

Quantitative and objective assessment of motor functions in subjects affected by Parkinson's disease



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Introduction

General context of application

- The effects of Parkinson's Disease (PD) on sleep are researched through the study of PD motor symptoms or PD-associated neurodegeneration overnight.
- A substantial proportion of patients with PD report prominent spontaneous, transitory improvements in motor function after nighttime sleep and before taking the first morning dose of dopaminergic medications – so called Sleep Benefit (SB) phenomenon. Percentages ranging from approximately 30 to 72% of PD patients experiencing SB phenomenon.
- A better understanding of SB could pave the way to new therapeutic strategies addressing motor disability in PD patients.

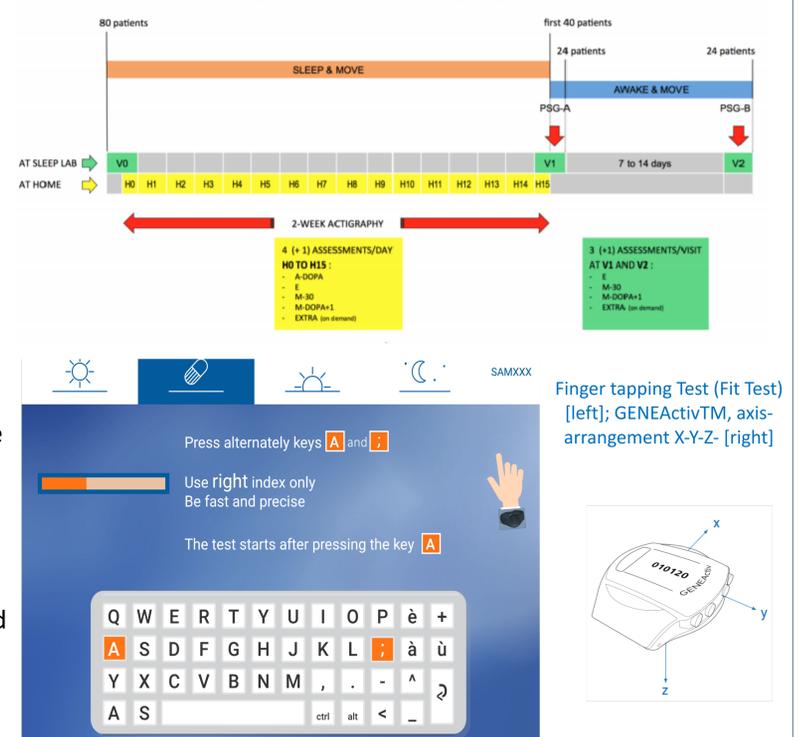
Aims

- to develop an algorithm able to objectively define and detect the main characteristics of the abnormal movements - cardinal motor symptoms - in PD.
- to detect an inter-variability of the movements of the patients.
- to group several patients in the same cluster, testing their similarity in terms of clinical rating scores.

Methods

- 21 PD patients (14 male and 7 female, age 67.7 ± 11.1) participating to the *Awake & Move* Study.
- 3-axial actigraphy, worn on the most affected wrist, used while the subject was performing the Fit Test
- Akinesia, rigidity, tremor and Bradykinesia features extracted from the 3-axial accelerometer raw data. **NOTE** - data analysed on the hypothesis that the patients should be under the same condition - 1 hour after morning dopaminergic medications (M-DOPA+1).
- Clustering and classification techniques used to find a relationship between the motor assessments given by the machine learning algorithms and the clinical scores derived by neurologists' evaluations.
- K-Means and Expectation-Maximization algorithms applied to research primary grouping rules among the different subjects.
- Naive Bayes classifier employed to validate the clustering results and to verify the reliability and the stability of the assessed grouping rules.
- The outcomes of the grouping algorithms, obtained for each subject, shall comply with the clinical Unified Parkinson's Disease Rating Scale (UPDRS) score given by the neurologists.

The Sleep, Awake & Move project

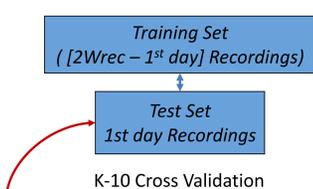


Results

SLEEP & MOVE – 2 WEEKS

Naïve Bayes classifier

❖ classification target
ID Patient Detection



Dataset created by removing one day at a time from all 2-weeks recording (2Wrec) of each subject. The data removed are the **Test set** and the remaining part is the **Training set**.

Performance statistical accuracy

Training Set & Test Set	Cross-Validation Testing mode	Experimenter Cross-Validation	Split Train/Test Testing mode
deleting 1st day	88.56%	88.47% ± 2.70	74.17%
deleting 2nd day	87.65%	88.06% ± 2.48	80.00%
deleting 3rd day	88.18%	88.42% ± 2.48	71.67%
deleting 4th day	88.79%	88.36% ± 2.63	81.67%
deleting 5th day	89.01%	88.66% ± 2.58	79.17%
deleting 6th day	87.73%	87.48% ± 2.67	93.33%
deleting 8th day	88.26%	88.12% ± 2.78	79.17%
deleting 9th day	88.18%	88.21% ± 2.65	86.67%
deleting 10th day	87.04%	87.11% ± 2.57	92.50%
deleting 11th day	87.88%	87.47% ± 2.70	85.00%
deleting 12th day	88.11%	87.95% ± 2.59	85.00%
deleting 13th day	87.88%	87.48% ± 2.82	89.17%

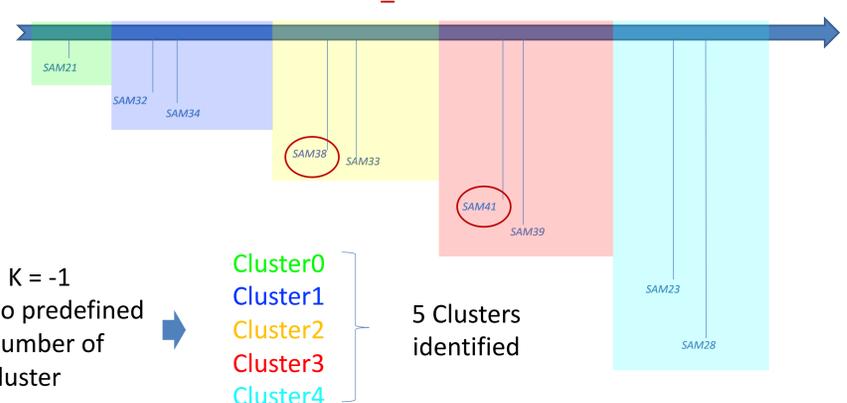
AWAKE & MOVE – V2 VISIT

Expectation Maximization clustering

❖ grouping target
UPDRS evaluation

Relationships between the estimates of the motor task grouping EM technique and the UPDRS clinical rating scores.

UPDRS_UP Evaluation



- K = -1
- No predefined Number of Cluster

5 Clusters identified

Conclusions

- The algorithm has proved to be able to detect the inter-variability of the motor functions of several patients.
- A partial correlation between the estimated clusters and the MDS-UPDRS-III assessments emerged.
- In order to understand if the identified rules are linked to any clinical status of PD patients a more accurate validation is required.