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Differentiation of Voluntary and Involuntary Movements †

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Abstract: Providers in an emergency department can be challenged by the presentation of patients who exhibit movements that could represent fatal conditions requiring interventions with significant risks. A particular goal is to differentiate those movements that necessitate potentially dangerous interventions from those that require restraint. Voluntary movements (expressions of emotion and fabricated symptoms and signs) do not benefit from the for neurological diseases. Providers must refrain from unnecessary interventions for voluntary movements. Child abuse must be ruled out. Involuntary movements include neurological diseases that require specific diagnostic and therapeutic interventions and functional movement disorder (FND), a condition that does not merit the interventions for neurological disease. A preliminary algorithm to classify movements is proposed.

Keywords: applause; Bereitschaftspotential; conversion disorder; functional movement disorder [FMD]; functional neurological symptom disorder [FND]; involuntary; malingering; movement disorders; Münchausen syndrome; ululation; voluntary

1. Introduction

The differentiation of subtypes of voluntary and involuntary movements represents a crucial challenge for observers, particularly providers who face the behaviors in an emergency.

A special quandary is the temptation of the clinicians to provide interventions required for the imminent benefit of people with organic disorders to individuals who actually have situations, including functional disorders and voluntary movements, that may be harmed by the intermissions.

We seek to provide a foundation to identify movements that require immediate life-saving intervention from movements that merit observation. We follow the example of algorithms for Parkinson's disease (PD) [1-4] and functional movement disorders [5]. The current status of movement classifications is in flux. The trustworthiness of available evidence is questionable [6].Terminology is changing. Therefore, we draw on our personal experience practicing neurology, psychiatry, and child and adolescent psychiatry for several decades to propose a preliminary tool for the classification of movements to be developed utilizing rigorous methodology [7]. We present an approach to be developed in future investigations.

2. Materials and Methods

Utilizing our personal neuropsychiatric experience over several decades, we selected key articles on subtypes of voluntary and involuntary movements to construct a framework to classify movements in the crucial subtypes of voluntary or involuntary. Red flags to identify movements that require treatment or restraint are highlighted. A comprehensive review of the literature is beyond the scope of this preliminary proposal.

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3. Results and Discussion

3.1. Movement Execution

The primary motor cortex (M1) plays a key role in the generation of movements [8]. Additionally activity in the supplementary motor area (SMA) appears to correspond to awareness of intention to preform actions [9].

Electrophysiological and motion measurements may facilitate the identification of voluntary movements. For example, a Bereitschaftspotential, a surface-negative electrical brain potential identified on electroencephalograph (EGG), can identify self-initiated voluntary acts. Thus, a Bereitschaftspotential characterizes most involuntary functional movement disorders and voluntary movements [10, 11].

Identification of involuntary functional movement disorder (FMD) and voluntary movements is crucial to avoid providing inappropriate interventions, such as medications and surgeries with significant risks and no beneficial effects.

3.1. Voluntary Movements

Voluntary movements are intentionally produced actions [12] that include (A) motions deliberately performed by persons to express exuberance such as applause and *zaghrouta,* ululation [10] and (B) motions deliberately performed by persons to deceive others, such as (A) malingering, the fabrication of actions in order to avoid jail, work, school, and to obtain financial and other rewards, and (B) factitious disorder (Münchausen syndrome), the fabrication of symptoms and signs to seek medical attention and treatment [13,14].

While the goal of factitious disorder is to obtain medical attention and treatment, providers must cautiously weigh the risks and benefits of interventions. In particular factitious disorder imposed on another (Münchausen syndrome by proxy) represents a subtype of abuse by the perpetrator [13, 14]. When the accompanying person fabricate symptoms for a child, clinicians may institute procedures with serious risks and adverse effects. Factitious disorder imposed on another [13,14] and other forms of child abuse must be ruled out.

3.2. Involuntary Movements

Involuntary movements consist of a broad class of movement disorders, including (A) neurological disease with identified pathophysiology and known organic lesions, (B) conversion disorder [functional neurological symptom disorder (FND)] [13-17], a group of conditions (A) reflecting abnormal function of the nervous system utilizing voluntary pathways and (B) exhibiting a wide variety of movements that may or may not resemble movement disorders with identified pathophysiology.

3.2.1. Functional Neurological Disorder (FND)

While functional neurological disorder (FND) may resemble some organic disorders, it is often distinguished by the variability of symptoms and signs. Patients with FND may be distracted from performing the abnormal movements by various maneuvers. Additionally repetitive functional movement disorder (FMD) may exhibit entrainment: the rate of the movement may change in response to other rhythms provided by examiners.

FND represents around a tenth of acute neurological admissions [18]. Women more commonly exhibit FND [12,16].

The diagnosis of FND requires the positive diagnosis [19-21] utilizing the demonstration of symptoms and signs that are incongruent and inconsistent with known organic disorders [22].

Functional neuroimaging provides a means to distinguish some subtypes of FND [12,23]. Increased activation of the amygdala and altered functional connectivity (FC) between the amygdala and other structures are neuroimaging characteristics of FND [24].

Clinical neurophysiology and neuroimaging may facilitate the basis to diagnose FND [25-28].

Beneficial interventions for FMD include physical, occupational, and speech therapy along with cognitive behavioral interventions [29-38].

3.2.1.1. Biopsychosocial models

Biopsychosocial models are useful to consider the presence of FND and the role of stress [34,35], environment, and other aspects of the conditions [36,37]. Manifestations of FND may include alternations in motor functioning, alertness, cognitive functioning, and emotional effects. FND also include psychogenic nonepileptic seizures (PNES). Effective treatments include physical therapy and cognitive behavioral therapy [30,38]. People with possible FNDs may benefit from the use of resources including fndhope.org.

Neuroticism and conscientiousness characterize individuals with FMD [39].

3.3. Movements of Multiple Etiologies

Individuals may exhibit both organic and functional disorders. When people receive benefits for their condition, there is the possibility that they may fabricate the symptoms and signs in order to continue to receive the benefits. Since FND may co-exist with organic disorders, clinicians must be alert to the possible presence or development of organic conditions and psychiatric disorders in individuals with FND [38].

3.3. Preliminary Algorithm for Movement Classification

The key characteristics of movements are utilized to construct a proposal for an algorithm to classify movements.

Movement

Involuntary **Voluntary**

Organic **Functional** **Genuine expression of emotion** **Fabricated movement disorder**

Applause **Malingering** **Factitious disorder**

Zaghrouta **Imposed**

Self **Other**

Figure 1. Algorithm to differentiate involuntary and voluntary movements. Deliberate movement generation characterizes voluntary, but not involuntary, movements. Identified anatomical and physiological lesions characterize organic, but not functional, movement disorders. exhibit identified anatomic and physiological lesions. Malingering is motivated by the desire to avoid jail, school, work, and other activities. Factitious disorder is motivated by the desire to seek medical diagnosis and treatment for self or others.

While similar diagnostic procedures may be required to distinguish neurological disorder (involuntary organic movement disorder) from functional movement disorder and voluntary movements, clinicians must exercise caution to identify the anatomic and physiological bases for neurological disorders before instituting interventions with adverse effects. In particular, fabricated movement disorders do not benefit from the medical and surgical interventions to treat neurological disorder.

3.4. Limitations

While similar diagnostic procedures may be required to distinguish neurological disorder (involuntary organic movement disorder) from functional movement disorder and

voluntary movements, clinicians must exercise caution to identify the anatomic and physiological bases for neurological disorders before instituting interventions with adverse effects. In particular, fabricated movement disorders do not benefit from the medical and surgical interventions to treat neurological disorder.

This report represents a selective review of information about voluntary and involuntary movements by a single author utilizing decades of experience in the practice of neuropsychiatry. While the author strives to present an accurate summary of the current knowledge, he recognizes that this project can be enhanced by systematic reviews incorporating a team of experts to objectively assess information [7], a future goal that is beyond the scope of the current article.

4. Conclusions

Identification of the correct subtype of voluntary and involuntary movements is crucial to the administration of the appropriate interventions.

The differential diagnosis of movements in children can challenge clinicians in emergency rooms. Obtaining a comprehensive history issue key to develop an optimal treatment plan [3,9]. Identifying family members with similar subtypes of FND facilitates the diagnosis. Physical, sexual, and psychological abuse must be ruled out.

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Abbreviations

EEG	**Electroencephalograph**
FC	**Functional connectivity**
FMD	**Functional movement disorder**
FND	**Functional neurological symptom disorder**
M1	**Primary motor cortex**
PD	**Parkinson's disease**
PNES	**Psychogenic nonepileptic seizures**
SMA	**Supplementary motor area**

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