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: AHMED HISHAM AHMED ABDELAZEM GARDOH ESR04
Nationality: Egyptian
Research work-package (select): WP 5 (SEE)

Starting date ESR: 01-05-2014
Supervisor and co-supervisor: Prof. Dr. Richard van Wezel, Prof. Dr. Raymond van Ee
Host-institution - Department: Radboud University, Biophysics

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)

Project 1:

Title: Enhancement of orienting spatial attention through multisensory visuo-tactile stimulation in healthy subjects

Goal

Multisensory integration of stimuli can promote orienting spatial attention in healthy humans. In this study we want to show how visuo-tactile multimodal interaction in healthy subjects increases the detectability of visual stimuli.

Subjects performed a visual detection task under visual only and visuo-tactile conditions. Results (figure 1) show enhanced stimulus detection performance under visuo-tactile conditions.

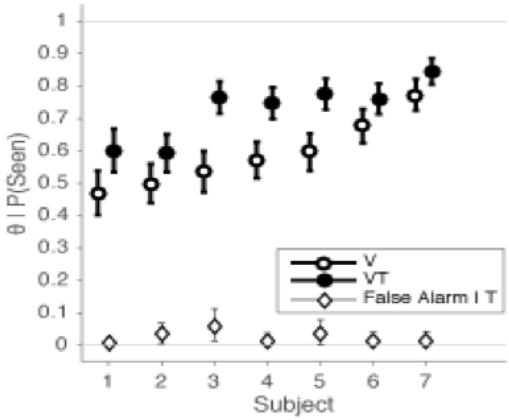

Figure 1. Subjects are sorted in visual only ascending performance order. Probability of stimulus detection in visual only or visual-tactile condition per subject.

The paper of this study is being written at the moment (**deliverable D21**, February 2018), and will be submitted to Journal of Vision for peer review.

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Project 2

Title: Interplay between visuo-tactile interactions and attentional control over perceptual selection

Apparent motion is an illusion in which static objects are perceived to be in motion when presented in quick succession. We investigated the interplay between cross-modal interactions of visual and tactile stimuli and attentional control over perceptual selection. We used a novel paradigm that combined apparent motion synchronously presented in both visual and tactile domains. As visual stimuli we used ambiguous motion quartets where the probabilities of horizontal and vertical percepts are equal. The tactile illusion of apparent motion was created using pairs of vibrotactile signals produced by a stimulation array of four solenoid tappers attached to the palmar surface of the upper and lower phalanxes of the middle and index fingers of the left hand. Ten subjects participated in two experiments. In Experiment 1, only visual stimuli were presented continuously in the peripheral visual field (15° from the fixation dot) and participants were instructed either to (a) passively report their percept of the apparent motion, (b) switch the direction of motion as quickly as possible, (c) hold the current motion direction as long as possible. The phase durations of the hold and switch conditions were significantly longer and shorter, respectively, than the phase durations of the passive condition. This demonstrates the ability of participants to select and attentively hold one of the alternating visual percepts. In Experiment 2, the visual stimuli were rhythmically synchronous with apparent tactile motion and the observers still had to report their perception under the three different instructions. The participants could hold the horizontal percept for significantly longer periods when the visual stimuli were presented in combination with synchronous congruent tactile stimuli. The experiments demonstrate that combinations of rhythmically synchronous visual and tactile stimuli enhance healthy observers' attentional control over what they perceive.

The paper of this study is being written at the moment (**deliverable D21**, March 2018), and will be submitted to Journal of Vision for peer review.

Project 3

Title: Enhancement of orienting spatial attention through multisensory visuo-tactile stimulation in spatial hemineglect patients

My main project is on multimodal interactions in hemispatial neglect patients. Hemispatial neglect is a frequent disorder following stroke and can be described as a process of ignoring one side of space. It is characterized by reduced awareness in patients of sensory stimuli on the contralesional side of space. Patients bump into people or things on their neglected side, groom or apply makeup only on one side of their face, or eat only half the food on their plate. Thus, it is a major cause of disability and handicap in stroke patients that impedes functional recovery and is associated with a poor outcome. Training patients with hemispatial neglect to attend to the non-functional visual field has proven to be one of the most robust rehabilitation methods (Lane et al., 2010), but still still takes long time / is not efficient / not 100% successful (something like this). It has recently been demonstrated that synchronous multisensory stimuli facilitate voluntary attention in healthy subjects and have a better opportunity to reach visual awareness than unisensory stimuli (Chen & Yeh, 2008; Chen et al., 2011). Similar evidence emerged from a binocular rivalry study that demonstrated that concurrently presented auditory or vibrotactile cues provide a substantial advantage to control attention over

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perceptual selection, even as much as 400% in healthy subjects when the multisensory cues are rhythmically synchronous (i.e., appearing at the same moment in the same rhythm) (van Ee et al., 2009). Furthermore, the spontaneous natural pattern of recovery in stroke patients can be modified by intensive task-oriented practice, especially when initiated within 6 months after stroke (Buma, Kwakkel, & Ramsey, 2013), which is often multisensory by nature. Therefore, we propose that further insight in multisensory stimulation in hemispatial neglect patients might lead to novel and more efficient rehabilitation tools for hemispatial neglect patients.

The goal of this project is to show that multisensory stimulation (using synchronous visual and tactile signals) enhances the ability of neglect patients to detect visual stimuli presented in their neglected side. We designed a novel experimental paradigm to test the advantage of synchronous multisensory visuo-tactile simulation.

In this study, we designed a novel paradigm to detect and quantify mild forms of neglect (i.e., attentional lapses) in chronic patients. We also assessed the efficacy of multisensory stimulation (i.e., visuo-tactile cues) on the ability of chronic neglect patients to detect sensory stimuli presented in the neglected hemispace. We hypothesize that multisensory stimulation, can provide neglect patients with mechanisms to enhance detection of visual stimuli when presented in their neglected hemifield. For this purpose, we compared the performance of chronic patients in detecting sensory stimuli presented in the neglected hemispace under two different conditions that differ from each other in terms of the properties of the sensory stimuli; 1) unisensory (i.e., only visual stimuli or only tactile stimuli), 2) multisensory (i.e., synchronous visuo-tactile stimulation). We show that synchronous visuo-tactile signals facilitates the patients' intrinsic ability to sustain attention towards the sensory stimuli in the neglected hemispace, allowing them to be consciously processed. In other words, we show that the number of attentional lapses decreases when the tactile stimuli are presented synchronously with the visual stimuli.

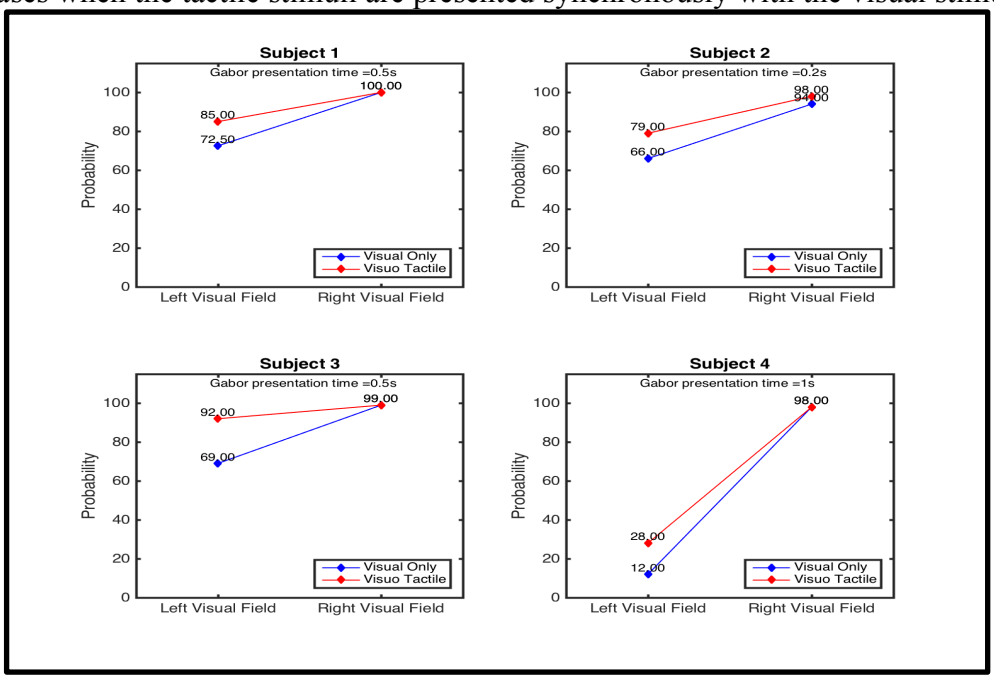

Figure 2: Performance of four neglect patients in a visual detection task

The y-axis shows the percentage of the trials in which the patient correctly reported the presence of a visual stimulus. The difference between the performance between the right and left visual fields shows

that the patients still had neglect. The blue line depicts performance of the patients when only visual stimuli were presented on the screen while the red line depicts their performance when the visual stimuli were synchronized with tactile taps on the patient's finger tips. There is an improvement in the patients' ability to correctly detect visual stimuli presented in their neglected side when the visual stimuli are synchronized with tactile signals.

The paper of this study is being written at the moment (**deliverable D21**, February 2018), and will be submitted to Scientific Reports for peer review.

Project 4:
Multimodal interactions in the speed of detecting stimulus changes
During my secondment with Prof. van Ee (Philips) I collaborated in a project with Philips and the University of Leuven (**secondment 1).** We have set up an experiment to test the influence of multimodal interactions on the speed of detecting changes in visual stimuli. The experiments are currently being tested in 20 healthy subjects. Furthermore, I was involved in developing a virtual reality setup based on multimodal stimulation that might be used as a rehabilitation tool for hemispatial neglect patients.

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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?

The following publication are in progress for publication in scientific journals:

- Multisensory stimulation is a potential tool to improve visual detection in chronic stroke patients with hemispatial neglect (In Progress).
- Tactile stimulation influences visual perception of ambiguous motion (In Progress)
- Visuo-Tactile simulation enhances attentional control in healthy over perceptual selection (In Progress).

Abstracts

- Gardoh, A., van Ee, R., and van Wezel, R.J.A. (2015). Interplay between visuo-tactile interactions and attentional control over perceptual selection. VSS 2015 Journal of Vision 16(12):1192
- van Wezel, R, Gardoh, A, Buimer, H, Stokkermans, M, Burg, I, Schellens, R, Nonnekes, J, Nemri, A, Bremen, P, van der Geest, T, van Ee, R, Zhao, Y (2017) Visual-tactile integration in low- and high-level visual processing: Applications for impaired persons. ECVP 2017

Public outreach activities (press, presentations at high schools, demo's, open days, brain awareness, etc.)

- Authored presentation in the Vision Sciences Society conference (Florida, May 2016)
- Demo's for scientific delegates from Western University, London, Canada
- Open Day (Donders Institute, 2016)
- Radboud Talks 2017
- Presentations for Biology and Physics students (2014 – 2017)
- Demo's for students (Biology, Biomedical Sciences and Physics, Bachelor and Master)

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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:

- Scientific writing course
- Advanced Statistics
- Dutch speaking, reading and writing course
- Visual perception and hemineglect: lecture for Biology students
- Neuroscience: optimizing cognitive function: mandatory HealthPAC course (January 2015, Radboud University)
- Signal analysis and Matlab: overview of how to analyze data. Knowledge gained in this course was used for all projects (April 2015, Radboud University)

Teaching assistance:

- Brain and Behaviour (Bachelor course)
- Translational neuroscience (Bachelor course)
- Optimizing cognitive functions (Masters level)
- Daily supervising the internships of a bachelor student and a master student.

Secondment with Prof. van Ee (Philips) at the University of Leuven under co-supervision of Dr. Celine Gilbert.

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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)

- Vision Sciences Society conference (Florida, May 2016)
- Vestibular processing in health and disease workshop.
- Donders sessions (Monthly workshops)
- Donders Discussions 2017
- Joint research symposium Donders Institute – Brain and Mind Institute (Western University, London, Canada)
- Cognition and Perception laboratories in New York University (May, 2016)
- Department of Motor Neuroscience and Movement Disorders, UCL institute of Neurology (2016)
- Prof. Samuel Solomon laboratory, Faculty of Brain sciences, UCL (London, 2016)
- Visit company Xsense (2015)
- Cosmo Summer School, Nijmegen, The Netherlands (July 2015)
- Neurovation (Technological applications in neurocognition) 6-7 October 2014
- HealthPAC summerschools
- HealthPAC Business School, part 1. Nijmegen, The Netherlands (April 2017)
- HealthPAC Business School, part 2. Eindhoven, The Netherlands (May 2017)
- Masterclasses HealthPAC
- Donders Discussions (November 2015, 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? My short-term plan is to obtain a PhD based on the research that I did during the HealthPAC projects and submit 4 peer reviewed papers of my projects during HealthPAC. I plan to defend my thesis publicly at the Radboud University at the end of 2018. I have a background in medicine and neuroscience and during my HealthPAC period found out that I like teaching a lot. My long-term plan is to find a job that combines those three aspects in academia, in a company or at a teaching institute.

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