#Characterizing Freezing of Gait in Parkinson's Disease: Models of an Episodic Phenomenon (uguale a Characterization of FOG_2013)

Decision tree to refine freezer/non-freezer classification by identifying 3 categories:

(1) a "self-reported freezer"

(2) a "probable freezer" when FOG is confirmed by a third person (caregiver)

(3) a "definite freezer" when freezing is actually observed during formal objective testing.

FOG is defined as a "brief, episodic absence or marked reduction of forward progression of the feet despite having the intention to walk."

Freezing episodes never occur at rest but at "the wish to move." This intention to engage in voluntary action combined with the need to adjust movement to external circumstances or to internal motor commands seems to jam the system.

Four models of Freezing Episodes:

The "**threshold model**" of FOG

Principle --> accumulation of motor deficits until threshold is reached and freeze occurs

Prediction --> increase motor cycle frequency, decrease amplitude, increase coordination complexity

The "**interference model**" of FOG

Principle --> Competition for common central processing resources induces breakdown

Prediction --> increase number concurrent tasks, increase difficulty level tasks, increase load on executive function

The "**cognitive model**" of FOG

Principle --> Deterioration in processing of response conflict induces block

Prediction --> increase incongruency level, increase response speed, increase load on executive function

The "**decoupling model**" of FOG

Principle --> decoupling between motor programs and motor response induced block

Prediction --> increase strength stratle stimuli, increase frequency stratle stimuli, increase postural load or instability

Maybe, combining some of the previous model, the results obtained could be better

The Clinical Spectrum of Freezing of Gait in Parkinson's Disease

The strongest provocative factor of FOG is:
- turning (turning hesitation). Most patients have their favorite direction of turning. Usually, PD patients prefer to turn towards more affected side, but there are some exceptions, because each patient has his or her own strategy for turning
- initiation of gait (start hesitation), and when a patient is passing through a narrow space (tight quarters hesitation) or immediately before reaching a destination (destination hesitation).
- Time pressure to execute walking
- distraction of the attention to walking
- Cognitive load, such as verbal fluency task and "serial calculation", worsens FOG
- Dual tasking, such as carrying a tray or bags

Overcoming FOG:
- if a line is drawn on the ground in front of the foot of a patient, the patient can usually step over it (kinesia paradoxa)
- verbal or auditory stimuli such as giving a marching command similar to that given to a soldier
- visual stimuli such as stepping over objects, including inverted walking sticks, another person's foot, and carpet patterns

Gait festination: "The propensity to lean forward becomes invincible, and the patient is thereby forced to step on the toes and forepart of the feet, ...irresistibly impelled to make much quicker and short steps, and thereby to adopt unwillingly a running pace."
Gait festination is highly associated with FOG such as disturbance of the central timing mechanism

A significant correlation of FOG with the duration of the disease was found, but not with the duration of L-dopa therapy; A significant association between FOG and the presence of dyskinesia or early morning dystonia.

95% of the patients experienced freezing on turning in the "off" state, but only 32% experienced freezing on turning in the "on" state.
The duration of the freezing episode in the "on" state was significantly shorter than that in the "off" state

A progressive decrease in stride length occurs with stable cadence just before freezing; increased stride-to-stride variability, bilateral uncoordinated gait, and marked gait asymmetry are associated with FOG.

Reaction Floor: shuffling gait (like freezing) showed a different pattern than normal subjects, in which the two peaks of vertical pressure in one step were replaced by a narrow, single peak

#Clinimetrics of Freezing Gait

HISTORY TAKING
Ask if patient feel of "being glued to the floor" or show videos of typical FOG episodes

Three types of falls: forward, lateral and spontaneous falls. Even a brief FOG episode can be sufficient to make people fall.

Festination is correlated to FOG, where patients take increasingly rapid and small sequential steps during walking, but it hasn't the characteristic "magnetic feeling". The first typically occurs while walking, the second while initiating gait or during turning.

Freezing Circumstances: shift of attention, directional change, dual tasking, reaching a destination, moving in tight quarters, turning around

90% of freezers suffer from "OFF" state FOG, especially when medication have worn off

When in doubt, a useful trick is to ask patients whether they experience any FOG immediately after waking up, before intake of the first morning dose of antiparkinson medication → if yes, then more probability of OFF FOG

Most FOG episodes are actually brief, certainly during the ON state, typically lasting only several seconds and rarely more than 30 seconds.
There are **three** subtypes of FOG: shuffling forward with small steps (the least severe form); trembling in place; and total akinesia (the severest form).
FOG during the ON state is less severe compared to OFF period FOG, with less frequent and briefer episodes, and presenting less often as total akinesia

PHYSICAL EXAMINATION
Many patients only experience FOG during full turns (360° to 540°) and not during partial turns (180°)
Slow turns are easier than rapid turns, FOG often shows a directional sensitivity
An individual tailoring of cueing parameters is critical (http://www.kngf.nl/index.html?dossier_id=81&dossiers=1)

Pay attention to the characteristics of the stop itself and the steps **preceding** the stop: a gait stop caused by FOG is accompanied by a flexed posture with fixed flexion in the hip, knee and ankle joints. Second, the FOG stop is often not complete, with some residual trembling in place or forward shuffling. Third, FOG episodes are often preceded by a progressive decrease in step length and increase in cadence. Finally, it can be useful to ask patients whether they experienced the feeling of ''being glued to the floor.''

QUANTITATIVE GAIT ANALYSIS
Device using **angular velocity sensors** that can measure trunk motion in different planes
goniometer and angular velocity sensor attached to the shank of one of the legs
an **ambulatory** gait analysis system with **pressure sensitive** insoles that continuously record walking in freely moving subjects

POSSIBLE LECTURE

34. Visser JE, Voermans NC, Nijhuis LB, et al. Quantification of trunk rotations during turning and walking in Parkinson's disease. Clin Neurophysiol 2007;118:1602–1606.

37. Plotnik M, Giladi N, Balash Y, Peretz C, Hausdorff JM. Is freezing of gait in Parkinson's disease related to asymmetric motor function? Ann Neurol 2005;57:656–663.

A System for Monitoring, Assessment and Management of Patients with Parkinson's Disease

The PERFORM system is an intelligent closed-loop system that seamlessly integrates a wide range of wearable sensors constantly monitoring several motor signals of the PD patients, The information collected by the sensors (accelerometers and gyroscopes) is processed by several classifiers

Sensors have been used as activity monitor or for the classification of different body postures
Most of commercial products lack important characteristics for Parkinson's disease and monitoring services such as long-term recording, qualitative and quantitative assessments, high reliability, sensitivity and specificity

3 Subsystem:
1. Wearable Multi-Sensor Monitor Unit → continuous recordings of specific signals, 4 tri-axial accelerometers (one at each extremity), 1 accelerometer/gyroscope on the waist, 1 data acquisition
2. Local Base Unit → touch screen computer responsible for downloading, storage and processing of the raw signals coming from the test devices and the WMSMU, the identification and quantification of motor symptoms, the UPDRS evaluation of the patient and the patient's diary keeping
3. Centralized Hospital Unit → processing all patient data and assisting the treating clinician in making appropriate treatment decisions (web-based application)

System includes intelligent modules for tremor, bradykinesia, LID and FoG; all of them have been developed using a database of short-term (15 min) recordings and a long-term recording (4 h)

The FoG detection module methodology consists of three stages:
1. Preprocessing of the signals is performed and then the signals are analyzed using a sliding window of 1 s length and 0.5 s overlap.
2. The entropy of the signal for each axis of each sensor is extracted; these values formulate a feature vector which is used for the classification of each second of the recorded signals as FoG or not, based on a Random Forest classifier, which is a collection of tree-structured classifiers.
3. For the construction of each tree of the forest a subset of samples is selected from the dataset, using the bootstrap technique, while each tree is built to the maximum size without pruning. In our study the Random Forests consist of 10 trees.