Effects of short pulse-width stimulation on gait ataxia of Essential Tremor patients implanted with thalamic Deep Brain Stimulation

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Introduction: Deep Brain Stimulation (DBS) of the Subthalamic nucleus (STN) is a well-established and effective treatment for disabling and drug-refractory essential tremor (ET), but it can lead in some cases to a delayed onset cerebellar syndrome (e.g. ataxia), possibly caused by a maladaptive response to the neurostimulation. In this study we investigated the effect of stimulation pulse-width on gait ataxia of ET patients. We envisioned that short pulse-width (30 μs) could prevent gait disturbances in ET patients by selective neurostimulation only of fast conducting dentate-thalamic myelinated fibers, thus ensuring tremor suppression but without ataxia symptoms.

Methods: We enrolled 7 patients (2 M, age: 73(65+86) years) with pharmacologically intractable ET and gait progressive ataxia with bilateral DBS implant of the STN area. Patients were studied under two stimulation conditions: at the baseline, with their usual stimulation parameters, and at 2-week follow-up after reducing the pulse-width to 30 μs. The protocol included a clinical evaluation with the Fahn-Tolosa-Marin tremor rating scale (TRS) and the SARA scale for ataxia (items 1-3) and a kinematic assessment of locomotion. Subjects were instructed to perform at least 5 walking trials (8 m each) in a gait laboratory environment walking barefoot at their preferred speed. Kinematics was recorded with an optoelectronic system (SMART DX, BTS) and gait spatio-temporal parameters were calculated with ad hoc Matlab algorithms. We averaged the parameters across trials and calculated the coefficient of variation (CV, the ratio between the standard deviation and the average value) as an index of parameter variability. The baseline and ataxic conditions were compared with a Wilcoxon matched pairs test (JMP13).

Results: Error in stance and swing time detection significantly increased from hard surface (Stance Dm 56ms; Swing Dm: 55ms) to wet (59ms; 56ms) and dry sand (137ms; 138ms) condition. Conversely, no difference was found in stride and step detection errors (Fig. 1a). Successively, the estimated stride and step time were found to be different across all conditions increased from hard surface to dry sand (Fig. 1b).

Discussion: Even though errors in stance and swing time tended to triple from hard surface to dry sand condition, preliminary accuracy results suggest that the use of IMUs for the estimation of GTPs can be adopted in gait performance assessment. Findings from this study warned to be cautious on the interpretation of increasing trend associated to stance and swing time across different conditions, since this variation resulted to be lower than accuracy in their estimation. Future research will focus on assessing more accurate methods to obtain a comprehensive characterization of WOS in real and ecological conditions.

References


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Can be a subjective qualitative evaluation reliable to assess the perceived physical status and the level of the performance in elite sprinters with Intellectual Impairments?

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Introduction: Training programs for athletes are usually based on quantitative objective performance measures and qualitative subjective feedback coming from the athletes. However, it is difficult to have reliable qualitative feedback when the athletes are affected by Intellectual Impairments (II). The current practice is to perform a functional evaluation to assess quantitative performance measures. Previous studies suggested the use of wearable devices to evaluate and correlate physical and mental functions in II subjects [1]. The aim of this study is to clarify whether a simplified version of the Smiley Face Likert Scale (SMLs) [2] might be adequate to self-assess the perception of the II subjects’ physical status after the test and of the level of their performance when compared to objective measures such as the metabolic and kinematic analyses.

Methods: Three male sprinters, members of the national team of the Italian Federation for Athletes with Intellectual Impairments, were tested. After 20’ of warm up, they were asked to perform 2 series of 4 sprints each on 80-meters distance, as fast as possible. During the experiments, we used photocells to measure the duration of the test and a triaxial inertial sensor was placed at the L5
vertebra, to record four spatial-temporal parameters, for each of the 24 sprints: velocity ($v$); step frequency ($f$); step length ($\rho$); smoothness performance index by normal jerk ($\mu$) [3,4]. The metabolic assessment was reached through lactate ($\text{lac}$) measurement six times during each test: at baseline, every 2 sprints and after 5’ recovery from the last sprint. Furthermore, the athletes were asked to report a subjective evaluation on their physical status (Ph) and on the level of the performance (P), based on the simplified version of the SMLS, composed by three faces (good = 1, neutral = 2, bad = 3), after each sprint. The statistical analysis compared different groups according to their perceived physical status (Ph1, Ph2, and Ph3) and to their perceived level of performance (P1, P2, and P3). The one-way ANOVA and the Tukey test ($p < 0.05$) were used to assess the significant differences between the groups.

**Results:** Table 1 shows the results: the physical status (reported as good) was significantly correlated with lower levels of lactate as well as better kinematics parameters were found in cases where the II athletes stated their performance as good.

**Discussion:** A simplified version of the SMLS might be useful to help élite II athletes to communicate their physical condition after any athletic training or competition and their perceived level of performance. Further studies will be necessary to verify the reliability of the simplified version of the SMLS and eventually to standardize it. However, the metabolic and kinematic evaluation still remain the only reliable analysis, to ensure the best performances without compromising the safety of the II athletes.

### Table 1

<table>
<thead>
<tr>
<th>Groups</th>
<th>$v$ (m/s)</th>
<th>$f$ (step/min)</th>
<th>$\rho$ (cm)</th>
<th>$\mu$</th>
<th>$\text{lac}$ (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph1</td>
<td>8.32±0.30</td>
<td>2.74±0.33</td>
<td>2.52±0.21</td>
<td>2.54±0.37</td>
<td>3.2±0.32</td>
</tr>
<tr>
<td>Ph2</td>
<td>8.43±0.39</td>
<td>2.64±0.21</td>
<td>2.52±0.21</td>
<td>2.54±0.37</td>
<td>3.2±0.32</td>
</tr>
<tr>
<td>Ph3</td>
<td>8.15±0.38</td>
<td>2.63±0.21</td>
<td>2.52±0.21</td>
<td>2.54±0.37</td>
<td>3.2±0.32</td>
</tr>
</tbody>
</table>

### Discussion

A simplified version of the SMLS might be useful to help élite II athletes to communicate their physical condition after any athletic training or competition and their perceived level of performance. Further studies will be necessary to verify the reliability of the simplified version of the SMLS and eventually to standardize it. However, the metabolic and kinematic evaluation still remain the only reliable analysis, to ensure the best performances without compromising the safety of the II athletes.

**References**


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### Preliminary comparison between actigraphic measures and sleep diary reports in people with Mild Cognitive Impairment

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**Introduction:** Mild cognitive impairment (MCI) is the transitional state between intact cognitive function and mild dementia [1]. Poor cognitive functioning has been shown to introduce a bias in estimating sleep duration [2], which indeed needs a careful assessment as it has important implications on cognitive decline. The use of actigraphic measures might thus represent a viable and relatively inexpensive alternative to sleep diaries. This study is a preliminary investigation on subjective-actigraphic sleep discrepancy in people with MCI.

**Methods:** Five subjects with MCI, aged 70–79 years, wore an actigraph (GENEActiv, Activinsights, United Kingdom) and kept a sleep diary for ten consecutive nights. Baseline data on subjective sleep quality (scale range: 1, very poor, to 5, very good), number of awakenings (minimum 5 minutes duration of the awake phase), depressive symptoms and cognitive functioning were also recorded. To discriminate between wake and sleep status from acceleration data measured by the device, activity counts were estimated using the zero-crossing technique [3]. Activity counts were then collapsed in 1-minute epochs and used in the algorithm proposed by Sadeh et al. for sleep-wake identification [4]. A Student t-test for paired samples (significance $p<0.05$) was used to compare total sleep time (TST) and number of awakenings estimated by the actigraphic data and reported by patients on diaries.

**Results:** Demographic and clinical characteristics of the five participants are reported in Fig. 1a together with sleep parameters measured by the actigraph and recorded on diaries, averaged over ten nights. No significant difference ($p=0.935$) was found in the assessment of number of awakenings while a significant discrepancy was found in the estimation of TST ($p=0.014$, Fig. 1b). Participants reported an overall poor (score 2) to fair (score 3) sleep quality.

**Discussion:** Participants presented a significant underestimation of sleep time, confirming a mismatch between subjective reports and objective measurements. The reported poor quality of sleep needs further examination by assessing additional sleep parameters, such as the sleep-onset latency. Results obtained in this preliminary study are sufficiently encouraging to warrant a further investigation, which will be conducted on a larger sample of 12 subjects, on clinical characteristics assessed at the baseline as possible determinants of the observed disagreement and reported poor quality of sleep.

**References**