The HealthPAC project received its funding from the EU 7th Framework Programme Marie-Curie FP7-PEOPLE-2013-ITN under IDP Grant agreement nr. 604063

Name ESR and number in HP: Sonal Sengupta (ESR 07)
Nationality: Indian
Research work-package (select):4,6 WP3 (HEAR), WP4 (FEEL), WP 5 (SEE), WP 6 (ACT)

Starting date ESR: 1st January 2015
Supervisor and co-supervisor: Dr. Peter Praamstra
Host-institution - Department: Radboud University

RESEARCH

RESEARCH PROJECTS AND RESULTS FROM **01/01/2014** UNTIL **31/12/2017** ***(use 1-2 pages)***
(for each project give title, its goal(s), the main results and conclusions, with a representative photo/figure which we can use on the Website!
Indicate, where appropriate, Milestone/Deliverable number (see Annex 1 pp 25-26)

Slowness of movements is an obligatory characteristic of Parkinson's Disease (PD). However, there are conditions when patients respond uncharacteristically fast, attributed to impaired inhibitory mechanisms. We investigated impaired inhibition in PD using two approaches, first using optimal sensorimotor integration framework and second using short latency visual stimulus locked responses (SLR).

Project 1: Sensorimotor Tradeoff

Many daily activities have a time constraint for successful outcome. This forces sensory processing and motor execution into competition. Earlier studies have explored how this competition is resolved by using experimental designs that segregate the sensing and acting phase of the task. They found that participants switch from the sensing to the acting stage such that the overall (sensorimotor) uncertainty in the outcome of the task is minimized. That is participants withhold movement till the combined minimum uncertainty has been reached. Therefore, investigating sensorimotor tradeoff in similar paradigms provide an opportunity to investigate deficient inhibition, which could, in theory, manifest as premature movement initiation. However, an unexplained observation in sensorimotor tradeoff experiments is the substantial variability in switching times. This variability may pose challenges in comparing the results between the HC and PD populations. Also, like reaction times, variability in switching times may be informative of the process of minimizing sensorimotor uncertainty. Therefore we approach this problem in two steps. First, we conduct experiments to understand the underlying causes of variability in sensorimotor tradeoff. Next, we compare the behavior of the PD patients and HC to identify the potential signatures of impaired inhibition in PD.

We found that variability in switching times is greater when the sensorimotor uncertainty is large or when sensory and motor processing compete such that small changes in switching times do not substantially increase the sensorimotor uncertainty. Thus, we conclude that variability in switching times results from an active exploration process that factors in both the overall uncertainty and its sensitivity to small variations of switching time. Comparing between the HC and PD groups we found that switching times of both PD patients and healthy controls were not significantly different. However, the exploratory behavior, observed as the variability in switching times was significantly compromised in PD patients. That is the PD patients did not modulate their behavior based on the task requirements. Thus we conclude that in the sensorimotor tradeoff paradigm, impaired inhibition manifests as repetitive behavior rather than premature movement release.

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Project 2: Measurement of SLR using HD-EMG

The SLR is a short-latency (~100 ms) stimulus-locked EMG response to task-relevant peripheral visual stimuli, recorded in neck and upper limb muscles. The SLR was first recorded with intra-muscular wire electrodes, and has long eluded recording with surface electrodes. Only recently surface recorded SLRs were detected in the m. pectoralis, with properties comparable to the intra-muscularly recorded SLR. However, even with intramuscular electrodes the SLR is not always detectable. Moreover, in subjects with an SLR recorded intra-muscularly, it can fail to show up in surface recordings. This state of affairs has limited the investigation of the reflex' physiological significance and exploration of its behavior in pathological conditions. We aimed to improve the non-invasive recording of the SLR using high-density surface EMG with a 64-channel electrode grid. The EMG responses of 12 out of 13 subjects demonstrated an SLR. The spatial distribution of the SLR over the 64-electrode grid was consistent across subjects and very similar to the distribution of the voluntary EMG activity following the SLR. The results disprove an earlier suggestion that surface recordings are ill-suited for SLR detection because it is generated by motor units located deep in the muscle. The results suggest that use of high-density EMG may facilitate the recording of the SLR and increase its pick-up rate with surface recordings.

Project 3: Measurement of SLR in Parkinson's Disease Patients

The SLR is also associated with oscillatory activity in the 12-15 Hz range, which may link to oscillatory activity in midbrain nuclei relevant to locomotion (pedunculopontine nucleus). Hence, we measured the SLR in an experiment with PD patients, where they were instructed to perform reaching and anti-reaching movements in response to peripheral visual stimulus. The aim of the experiment was to assess whether the reflex response is enhanced in PD and if errors in the anti-reaching trials were correlated with the enhanced reflex. Our preliminary analysis suggests that the SLR may not necessarily be enhanced in PD patients. However, the oscillatory activity may have some key differences between the PD and HC groups. Further experiments may be required to elucidate the role of SLR in the movements, before it can be used to investigate impaired inhibition in PD.

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OUTREACH ACTIVITIES

OUTREACH ACTIVITIES FROM 01/01/2014 UNTIL 31/12/2017

(mention your public presentations on open days, participation in general public events, press, etc. etc.: when, what and where).

Your publications: those that have been submitted/published (provide all bibliographic details), and those that you are currently finishing: give title, and foreseen journal, if possible)

Are there any patents? New foreground? Applications for the general public/society?

Publications

Submitted

1. Sengupta, S., Medendorp, W.P., Praamstra, P. & Selen, L.P.J. (2017) Exploration and exploitation effects in the trade-off between sensing and acting. PLOS One.

In Preparation

1. Sengupta, S., Selen, L.P.J., Medendorp, W.P., Gu, C., Corneil, B. & Praamstra, P. (2018) High-density surface EMG recording of the SLR
2. Sengupta, S., Selen, L.P.J., Medendorp, W.P. & Praamstra, P. (2018) Sensorimotor integration in Parkinson's disease: optimal or not?

Other Activities

1. Presented lab demos at Radboud Researchers' Night'15, Donders Open Day'16 and at the Vierdaagse Fest'17.

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TRAINING ACTIVITIES

TRAINING ACTIVITIES FROM 01/01/2014 UNTIL 31/12/2017

describe your courses (received and given), (summer)schools, and your Secondments: when, what, and where

Courses Taken

1. Neuro-science: Optimising Cognitive Functioning? Sleep, Mood and Attention Management, Radboud University, Nijmegen
2. Communication in Cognitive neuroscience, Radboud University, Nijmegen
3. Book club on Reza Shadmehr's Motor Learning and Control, Radboud University, Nijmegen
4. Dutch Language courses, 0-A1, A1-A2, Radboud University, Nijmegen

Schools Attended

1. HealthPAC Winter School
2. Summer School in Computational Sensory-Motor Neuroscience
3. HealthPAC Business School

Courses Given

1. Introduction to Programming (using C)
   Duration: Nov-Dec 15
2. Introduction to Programming (using Python)
   Duration: Nov-Dec 16
3. Programming using MATLAB
   Duration: March 17
4. Introduction to Programming (using Python)
   Duration: Nov-Dec 17

Secondment

Location: University of Western Ontario, Brain and Mind Institute
London, Ontario, Canada
Duration: 10th January 2018 – 31st March 2018
Training Objectives: We plan to investigate the SLR along with eye and hand movements, in an experimental paradigm where we can observe spatial averaging. Additionally, I will also participate in relevant training opportunities inside and outside the research group. For example, take part in Journal Club and lab meetings of this and other groups (Pruszynski, Gribble, Diedrichsen).

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CONFERENCES

CONFERENCES, WORKSHOPS FROM 01/01/2014 UNTIL 31/12/2017
(mention which conferences and workshops you have attended: when and where)

Conferences and Seminars

Conferences

1. 2016 *46th annual meeting of the Society for Neuroscience*, San Diego, CA, USA
   Presented poster titled "Sensorimotor integration in Parkinson's disease: optimal or not?"
2. 2017 *27th annual meeting of the Society for the Neural Control of Movement*, Dublin,
   Presented poster titled "High-density surface EMG recording of the SLR".
3. 2017 Donders Discussions, Nijmegen, The Netherlands
   Presentation titled "Optimal behavior and variability sensorimotor trade-off"

Workshops

1. 2016 Motor Learning and Motor Control, San Diego, CA, USA
2. Bayesian Statistics, Nijmegen, The Netherlands

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FUTURE CAREER PLANS

Describe your future career plan(s), after the end of the project. Note: the PhD is obtained *after* HP (31/12/2017!), so it's part of the future career plan.
What are your career plans after obtaining your PhD?

The main goal for the upcoming year is to complete the projects that I have started, including finishing the manuscripts and remaining measurements. This includes

1. Conduct an experiment to investigate the SLR along with eye and hand movements, in an experimental paradigm where we can observe spatial averaging.
2. Conduct a follow up experiment with PD subjects, if the experiments confirm useful correlates of SLR in spatial averaging.

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