability to voluntarily suppress the movement, incomplete premonitory urge, and lack of fully stereotyped movements (15).

Positive signs for functional oro-facial movements compared with tardive dyskinesia include lack of chewing movements or self-biting, lingual movements without mouth movements, and abnormal speech (23). Positive functional facial dystonia signs include downward lip pulling, orbicularis oculis spasm, jaw deviation, and platysma overactivation (24, 83).

Positive signs for FND-par can be detected by the sternocleidomastoid test, presence of discordance/inconsistency, collapsing/giveway weakness, and drift without pronation, as well as the finger abductor sign in hand plegia, flexion-extension sign, Hoover's sign, co-contraction, abductor sign, and the Spinal Injuries Center test (70) (see also reference S56 in the online supplement).

In pediatrics, many of the same signs have been used to support a motor FND diagnosis, including inconsistency/

TABLE 2. Examples of positive "rule-in" signs of functional movement disorders and functional limb weakness

Sign
General signs
Distractibility
Variability (e.g., difference in symptom severity between history taking and examination)
Suggestibility
Gait
Dragging monoplegic gait
Knee buckling
Noneconomic posture
Tremor
Variability
Distractibility
Entrainment
Spread of tremor to another body part if the tremor is restrained
Jerks
Predominantly axial
Distractibility
Variability
Parkinsonism
Excessive slowness without loss of amplitude
Increased tone without cogwheel rigidity
Concurrent functional tremor
Dystonia
Fixed posture (typically hand flexion with sparing of digits 1 and 2 or fixed ankle inversion)
Lack of sensory trick/geste antagoniste
Tics
No voluntary suppression
No or atypical/incomplete premonitory urge
Movements not stereotypical
Weakness
Hoover sign/hip abductor sign
Spinal Injuries Center sign
Asymmetry of head rotation
Arm drift without pronation
Giveway/collapsing and/or global pattern of weakness

variability, reciprocal contraction palpable during attempts to use an apparently paralyzed muscle, normal tendon reflexes present concurrently with a flaccid paralysis, Hoover's sign, tremor entrainment, and nondermatomal sensory loss (10, 17, 34) (see also references S60 and S61 in the online supplement).

In summary, DSM-5 diagnostic criteria emphasize that physical examination signs are one of the core elements used to rule in an FND.

ADJUNCTIVE TESTS

Electromyography (EMG) and Accelerometry

Surface EMG can aid detection of features of complex functional tremors (see reference S62 in the online supplement). Early "tremorgrams" illustrated changes in amplitude and frequency, along with resolution with distraction (see reference S63 in the online supplement). Time-frequency analysis can illustrate entrainment (see reference S64 in the online supplement). Other features more easily demonstrated with electrophysiology include differences in loading with paradoxically increased tremor amplitude in patients with functional tremor as a result of increased coactivation(see reference S65 in the online supplement) and pause of tremor during contralateral ballistic movements (84). As a cautionary note, Milanov (see reference S66 in the online supplement) followed 29 patients with functional tremor for more than 36 months and found that the decrease in tremor amplitude during distraction was present in less than half of these patients at the initial assessment, and the coactivation sign was consistently observed initially. However, with prolonged illness duration, these features were less obvious and even disappeared.

EMG in functional myoclonus can identify features incompatible with reflex cortical or brainstem myoclonus, including variable and increased latencies in stimulus-induced jerks (which have been reported to be longer than the fastest voluntary reaction times among healthy subjects), variable muscle recruitment patterns within each jerk, and significant habituation with repeated stimulation (see reference S67 in the online supplement). In another FND-movt subtype, functional fixed dystonia and "organic" dystonia showed partially overlapping features (reaction times and cocontraction), suggesting that these parameters were not diagnostically useful (85). In addition, in functional jerky movements, there were exaggerated and increased auditory startle reflexes but with a normal EMG pattern (66). On EMG, the presence of incomplete motor activation with a twitch superimposed on the recording of voluntary torque is potentially suggestive of FND-par (see reference S68 in the online supplement). Overall, surface EMG can be a useful adjunctive test for functional tremor and functional myoclonus, with unclear utility in functional dystonia and other motor FND subtypes.

Accelerometry may also record adjunctive diagnostic features. In functional tremor, the accelerometer has captured distractibility, interlimb coherence, and dual-task interference (see reference S69 in the online supplement). As such, the combination of EMG and accelerometry has been advocated to aid diagnosis in functional tremor (84, 86–88) (see also references S70 and S71 in the online supplement).

EEG

EEG may help in diagnosing functional myoclonus by demonstrating the *Bereitschaftspotential* prior to the jerk (a feature of voluntary movement) (see S72 in the online supplement). However, the *Bereitschaftspotential* is not invariably present (89, 90), and event-related desynchronization has also been proposed (90). Highlighting this, a study of 65 patients suspected of having propriospinal myoclonus, with 34 patients reclassified as having functional myoclonus and 31 clinically diagnosed with propriospinal myoclonus by movement disorders experts, the vast majority (>80%) had neurophysiological evidence for FND-movt, suggesting the potential unreliability of clinical examination for certain diagnoses even in expert hands (22, 91).

Transcranial Magnetic Stimulation (TMS)

TMS has been studied in FND-par, revealing normal central motor conduction times and motor-evoked potentials (MEPs) (92, 93) (see also references S73–S83 in the online supplement). During motor imagery, decreased MEPs have been described in patients with FND-par compared with healthy controls, and patients with FND-par had a low excitability pattern, which was hypothesized to be an electrophysiological correlate of the inability to perform voluntary movements (92). Reduced MEPs, however, are not specific for FND (see reference S74 in the online supplement). In addition, TMS has been used in functional dystonia, with abnormally high plasticity in primary but not functional dystonia(see reference S84 in the online supplement). By comparison, cortical excitability was shown to be abnormal in both primary and functional dystonia (see reference S85 in the online supplement). Currently, TMS in dystonia is only a research tool.

Neuroimaging

Structural MRI is often important when looking for neurological comorbidities, which commonly co-occur with FND. Single-photon emission computerized tomography DaTscans can aid in distinguishing neurodegenerative Parkinson's disease from other tremor disorders, including functional parkinsonism and functional tremor, which lack a dopaminergic deficit (94, 95) (see also references S86–S88 in the online supplement). Other quantitative MRI approaches remain research tools only.

Other Tests

Kinematic analysis with motion sensors and optoelectric systems are in their early phases of being studied for motor FND (96, 97) (see also reference S89 in the online supplement). Other adjunctive tests have included the placebo (immediate) response to botulinum toxin injections (98) and examination under general anesthesia in patients with functional dystonia (see reference S90 in the online supplement).

In summary, for diagnostically challenging cases, select adjunctive tests, if available, may provide supporting evidence of motor FND.

DISCUSSION

Initial Neuropsychiatric Assessment for Motor FND

With renewed and growing interest in FND, skill in the neuropsychiatric evaluation of patients with FND is paramount. In this literature review, we illustrated that not enough large-scale controlled studies are available to formulate definitive guidelines on how to conduct a neuropsychiatric evaluation at this stage. However, we provide suggestions below on good practices—based on the available evidence—that can both inform diagnosis as well as guide the development of a patient-centered treatment plan.

Clinical History (Table 1)

- The onset, time course, and evolution of motor symptoms should be characterized.
  - Acute onset, spontaneous remissions, and variability in symptomatology are common in FND but diagnostically nonspecific.
- Inquire about other current or past sensorimotor FND symptoms, including PNES, because mixed symptomatology is common in adults and children.
- Ask about the presence of other physical symptoms.
  - Body pain, headaches, cognitive difficulties, fatigue, sleep disturbances, gastrointestinal concerns, and bowel/bladder symptoms are often reported by patients with FND.
- Evaluate for triggers across physical/medical events and emotional stressors.

Other Medical and Psychiatric Histories

- The concurrent presence of a comorbid functional somatic disorder (e.g., fibromyalgia, irritable bowel syndrome) should be evaluated.
- While an exhaustive psychiatric evaluation may not be initially necessary, active psychiatric symptoms (e.g., depression, anxiety, PTSD, alcohol/substance use disorders, personality disorders and unhelpful personality traits, suicidality, and self-injurious behaviors) and prior mental health treatments (e.g., psychotherapy, medication trials) should be assessed to aid triage of therapeutic options.
- The characterization of relevant personality traits and cognitive styles (e.g., jumping to conclusions [99]) may require a more longitudinal assessment.
- For screenings, self-report questionnaires (e.g., the Patient Health Questionnaire-9, General Anxiety Disorder-7, Post Traumatic Stress Disorder Checklist-5, or other questionnaires) provide complementary mental health information in adults. In pediatric FND, self-report questionnaires have less utility (63). For further details regarding self-report questionnaires, particularly for research purposes, see Pick et al. (100) and Nicholson et al. (101).

Psychosocial History

- While an all-encompassing psychosocial history is not necessary in the initial assessment, sensitively incorporating focused inquiries about childhood experiences, developmental trajectories, past or present trauma or abuse (assuming that there is sufficient time to ask appropriately), education and work histories (including disability status and benefits), military service, relationship status, social/community supports, and legal issues (including injury-related litigations) into routine practice can help develop a patient-centered treatment plan.

TABLE 3. Adjunctive diagnostic tests for consideration in diagnostically challenging cases

Test	Description
Surface electromyography (EMG)	May be useful to detect electrophysiological features consistent with functional tremor and functional myoclonus.
Accelerometry	May be combined with EMG data for characterization of features supportive of functional tremor.
EEG	Can aid the diagnosis of functional myoclonus by demonstrating the *Bereitschaftspotential* prior to a jerk.
Single-photon emission computed tomography DaTScan	Can assist in detecting a basal ganglia dopaminergic deficit found in Parkinson's disease.

- In pediatric FND, relational and scholastic difficulties (e.g., stress in the family, academic challenges, bullying, etc.) are also important to assess.

Illness Perceptions and Health Care Experiences

- Illness perceptions regarding diagnosis and treatment are helpful to explore, particularly so that they can be addressed during diagnostic discussions.
- Additionally, some with FND will have had prior negative experiences with health care providers, and inquiring about these instances while also validating the patient's symptom complex can help build rapport and engagement.
- Providers should also obtain a sense of how the patient arrived at his or her current state, what he or she has been previously told, the reason for the current clinic visit, and goals and motivation levels.

Cautionary Notes Regarding Clinical History

- The clinical history should not be used alone to make the diagnosis of motor FND.
- Likewise, all FND symptoms are not stress-induced; stressors (as outlined above) are not synonymous with stress. Many patients describe the presence of or increase in symptoms in low-stress situations, sometimes seen in the let-down period, where patients are more relaxed.

Physical Examination Signs (Table 2)

- The detection of physical examination rule-in signs for motor FND is one of the core diagnostic criteria (5). Most signs have high specificity, but the use of a single positive sign or some that have low interrater reliability should be interpreted cautiously.
- The diagnostic evaluation should include a neurologist, neuropsychiatrist, and/or another physician with neurological examination expertise.
- FND can coexist with, or occur in the prodrome of, comorbid medical-neurological conditions. As such, clinicians should not generalize a robust functional sign (e.g., tremor entrainment) and appropriately consider signs indicating another neurological condition when present (e.g., rest tremor and cogwheel rigidity in a patient with FND-movt and comorbid Parkinson's disease).
- Clinicians should also consider evaluating other concurrently present symptoms (e.g., pain, fatigue, cognitive complaints, dizziness, etc.) as indicated and/or ensure that appropriate tests are performed by the patient's general practitioner.

Adjunctive Tests (Table 3)

- In diagnostically challenging cases, EMG and accelerometry data, if available, may support the diagnosis of functional tremor.
- EEG-identified *Bereitschaftspotential* may assist in the diagnosis of functional myoclonus.
- DaTscans may help detect Parkinson's disease in diagnostically challenging tremor cases.

Other Comments

- The initial clinical assessment can be performed by one individual with expertise in the neurological examination and neuropsychiatric interview (e.g., a neurologist or neuropsychiatrist) or by an interdisciplinary team.
- A review of medical, neurologic, and psychiatric records can also be helpful, including prior diagnoses of a functional somatic disorder, as well as consideration of past surgeries and overall health care utilization. This type of chart review can be particularly helpful in the following three ways:
  - Some patients with motor FND may have paroxysmal (or fluctuating) physical examination signs, such that noting previously documented rule-in signs by another physician can be helpful (although it is important to not solely base one's diagnostic impressions on the impressions of another).
  - It will enable clinicians to avoid repeating unnecessary tests previously performed.
  - It will show patients that the diagnosis is carefully made on the basis of positive signs, clinical interview, and chart review, aiding the therapeutic relationship.

FUTURE DIRECTIONS AND CONCLUSIONS

As we move forward in disseminating the suggested neuropsychiatric clinical approach and further refining the motor FND assessment based on new research, we should also address the current need to educate practicing clinicians and trainees (as well as supervisors) across the clinical neurosciences in this approach. Considerable challenges

exist, including the increasing pressures to evaluate patients as quickly as possible, a health care trend increasingly focused on efficiency that does not generally serve well patients with complex disorders, including those with FND. Furthermore, neurologists would benefit from added training in neuropsychiatric principles, while psychiatrists working at this interface require increased training in the neurological examination and neurological differential diagnosis. We hope that the neuropsychiatric approach to the assessment of motor FND detailed here will inform diagnosis and management, integrating physical and mental health aspects of patient care for this common and underserved neuropsychiatric disorder.

AUTHOR AND ARTICLE INFORMATION

Departments of Neurology and Psychiatry, Cognitive Behavioral Neurology and Neuropsychiatry Units, Massachusetts General Hospital, Harvard Medical School, Boston (Perez); Department of Neurology, Functional Neurological Disorders Clinic, University Hospital Inselspital and Clinical Neurosciences, Bern University, Bern, Switzerland (Aybek); Department of Neurology, University Hospital Knappschaftskrankenhaus Bochum, Bochum, Germany (Popkirov); Children's Hospital at Westmead, New South Wales, Australia (Kozlowska); Discipline of Psychiatry, University of Sydney Medical School, Sydney, Australia (Kozlowska); Department of Neurology, Movement Disorders Unit, Massachusetts General Hospital, Harvard Medical School, Boston (Stephen); Departments of Neurology and Psychiatry, Alpert Medical School, Brown University, Rhode Island Hospital, Providence, R.I. (Anderson, LaFrance); VA Mid-Atlantic Mental Illness, Research, Education, and Clinical Center, Salisbury, N.C. (Shura); Mental Health and Behavioral Sciences Service Line, Salisbury Veterans Affairs Medical Center, Salisbury, N.C. (Shura); Department of Neurology, Wake Forest School of Medicine, Winston-Salem, N.C. (Shura); McConnell Brain Imaging Center, Montreal Neurological Institute, McGill University, Montreal (Ducharme); Department of Psychiatry, McGill University Health Center, Montreal (Ducharme); Center for Clinical Brain Sciences, University of Edinburgh, Edinburgh, United Kingdom (Carson, Stone); Human Motor Control Section, National Institute of Neurological Disorders and Stroke Intramural Research Program, Bethesda, Md. (Hallett); Section of Cognitive Neuropsychiatry, Institute of Psychiatry, Psychology and Neuroscience, King's College London (Nicholson); Behavioural and Clinical Neuroscience Institute, Cambridge, United Kingdom (Voon); and Department of Psychiatry, University of Cambridge, Cambridge, United Kingdom (Voon).

Send correspondence to Dr. Perez (dlperez@nmr.mgh.harvard.edu).

Drs. Perez and Aybek share first authorship, and Drs. LaFrance and Voon are co-senior authors.

This article presents independent research funded by NIHR.

The views, opinions, and/or findings presented in this article are those of the authors and should not be construed as an official position, policy, or decision of the U.S. Department of Veterans Affairs, U.S. Federal Government, the NIHR, or the United Kingdom Department of Health and Social Care.

Dr. Perez has received grant support from a Massachusetts General Hospital Physician-Scientist Career Development Award and the Sidney R. Baer, Jr. Foundation; he has also received funding from NIH and honoraria for continuing medical education lectures on functional neurological disorder. Dr. Popkirov has received a speaker's fee from Novartis. Dr. Stephen has received funding from UPenn Orphan Disease Center Million Dollar Bike Ride/National Tay-Sachs and Allied Diseases Association; he has served on the scientific advisory board of Xenon Pharmaceuticals for a study on ATP1A3-related disorders; he has received research grant support from Sanofi-Genzyme for a longitudinal study of video oculography in late-onset GM2 gangliosidosis; and he has received financial support from Biogen, Biohaven, Cadent, and Sanofi-Genzyme as an investigator in clinical trials. Dr. Hallett is supported by the National Institute of Neurological Disorders and Stroke Intramural Program; he holds patents for an immunotoxin for the treatment of focal movement disorders and the H-coil for magnetic stimulation; in relation to the latter, he has received license fee payments from NIH (from Brainsway); he serves on the medical advisory boards of Brainsway, Cadent, and CALA Health; he receives royalties and/or honoraria from Cambridge University Press, Elsevier, Springer, and Oxford University Press; he has received research grant support from Allergan for studies of methods to inject botulinum toxins, Medtronic for a study of deep-brain stimulation for dystonia, and CALA Health for studies of a device to suppress tremor. Dr. Nicholson has received grant support from a United Kingdom National Institute for Health Research (NIHR) Clinician Scientist Award. Dr. Aybek has received noncommercial funding and honoraria for medical education from the Swiss National Research Foundation (grant PP00P3-176985). Dr. Stone has received research grant support from a National Research Scotland Career Fellowship; he also performs expert witness work in medicolegal settings, receives honoraria from *UpToDate*, and runs a free self-help website (www.neurosymptoms.org) for patients with functional neurological disorder. Dr. LaFrance receives editor's royalties from Cambridge University Press and author's royalties from Oxford University Press; he receives research grant support from the U.S. Department of Defense (grant W81XWH-17-0169 [principal investigator]); he serves on the advisory board of the Epilepsy Foundation New England Professional; he has received honoraria for the American Academy of Neurology Annual Meeting Annual Course; he has served as a clinic development consultant for Cleveland Clinic, Emory University, Oregon Health and Science University, Spectrum Health, and the University of Colorado Denver; and he has provided medico legal expert testimony. The other authors report no financial relationships with commercial interests.

Received January 29, 2020; accepted April 23, 2020; published online Aug. 11, 2020.

REFERENCES

1. Gelauff JM, Carson A, Ludwig L, et al: The prognosis of functional limb weakness: a 14-year case-control study. Brain 2019; 142:2137–2148
2. Baizabal-Carvallo JF, Hallett M, Jankovic J: Pathogenesis and pathophysiology of functional (psychogenic) movement disorders. Neurobiol Dis 2019; 127:32–44
3. Daum C, Hubschmid M, Aybek S: The value of 'positive' clinical signs for weakness, sensory and gait disorders in conversion disorder: a systematic and narrative review. J Neurol Neurosurg Psychiatry 2014; 85:180–190
4. Espay AJ, Aybek S, Carson A, et al: Current concepts in diagnosis and treatment of functional neurological disorders. JAMA Neurol 2018; 75:1132–1141
5. American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, 5th ed. Washington, DC, American Psychiatric Publishing, 2013
6. Ganos C, Martino D, Espay AJ, et al: Tics and functional tic-like movements: Can we tell them apart? Neurology 2019; 93: 750–758
7. Pick S, Goldstein LH, Perez DL, et al: Emotional processing in functional neurological disorder: a review, biopsychosocial model and research agenda. J Neurol Neurosurg Psychiatry 2019; 90: 704–711
8. Baslet G, Bajestan S, Aybek S, et al. Evidence-Based Practice for the Clinical Assessment of Psychogenic Nonepileptic Seizures: a report from the American Neuropsychiatric Association Committee on Research. J Neuropsychiatry Clin Neurosci 2021; 33: 27–42

9. Gelauff J, Stone J, Edwards M, et al: The prognosis of functional (psychogenic) motor symptoms: a systematic review. J Neurol Neurosurg Psychiatry 2014; 85:220–226
10. Faust J, Soman TB: Psychogenic movement disorders in children: characteristics and predictors of outcome. J Child Neurol 2012; 27:610–614
11. Batla A, Stamelou M, Edwards MJ, et al: Functional movement disorders are not uncommon in the elderly. Mov Disord 2013; 28: 540–543
12. Gargalas S, Weeks R, Khan-Bourne N, et al: Incidence and outcome of functional stroke mimics admitted to a hyperacute stroke unit. J Neurol Neurosurg Psychiatry 2017; 88:2–6
13. Hopp JL, Anderson KE, Krumholz A, et al: Psychogenic seizures and psychogenic movement disorders: are they the same patients? Epilepsy Behav 2012; 25:666–669
14. Stone J, Warlow C, Sharpe M: The symptom of functional weakness: a controlled study of 107 patients. Brain 2010; 133: 1537–1551
15. Demartini B, Ricciardi L, Parees I, et al: A positive diagnosis of functional (psychogenic) tics. Eur J Neurol 2015; 22:527–e36
16. Ani C, Reading R, Lynn R, et al: Incidence and 12-month outcome of non-transient childhood conversion disorder in the UK and Ireland. Br J Psychiatry 2013; 202:413–418
17. Canavese C, Ciano C, Zibordi F, et al: Phenomenology of psychogenic movement disorders in children. Mov Disord 2012; 27: 1153–1157
18. Pareés I, Kojovic M, Pires C, et al: Physical precipitating factors in functional movement disorders. J Neurol Sci 2014; 338:174–177
19. Stone J, Warlow C, Sharpe M: Functional weakness: clues to mechanism from the nature of onset. J Neurol Neurosurg Psychiatry 2012; 83:67–69
20. Lewandowski C, Mays-Wilson K, Miller J, et al: Safety and outcomes in stroke mimics after intravenous tissue plasminogen activator administration: a single-center experience. J Stroke Cerebrovasc Dis 2015; 24:48–52
21. Jones AT, O'Connell NK, David AS: The epidemiology of functional stroke mimic (FSM) patients: a systematic review and meta-analysis. Eur J Neurol 2019
22. van der Salm SM, Erro R, Cordivari C, et al: Propriospinal myoclonus: clinical reappraisal and review of literature. Neurology 2014; 83:1862–1870
23. Baizabal-Carvallo JF, Jankovic J: Functional (psychogenic) stereotypies. J Neurol 2017; 264:1482–1487
24. Fasano A, Valadas A, Bhatia KP, et al: Psychogenic facial movement disorders: clinical features and associated conditions. Mov Disord 2012; 27:1544–1551
25. Stone J, Carson A, Aditya H, et al: The role of physical injury in motor and sensory conversion symptoms: a systematic and narrative review. J Psychosom Res 2009; 66:383–390
26. Nicholson TR, Aybek S, Craig T, et al: Life events and escape in conversion disorder. Psychol Med 2016; 46:2617–2626
27. Erro R, Edwards MJ, Bhatia KP, et al: Psychogenic axial myoclonus: clinical features and long-term outcome. Parkinsonism Relat Disord 2014; 20:596–599
28. Ganos C, Aguirregomozcorta M, Batla A, et al: Psychogenic paroxysmal movement disorders: clinical features and diagnostic clues. Parkinsonism Relat Disord 2014; 20:41–46
29. Kamble N, Prashantha DK, Jha M, et al. Gender and age determinants of psychogenic movement disorders: a clinical profile of 73 patients. Can J Neurol Sci 2016; 43:268–277
30. Pellicciari R, Superbo M, Gigante AF, et al: Disease modeling in functional movement disorders. Parkinsonism Relat Disord 2014; 20:1287–1289
31. Baizabal-Carvallo JF, Jankovic J: Distinguishing features of psychogenic (functional) versus organic hemifacial spasm. J Neurol 2017; 264:359–363
32. Popkirov S, Hoeritzauer I, Colvin L, et al: Complex regional pain syndrome and functional neurological disorders - time for reconciliation. J Neurol Neurosurg Psychiatry 2019; 90:608–614
33. Guerriero RM, Pier DB, de Gusmão CM, et al: Increased pediatric functional neurological symptom disorders after the Boston marathon bombings: a case series. Pediatr Neurol 2014; 51:619–623
34. de Gusmão CM, Guerriero RM, Bernson-Leung ME, et al: Functional neurological symptom disorders in a pediatric emergency room: diagnostic accuracy, features, and outcome. Pediatr Neurol 2014; 51:233–238
35. Kozlowska K, Scher S, Williams LM: Patterns of emotional-cognitive functioning in pediatric conversion patients: implications for the conceptualization of conversion disorders. Psychosom Med 2011; 73:775–788
36. Kozlowska K, Chudleigh C, Cruz C, et al: Psychogenic non-epileptic seizures in children and adolescents, part I: diagnostic formulations. Clin Child Psychol Psychiatry 2018; 23:140–159
37. Batla A, Pareés I, Edwards MJ, et al: Lower urinary tract dysfunction in patients with functional movement disorders. J Neurol Sci 2016; 361:192–194
38. Pareés I, Saifee TA, Kassavetis P, et al: Believing is perceiving: mismatch between self-report and actigraphy in psychogenic tremor. Brain 2012; 135:117–123
39. Matin N, Young SS, Williams B, et al: Neuropsychiatric associations with gender, illness duration, work disability, and motor subtype in a US functional neurological disorders clinic population. J Neuropsychiatry Clin Neurosci 2017; 29:375–382
40. Kramer G, Dominguez-Vega ZT, Laarhoven HS, et al: Similar association between objective and subjective symptoms in functional and organic tremor. Parkinsonism Relat Disord 2019; 64: 2–7
41. Espay AJ, Lang AE: Phenotype-specific diagnosis of functional (psychogenic) movement disorders. Curr Neurol Neurosci Rep 2015; 15:32
42. Wissel BD, Dwivedi AK, Merola A, et al: Functional neurological disorders in Parkinson disease. J Neurol Neurosurg Psychiatry 2018; 89:566–571
43. Onofrj M, Thomas A, Tiraboschi P, et al: Updates on somatoform disorders (SFMD) in Parkinson's disease and dementia with Lewy bodies and discussion of phenomenology. J Neurol Sci 2011; 310: 166–171
44. Graham CD, Kyle SD: A preliminary investigation of sleep quality in functional neurological disorders: poor sleep appears common, and is associated with functional impairment. J Neurol Sci 2017; 378:163–166
45. Stone J, Warlow C, Deary I, et al: Predisposing risk factors for functional limb weakness: a case-control study. J Neuropsychiatry Clin Neurosci 2020; 32:50–57
46. Stamelou M, Cossu G, Edwards MJ, et al: Familial psychogenic movement disorders. Mov Disord 2013; 28:1295–1298
47. Kranick S, Ekanayake V, Martinez V, et al: Psychopathology and psychogenic movement disorders. Mov Disord 2011; 26:1844–1850
48. Ludwig L, Pasman JA, Nicholson T, et al: Stressful life events and maltreatment in conversion (functional neurological) disorder: systematic review and meta-analysis of case-control studies. Lancet Psychiatry 2018; 5:307–320
49. Kozlowska K, Chudleigh C, Cruz C, et al: Psychogenic non-epileptic seizures in children and adolescents, part II: explanations to families, treatment, and group outcomes. Clin Child Psychol Psychiatry 2018; 23:160–176
50. Defazio G, Pastore A, Pellicciari R, et al: Personality disorders and somatization in functional and organic movement disorders. Psychiatry Res 2017; 257:227–229
51. Epstein SA, Maurer CW, LaFaver K, et al: Insights into chronic functional movement disorders: the value of qualitative psychiatric interviews. Psychosomatics 2016; 57:566–575

52. Ekanayake V, Kranick S, LaFaver K, et al: Personality traits in psychogenic nonepileptic seizures (PNES) and psychogenic movement disorder (PMD): neuroticism and perfectionism. J Psychosom Res 2017; 97:23–29
53. Demartini B, Petrochilos P, Ricciardi L, et al: The role of alexithymia in the development of functional motor symptoms (conversion disorder). J Neurol Neurosurg Psychiatry 2014; 85: 1132–1137
54. Robinson S, Hedderly T: Novel psychological formulation and treatment of "tic attacks" in Tourette syndrome. Front Pediatr 2016; 4:46
55. Ricciardi L, Demartini B, Morgante F, et al: Symptom severity in patients with functional motor symptoms: patient's perception and doctor's clinical assessment. Parkinsonism Relat Disord 2015; 21:529–532
56. van der Hoeven RM, Broersma M, Pijnenborg GH, et al: Functional (psychogenic) movement disorders associated with normal scores in psychological questionnaires: a case control study. J Psychosom Res 2015; 79:190–194
57. Akyüz F, Gökalp PG, Erdiman S, et al: Conversion disorder comorbidity and childhood trauma. Noro Psikiyatri Arsivi 2017; 54:15–20
58. Erten E, Yenilmez Y, Fistikci N, et al: The relationship between temperament and character in conversion disorder and comorbid depression. Compr Psychiatry 2013; 54:354–361
59. Sarisoy G, Kaçar OM, Öztürk A, et al: Temperament and character traits in patients with conversion disorder and their relations with dissociation. Psychiatr Danub 2015; 27:390–396
60. Güleç MY, Ýnanç L, Yanartaþ Ö, et al: Predictors of suicide in patients with conversion disorder. Compr Psychiatry 2014; 55: 457–462
61. Vizcarra JA, Hacker S, Lopez-Castellanos R, et al: Internal versus external frame of reference in functional movement disorders. J Neuropsychiatry Clin Neurosci 2020; 32:67–72
62. Williams B, Ospina JP, Jalilianhasanpour R, et al: Fearful attachment linked to childhood abuse, alexithymia, and depression in motor functional neurological disorders. J Neuropsychiatry Clin Neurosci 2019; 31:65–69
63. Kozlowska K, Cruz C, Davies F, et al: The utility (or not) of self-report instruments in family assessment for child and adolescent conversion disorders? Aust N Z J Fam Ther 2016; 37: 480–499
64. Ludwig L, Whitehead K, Sharpe M, et al: Differences in illness perceptions between patients with non-epileptic seizures and functional limb weakness. J Psychosom Res 2015; 79:246–249
65. Whitehead K, Stone J, Norman P, et al: Differences in relatives' and patients' illness perceptions in functional neurological symptom disorders compared with neurological diseases. Epilepsy Behav 2015; 42:159–164
66. Dreissen YEM, Boeree T, Koelman JHTM, et al: Startle responses in functional jerky movement disorders are increased but have a normal pattern. Parkinsonism Relat Disord 2017; 40:27–32
67. Pastore A, Pierri G, Fabio G, et al: Differences in psychopathology and behavioral characteristics of patients affected by conversion motor disorder and organic dystonia. Neuropsychiatr Dis Treat 2018; 14:1287–1295
68. Tomić A, Petrović I, Pešić D, et al: Is there a specific psychiatric background or personality profile in functional dystonia? J Psychosom Res 2017; 97:58–62
69. Jalilianhasanpour R, Williams B, Gilman I, et al: Resilience linked to personality dimensions, alexithymia and affective symptoms in motor functional neurological disorders. J Psychosom Res 2018; 107:55–61
70. Daum C, Gheorghita F, Spatola M, et al: Interobserver agreement and validity of bedside 'positive signs' for functional weakness, sensory and gait disorders in conversion disorder: a pilot study. J Neurol Neurosurg Psychiatry 2015; 86:425–430
71. Daum C, Aybek S: Validity of the "drift without pronation" sign in conversion disorder. BMC Neurol 2013; 13:31
72. Fekete R, Baizabal-Carvallo JF, Ha AD, et al: Convergence spasm in conversion disorders: prevalence in psychogenic and other movement disorders compared with controls. J Neurol Neurosurg Psychiatry 2012; 83:202–204
73. Laub HN, Dwivedi AK, Revilla FJ, et al: Diagnostic performance of the "huffing and puffing" sign in psychogenic (functional) movement disorders. Mov Disord Clin Pract (Hoboken) 2015; 2:29–32
74. McWhirter L, Stone J, Sandercock P, et al: Hoover's sign for the diagnosis of functional weakness: a prospective unblinded cohort study in patients with suspected stroke. J Psychosom Res 2011; 71: 384–386
75. van der Stouwe AMM, Elting JW, van der Hoeven JH, et al: How typical are 'typical' tremor characteristics? sensitivity and specificity of five tremor phenomena. Parkinsonism Relat Disord 2016; 30:23–28
76. Horn D, Galli S, Berney A, et al: Testing head rotation and flexion is useful in functional limb weakness. Mov Disord Clin Pract (Hoboken) 2017; 4:597–602
77. Lombardi TL, Barton E, Wang J, et al: The elbow flex-ex: a new sign to detect unilateral upper extremity non-organic paresis. J Neurol Neurosurg Psychiatry 2014; 85:165–167
78. Jordbru AA, Smedstad LM, Moen VP, et al: Identifying patterns of psychogenic gait by video-recording. J Rehabil Med 2012; 44: 31–35
79. Park JE, Maurer CW, Hallett M: The "whack-a-mole" sign in functional movement disorders. Mov Disord Clin Pract (Hoboken) 2015; 2:286–288
80. Hallett M: Psychogenic parkinsonism. J Neurol Sci 2011; 310: 163–165
81. Frasca Polara G, Fleury V, Stone J, et al: Prevalence of functional (psychogenic) parkinsonism in two Swiss movement disorders clinics and review of the literature. J Neurol Sci 2018; 387:37–45
82. Baizabal-Carvallo JF, Jankovic J: Examiner manoeuvres 'sensory tricks' in functional (psychogenic) movement disorders. J Neurol Neurosurg Psychiatry 2017; 88:453–455
83. Stone J, Hoeritzauer I, Tesolin L, et al: Functional movement disorders of the face: a historical review and case series. J Neurol Sci 2018; 395:35–40
84. Schwingenschuh P, Katschnig P, Seiler S, et al: Moving toward "laboratory-supported" criteria for psychogenic tremor. Mov Disord 2011; 26:2509–2515
85. Macerollo A, Batla A, Kassavetis P, et al: Using reaction time and co-contraction to differentiate acquired (secondary) from functional 'fixed' dystonia. J Neurol Neurosurg Psychiatry 2015; 86:933–934
86. van der Stouwe AM, Conway BA, Elting JW, et al: Usefulness of intermuscular coherence and cumulant analysis in the diagnosis of postural tremor. Clin Neurophysiol 2015; 126:1564–1569
87. Schwingenschuh P, Saifee TA, Katschnig-Winter P, et al: Validation of "laboratory-supported" criteria for functional (psychogenic) tremor. Mov Disord 2016; 31:555–562
88. Gironell A: Routine neurophysiology testing and functional tremor: toward the establishment of diagnostic criteria. Mov Disord 2016; 31:1763–1764
89. van der Salm SM, Tijssen MA, Koelman JH, et al: The Bereitschaftspotential in jerky movement disorders. J Neurol Neurosurg Psychiatry 2012; 83:1162–1167
90. Meppelink AM, Little S, Oswal A, et al: Event related desynchronisation predicts functional propriospinal myoclonus. Parkinsonism Relat Disord 2016; 31:116–118
91. Erro R, Bhatia KP, Edwards MJ, et al: Clinical diagnosis of propriospinal myoclonus is unreliable: an electrophysiologic study. Mov Disord 2013; 28:1868–1873
92. Liepert J, Hassa T, Tüscher O, et al: Motor excitability during movement imagination and movement observation in psychogenic lower limb paresis. J Psychosom Res 2011; 70:59–65

93. Liepert J, Shala J, Greiner J: Electrophysiological correlates of disobedience and feigning-like behaviour in motor imagery. Clin Neurophysiol 2014; 125:763–767
94. Sadasivan S, Friedman JH: Experience with DaTscan at a tertiary referral center. Parkinsonism Relat Disord 2015; 21:42–45
95. Menéndez-González M, Tavares F, Zeidan N, et al: Diagnoses behind patients with hard-to-classify tremor and normal DaT-SPECT: a clinical follow up study. Front Aging Neurosci 2014; 6:56
96. Wolfsegger T, Pischinger B, Topakian R: Objectification of psychogenic postural instability by trunk sway analysis. J Neurol Sci 2013; 334:14–17
97. Stins JF, Kempe CL, Hagenaars MA, et al: Attention and postural control in patients with conversion paresis. J Psychosom Res 2015; 78:249–254
98. Edwards MJ, Bhatia KP, Cordivari C: Immediate response to botulinum toxin injections in patients with fixed dystonia. Mov Disord 2011; 26:917–918
99. Pareés I, Kassavetis P, Saifee TA, et al: Jumping to conclusions bias in functional movement disorders. J Neurol Neurosurg Psychiatry 2012; 83:460–463
100. Pick S, Anderson D, Asadi-Pooya A, et al: Outcome measurement in functional neurological disorder: a systematic review and recommendations. J Neurol Neurosurg Psychiatry 2020; 91: 638–649
101. Nicholson TR, Carson A, Edwards MJ, et al: FND-COM (Functional Neurological Disorders Core Outcome Measures) Group: Outcome measures for functional neurological disorder: a review of the theoretical complexities. J Neuropsychiatry Clin Neurosci 2020; 32:33–42