CoBeN

Novel Network-Based Approaches for Studying Cognitive Dysfunction in Behavioural Neurology

H2020-MSCA-RISE-2016-734718

D3.1 Pilot data for kinematic assessment and analysis released

Work Package:	WP3
Task:	-
Deliverable due date:	31.12.2017
Responsible partner:	MU
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Dissemination level:	CO

1 Introduction

The aim of this package (WP3) till the end of 2017 was to develop and test a handwriting protocol, that will enable us to efficiently assess all aspects of micrographia (generally Parkinsonic dysgraphia) in patients with Parkinson's disease (PD).

2 Methods

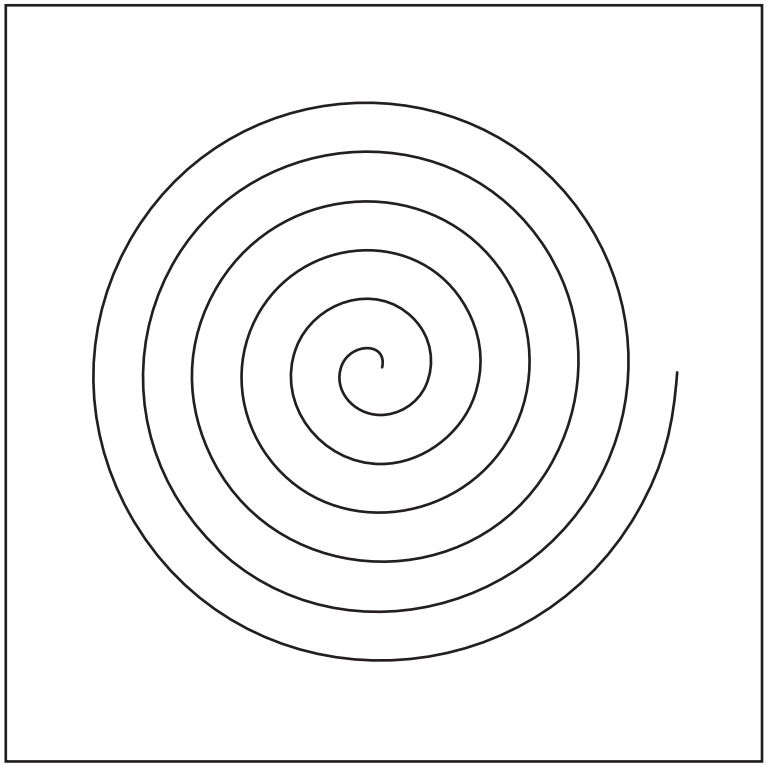
The whole process was split into three parts. Firstly, based on available research articles we proposed a first version of the acquisition protocol and recorded online handwriting from 10 Czech PD patients and 10 Czech healthy controls (HC) using a digitizing tablet Wacom Intuos 4M. Secondly, we parametrized the recordings using temporal (duration), spatial (e.g. width and height), kinematic (e.g. velocity and acceleration), and dynamic (e.g. pressure and tilt) on-surface features. Selected features were extracted from in-air movements as well. Finally, we performed a differential analysis based on Mann-Whitney U test and support vector machine algorithm (SVM with Gaussian kernel), identified most discriminative tasks/features, and further adjusted the protocol into its final version that has complex PD dysgraphia descriptive characteristics.

3 Results

The first version of protocol was developed for Czech participants and contains 8 tasks (Archimedean spiral, overlapped ellipses, letters "l", syllables, words and sentence), see supplementary Fig. 1. Based on the Mann-Whitney U test we observed that the most promising task for PD dysgraphia diagnosis is the copy of sentence, where mainly the in-air features appeared to be significant ($p < 0.05$ after FDR correction). The second most promising task is the series of cursive letter "l". From the parameterization point of view, mostly pressure and kinematic features (velocity, acceleration, jerk) had a high discrimination power. When fusing all the features into one set and performing automatic diagnosis based on the SVM, we obtained 81.3% classification accuracy, 87.4% sensitivity and 80.9% specificity. Based on these results, we modified the protocol, added one more (longer) sentence, omitted overlapped ellipses, syllables and words, and added connecting dots task (to better monitor a tremor), overlapped pentagons (to better monitor visuospatial functions), and signature (to better monitor the open-loop movement), see supplementary Fig. 2. Although we have not observed promising results based on the Archimedean spiral analysis, we have not decided to omit it, because many research works report its good discrimination power. The final version of protocol has been further translated into English and Hungary (see supplementary Fig. 3–4), but the meaning of the sentences has been changed. However, the number of words and complexity of each sentence has been kept.

4 Conclusion

Writing long sentences and drawing complex figures requires higher cognitive effort and escalates effect of dysgraphia in patients with PD. In the frame of this deliverable we have prepared a protocol that will enable us to quantify and monitor all manifestations of PD dysgraphia. Moreover, it is designed for analysis based on digitizing tablets, which will help scientists to effectively quantify the in-air movement as well.

① 

② o o o o o

③ l l l l l

④ le le le le le

⑤ les les les les les

⑥ lekłorka lekłorka

⑦ porovnał porovnał

⑧ nepopadnoul

⑨ Tramvaj dnes už nepojede.

① l l l l l

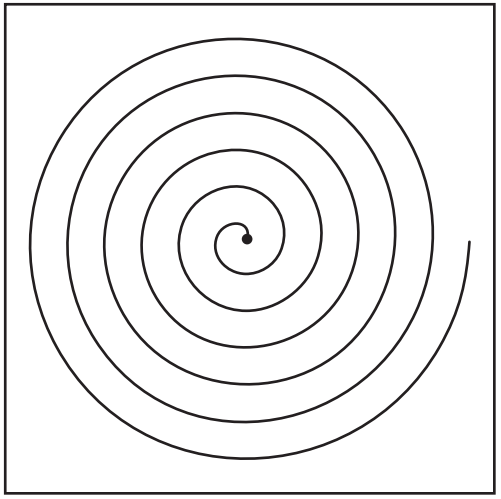
②

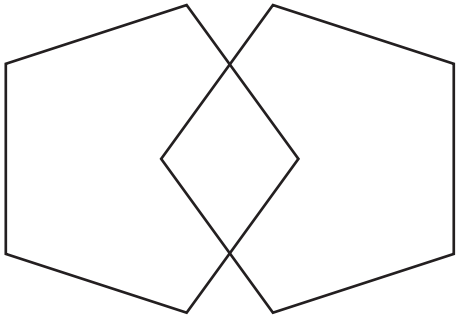
③ T. G. Masaryk,

④ T. G. Masaryk,

⑤ Tramvaj dnes už nepojede.

⑥ Máma a táta jeli dvakrát na dovolenou.

⑦ 

⑧ 

① l l l l l

②

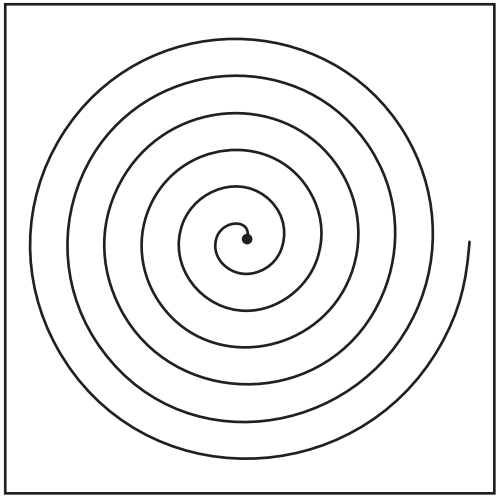
③ V. E. Masaryk,

④ V. E. Masaryk,

⑤ The weather turned nice.

⑥ The local train arrived at the station.

⑦



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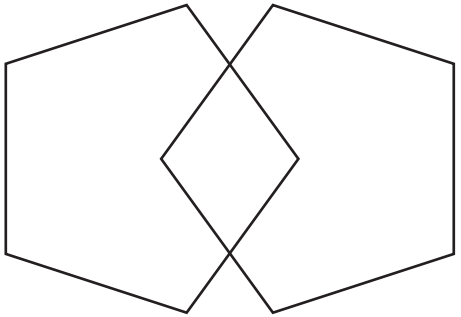


① l l l l l

②

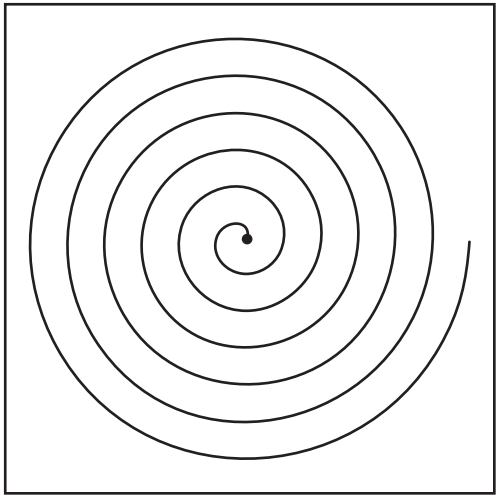
③ V. E. Masaryk,

④ V. E. Masaryk,

⑤ A vonat hirtelen megállt.

⑥ A kutya felkergette a macskát a fára.

⑦



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