Understanding how people with MS get tired while walking

Sébastien Piérard
Sebastien.Pierard@ulg.ac.be

Rémy Phan-Ba
Remy.PhanBa@alumni.ulg.ac.be

Marc Van Droogenbroeck
M.VanDroogenbroeck@ulg.ac.be

INTELSIG, Montefiore Institute, University of Liège, Belgium

Background

Walking impairment is frequent, appears early in the disease course of MS patients, and is perceived as the most disabling symptom [1]. When walking, patients get tired more and differently than healthy people [2]. This limits their maximum walking distance. Understanding and monitoring this phenomenon is thus important in the clinical setting.
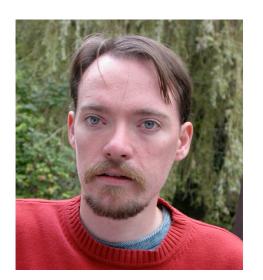
Objective

Our aim is to understand how MS patients get tired while walking compared to healthy people. Two groups of MS patients are considered: those with a low disability level (MSL) and those with a high one (MSH). We consider two criteria to measure the disability:

- [*EDSS criterion*] the EDSS;
- [*DI criterion*] and the deceleration index (DI) which compares the walking speed on the last 20% of a 500 m walk with the walking speed of a 25 ft walk [2].

The limit between the groups is set at DI=0.8 and EDSS=3 (inclusive for MSL).
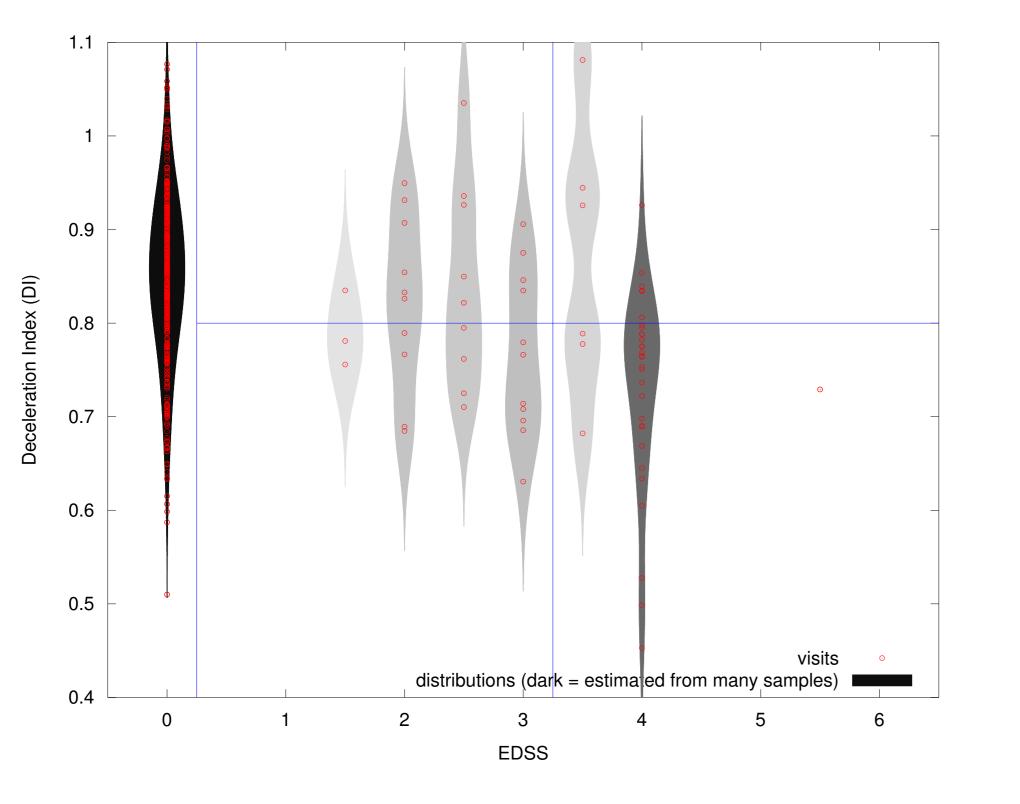

Figure: There is no perfect relationship between the EDSS and the deceleration index (DI). However, a negative correlation exists between these two scores. This figure shows the statistical distribution of DI for each value of EDSS determined experimentally from our database with the Parzen-Rozenblatt method. The blue lines depict the two limits considered in this work to define the populations MSL and MSH.

Methods

Many gait characteristics have been measured with the system *GAIMS* [3, 4, 5] along a 500m path walked as fast as possible. The dataset gathers 464 visits of healthy people and 70 of MS patients. Some people have been assessed several times. There are 33 visits in the group MSL with the EDSS criterion, and 25 with the DI criterion. Statistical tests (WELCH) were performed on the differences and relative differences of the gait characteristics measured during the first and last 100m of the test to detect differences between healthy people and MSL, and between MSL and MSH, as in [6].

Figure: The gait measuring system *GAIMS* [3, 4, 5] measures feet trajectories with range laser scanners (the patient does not need to be equipped with any marker or sensor) and derives many gait characteristics.

References

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Disclosure information. The authors have nothing to disclose.

Results

Both criteria for defining the groups lead to similar results. For many gait characteristics, the distributions of the variations are significantly different between MSL and MSH. The largest difference is for the relative difference of speed (p=0.000119 for EDSS and p=0.000021 for DI). In contrast, only the variation of the average lateral distance between the feet, which is related to the size of the base of support during walking (and thus to the balance) shows a very significant difference between healthy people and MSL (p=0.000116 for EDSS and p=0.000120 for DI). This gait characteristic does not seem to change much from MSL to MSH. Besides, we note that the variance decreases slightly from healthy people to MSL and increases a lot from MSL to MSH.

On the following figures, the dots represent the empirical means of the populations healthy (green), MSL (orange), and MSH (red). The ellipses depict the variance-covariance matrices at $\pm \sqrt{12}/2\,\sigma \simeq 1.7321\,\sigma$ (77.687 % of people are expected to be within these ellipses if a Gaussian distribution is assumed).
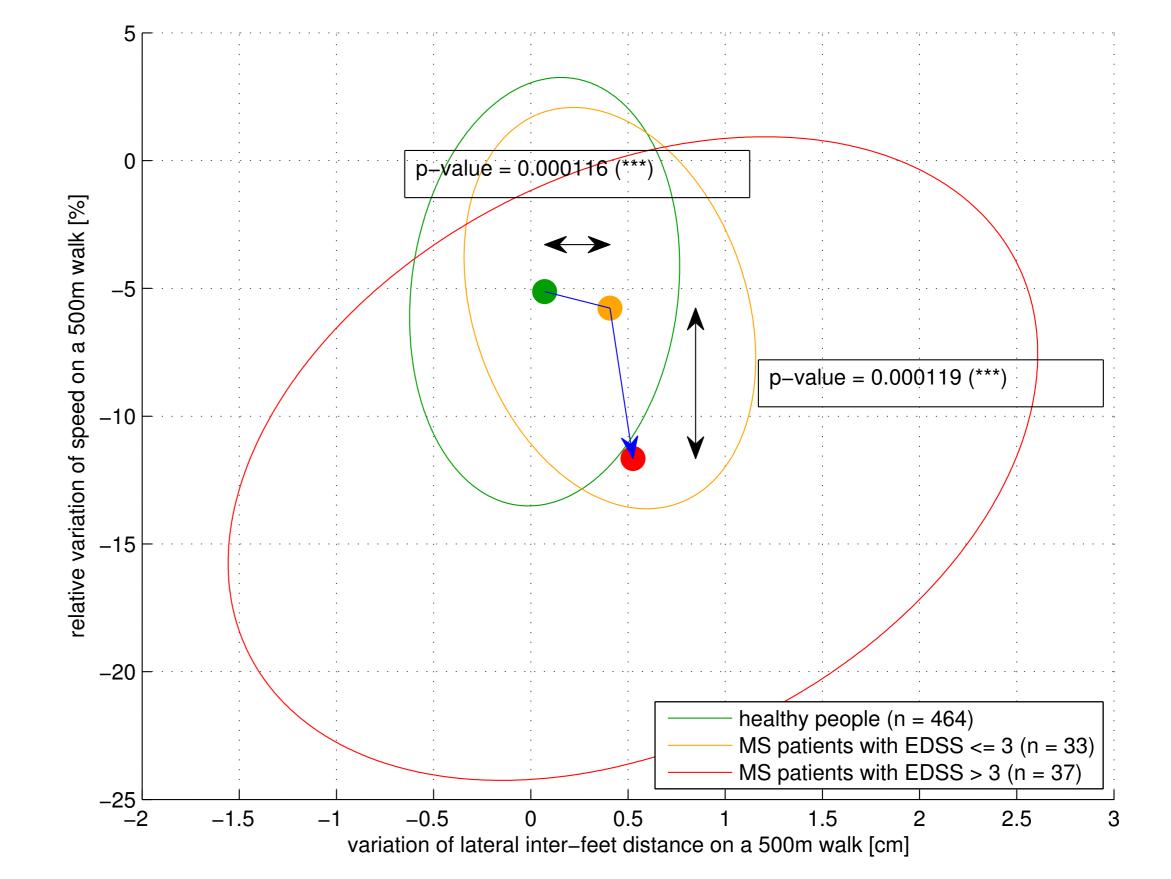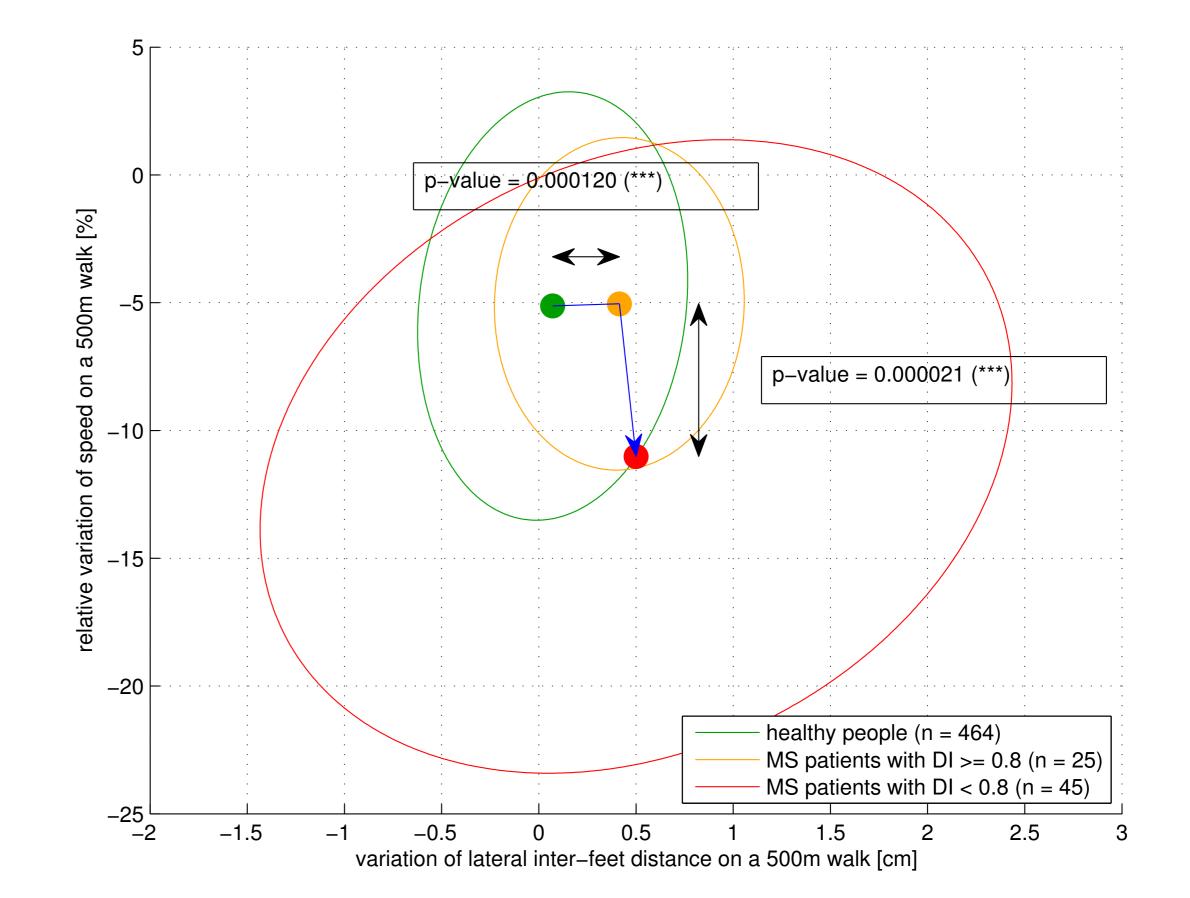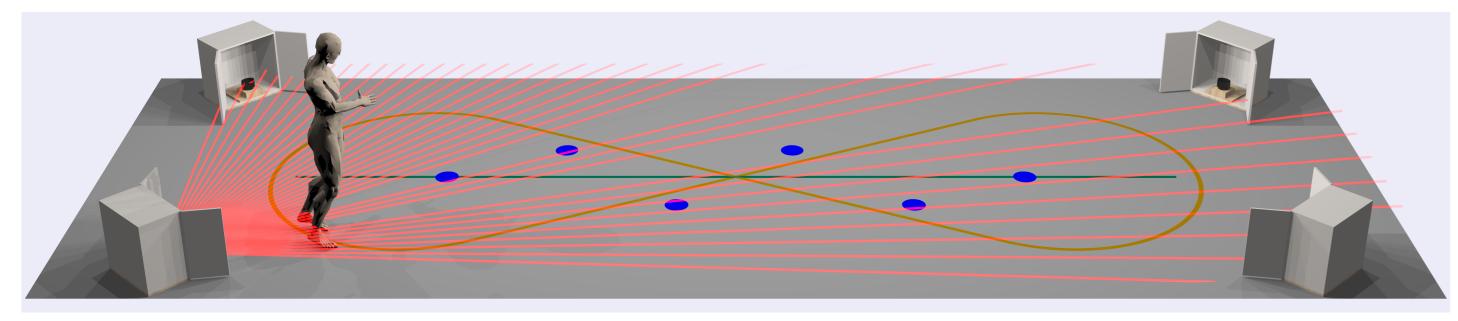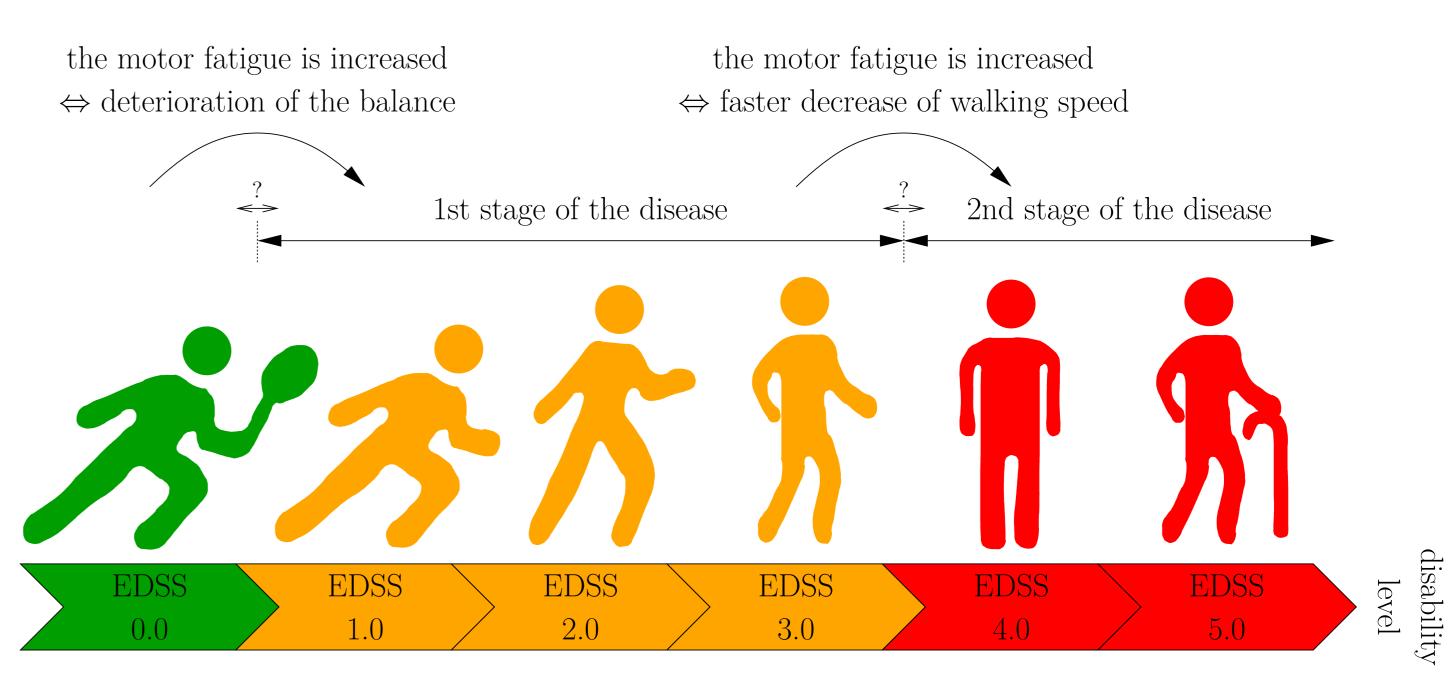

Figure: The two stages of the disease's course can been observed when the EDSS is considered as the criterion to distinguish the patients with a low disability level from those with a high disability level.

Figure: The two stages of the disease's course can been observed when the deceleration index (DI) is considered as the criterion to distinguish the patients with a low disability level (high DI) from those with a high disability level (low DI).

Conclusions

Statistically, from the motor fatigue point of view, it seems that the course of the MS disease is divided in two different stages. In the first one, MS patients get more tired than healthy people with a deterioration of the balance. Then, in the second one, their fatigue becomes related to a faster decrease of the walking speed. This suggests that physical therapy exercises focused on the balance could be given to MS patients in the early stage of the disease.