

Track and treat Parkinson's disease using wearable sensors and MRI

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Addendum

Impact paragraph



Contribution to science

The projects and results described in this thesis contribute to science and society in several ways. First of all, in **Chapter 2**, we gave an overview of the current available literature about adaptive deep brain stimulation for Parkinson's disease (PD). From the moment this overview was available online, it has been read and has been cited multiple times. We therefore conclude that there indeed was a need for a clear overview about the existing literature and the remaining challenges regarding adaptive deep brain stimulation in PD.

In **Chapter 3**, the feasibility of the presented home monitoring system is described. For the first time the experience sampling method (questionnaires) and wearable sensors were combined and its feasibility was tested. It is not obvious that such a new system is feasible to use, and that is why this project and the corresponding publication are so important. We have shown to the scientific community that the willingness of PD patients to use such a home monitoring system is huge and that they also are capable of using it. The collected data was made publicly available as described in **Chapter 8** and can therefore be used by other research groups all over the world. This contribution may speed up the development of PD symptom algorithms. **Chapter 3** and **Chapter 4** both describe a data analysis example and the corresponding results.

In **Chapter 5**, the protocol of the TRACK-PD study is described. This publication is online and is openly accessible. By publishing this protocol, other groups know what data will be collected for this project, and might get new research ideas or might be interested in collaborations. **Chapter 6** uses a subset of the data of the project described in **Chapter 5** and does show a 'negative finding'. This means that we did not find the expected difference between PD patients and healthy controls. Nonetheless, it is important to also publish these results, since this can keep other research groups away from doing identical analyses and encourage them to use different analyzing methods or look into different brain structures. **Chapter 6** also gives recommendations for future studies, which might be inspiring for other groups.

The results described in **Chapter 7** are important for the scientific community since moving towards the use of higher field strength images for deep brain stimulation targeting may result in targeting a different anatomical location within a structure itself. In **Chapter 7** we describe these results and we do mention that future studies should focus on what this anatomical target difference means. Maybe the difference means that with a higher field strength the position in the structure can be targeted more precisely, which results in less side-effects for the PD patient when receiving deep brain stimulation. We therefore encourage the scientific community to further look into this, as it might improve future deep brain stimulation treatments.

Contribution to society

This thesis has provided a deeper insight into the role wearable sensors and MRI can play in tracking and treating PD. It was shown that wearable sensors are feasible to use in the general PD population, and an important step towards wearable sensor validation has been made. For PD patients, valid home monitoring would mean that PD symptoms can be tracked more accurately over time, which may result in an improved adjustment of PD medication and/or deep brain stimulation settings. Also, home monitoring can give PD patients the possibility for remote care, since their PD symptoms can be tracked from a distance. This is particularly beneficial for PD patients with a reduced mobility and for patients with poor access to nearby medical facilities in other regions of the world. Moreover, the feasibility of home monitoring as shown for PD patients also encourages this approach for other diseases with reduced mobility. In addition, a reduction of hospital visits enabled by home monitoring will have a beneficial economical effect for society. The results of this thesis show progress regarding the diagnostic work-up for PD. As mentioned in the introduction, the diagnostic work-up of PD can be an endless process, which often entails a long period of insecurity for the patient and his or her loved ones. If a MRI biomarker is found for PD, this insecurity will be much less. In addition, the invasive and time consuming DaT-SCAN may become unnecessary and less visits to the outpatient clinic and second opinion visits elsewhere might be necessary. This not only is more comfortable for the PD patient, it again also may eventually have a beneficial economical effect. Finally, this thesis has provided new insights into the use of 7T imaging for deep brain stimulation targeting. Further research should continue in this field, since more precise targeting might lead to less side-effects, which in the end leads to an improved quality of life for the PD patient.

This thesis is relevant for everyone, since PD, as already mentioned before, has a rapidly increasing incidence and prevalence. Not only by increasing the awareness of PD and PD symptomatology, but also by the awareness of the current research developments. This will also be beneficial for the PD patient population, since they of all people know that PD is not 'just a shaking hand disease', and a higher awareness of PD by the general population will increase understanding towards the PD patient. The results of this these are, or will be, published online in international scientific journals. These publications are often hard to interpret and are not available in Dutch. The Parkinson Vereniging therefore translates and simplifies interesting publications to make it more accessible for the broader PD audience. A simplified and Dutch summary of **Chapter 3** for example was published on their website (<https://www.parkinson-vereniging.nl/archief/bericht/2019/11/01/Het-monitoren-van-Parkinson-symptomen-in-het-dagelijks-leven-Een-haalbaarheidsstudie>). Participants of the TRACK-PD study also receive a Dutch summary of the results in the TRACK-PD

newsletter. We inform participants about study outcomes, since we think it is an important way of showing our appreciation to them and since the results are relevant to them.