

The influence of visual feedback in phantom limb pain and perception –
application of a novel augmented reality platform in basic research and
treatment
by

Mikkel Thøgersen

The phantom limb pain condition has been puzzling researchers for decades. Despite that it is a well-studied and a common ailment for amputees, its origin and treatment is still unclear. In the previous two decades the dominant hypothesis in the field has been that maladaptive reorganizations in the cortex happen as a result of deafferentation and ultimately results in phantom pain. While it remains a question whether these reorganizations are causal, many new strategies to treat phantom limb pain are based on this hypothesis. This line of treatments was pioneered by the mirror box illusion wherein amputees could see a recreated visualization of their lost limb. The goal of using this illusion has been to recreate sensory feedback to stimulate the dormant cortical representation of the lost limb and thereby reverse the maladaptive cortical changes. In a recent study, the efficacy of the mirror illusion was investigated. The authors found that pain relief had a significant correlation to how much the patients could relate to the visualization of their lost limb. Furthermore, the study showed that phantom limb patients with a telescoped phantom, i.e. the feeling that the phantom has retracted towards the stump, did not obtain a pain relief from the treatment. This research points to a possible connection between body perception, cortical reorganizations and pain.

In line with these results, this PhD thesis concerns a series of three studies investigating how body perception, cortical plastic changes and pain processing are affected by a manipulation of the visual feedback in both healthy participants and phantom limb patients. Through this work, a special platform based on augmented reality was developed to study the above factors.

Following an introduction into the area of research, the initial chapter explores the link between vision, pain and body representations. To investigate these topics, a novel augmented reality platform was created and used to manipulate own-limb visual feedback. A study was conducted on healthy participants whom experienced a complete loss of visual feedback from the left upper limb. The influence of losing vision of the limb was assessed using both questionnaires related to the sense of ownership and agency over their arm, but also their response to nociceptive thermal stimuli. The final study focused on phantom limb pain patients and the recreation of visual feedback of their missing limb, based on the perception of their phantoms. A two-week training paradigm was used to induce up to 52% pain relief and significant changes in cortical activity, indicating a possible reorganization in the somatosensory cortices. Perception and integration of the visualized phantom seems to be an important factor in gaining pain relief.

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Ph.D. lecture

by

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Friday 22 March 2019



DEPARTMENT OF HEALTH SCIENCE AND TECHNOLOGY
AALBORG UNIVERSITY

This thesis is based on Mikkel Thøgersen's research work at:



CNAP
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To fulfill the requirements for the Ph.D. degree, Mikkel Thøgersen has submitted the thesis: The influence of visual feedback in phantom limb pain and perception – application of a novel augmented reality platform in basic research and treatment, to the Faculty Council of Medicine at Aalborg University.

The Faculty Council has appointed the following adjudication committee to evaluate the thesis and the associated lecture:

Junior-professor Jörg Trojan
University of Koblenz-Landau
Germany

Professor Salvatore M. Aglioti
University of Sapienza
Italy

Chairman:
Professor Winnie Jensen
Aalborg University
Denmark

Moderator:
Associate Professor Laura Petrini
Aalborg University
Denmark

The Ph.D. lecture is public and will take place on:

Friday 22 March 2019 at 13:00
Aalborg University – Room D2-106
Fredrik Bajers Vej 7 D2
9220 Aalborg East

Program for Ph.D. lecture on

Friday 22 March 2019

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Chairman: Professor Winnie Jensen
Moderator: Associate Professor Laura Petrini

13.00	Opening by the Moderator
13.05	Ph.D. lecture by Mikkel Thøgersen
13.50	Break
14.00	Questions and comments from the Committee Questions and comments from the audience at the Moderator's discretion
16.00	(No later than) Conclusion of the session by the Moderator

After the session a reception will be arranged