Written Text as a Promising Diagnostic Tool for Parkinson's Disease

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In this particular case, we do not need to go abroad to witness a promising discovery. We can stay in Brno. At the Faculty of Electrical Engineering and Communication, Brno University of technology, a research team led by Jiří Mekyska is developing a tool for early diagnostics of Parkinson's disease which is based on processing the handwriting and speech utterances of patients. And it has to be said that their work looks very promising.

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Parkinson's disease (PD) is a neurodegenerative disease which affects the structures in the central brain area, specifically the substantia nigra – a part of basal ganglia which is responsible for the production of the neurotransmitter dopamine. In patients, the disease results in a triad of symptoms: bradykinesia (movement deceleration), muscle rigidity (inflexibility, stiffness) and resting tremor, which is a typical indication sign for these patients; unlike the intention tremor, it appears also during times when the individual does not move in any way (Zamyšková et al., 2010). A striking and at the same time extremely

limiting symptom of patients with PD are speech impediments which accompany the so-called hypokinetic dysarthria. Issues appear especially in respiration during phonorespiration (problems with respiration caused by the stiffness of respiratory muscles negatively affect the process of voice formation), facial kinesis (rigidity of facial muscles makes the articulation difficult or even impossible; it also affects the facial expressions, which are an important non-verbal part of the discourse; therefore, an individual with PD gives the impression of an indifferent listener which may lead to a negative response from their communication partners), and phonetics (patients have difficulties with the correct pronunciation of respective phonemes, the correct prosody, i.e. the speech rhythm and melody, and fluency). A disruption is present also in handwriting where the so-called micrographia is typical. The size of handwriting is decreased which, together with its general shakiness, lowers the overall readability (Zamyšková et al., 2010).

[http://psychologon.cz/data/obrazky/368-psany-text-jako-slibny-diagnosticky-nastroj-parkinsonovy-choroby/parkin.jpg] Fig. 1: The location of substantia nigra in the brain (source: parkinsoninfo.org).

An early diagnostics of Parkinson's disease is crucial because an early intervention brings a better prognosis and a larger success of therapy. Therefore, a large number of scientists from all over the world focus on its research. Some of the possible areas are, for instance, measuring the deterioration of the sense of smell as an indicator of possible progress of Parkinson's disease in an individual (Martinec Nováková, 2015), diagnostics of the disease from disorders in the eye movement (Gitchel et al., 2012) or the presence of immunity antibodies in blood (Mougenot, A-L. J. et al., 2010). (We have already written about other contemporary trends in the research of PD diagnostics here.) Last but not least, the scientists focus on the speech research.

And the speech as a potential diagnostic criterion is what the BUT team has focused on. In their study, the authors focused on both the spoken language and the written discourse of

patients. In their article, Mekyska et. all (2011) introduce and critically assess the parameters (and together with that also the diagnostic methods) which might be useful for the diagnostics of PD. When observing the disease progress based on the patient's speech, the authors recommend using parameters based on the frequency difference in the basic tone (while listening to a longer utterance, one can register the monotony in the patient's speech), the speech rhythm (the speed of the individual's speech, and the frequency of pauses he or she makes), and the dynamics of ending and beginning of phonation, i.e. how the patients are able to start and stop speaking, lower their voices, etc. (Mekyska et all., 2011).

In addition to the speech, the BUT team also focused on the handwriting of patients with PD. People were instructed to write a sentence using a special pen following a template on a digital tablet. The written discourse as such was not, from the differentially-diagnostic point of view, that interesting or convincing (as expected, a statistically significant decrease had been detected in the variables of immediate speed, immediate acceleration and immediate acceleration change in comparison to healthy individuals – Masárová et al., 2014). However, the researchers hit the bull's-eye when they decided to look at what is happening, when the pen is not touching the pad (i.e. during the transition between words or when writing punctuation). Thanks to a specialized computer application, it is possible to graphically represent and further examine the movement of the pen (see Fig. 2). The movements of the pen above the pad (so-called in-air trajectories) have proved to be a significant indicator of PD (Drotár, P. et al., 2014). The trajectories of people with PD are not only, even at first glance, significantly more shaky and inaccurate than those of healthy individuals (e.g. breaking the lines when moving between words). The authors calculated that they differ also especially in time spent "in-air" during writing in comparison to the time during which the pen is in contact with the pad (Drotár et al, 2014).

The researchers verified their findings in practice and found out that the predictive ability of this method is 85.61 %. These in-air movements during writing appear to be a promising

marker for the diagnostics of PD (Drotár, P. et al., 2014). The computer analysis is non-invasive which is another great benefit of this technique.

[http://psychologon.cz/data/obrazky/368-psany-text-jako-slibny-diagnosticky-nastroj-parkinsonovy-choroby/park2.png] Fig. 2: An example of a written sentence (blue) and in-air movements above the tablet (red) in a healthy person (left) and a person with PD (adapted from Drotár et al., 2014).

Examining the spoken and written utterances in people with PD seems to be a step in the right direction. The results of the research will have to be polished and verified in practice. Nonetheless, if everything goes according to plan and the method is put into practice, it will certainly be a significant step forward in the diagnostics of PD and a hope for patients and those close to them.

Translation: Patrik Míša (pmisa@phil.muni.cz)

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