

On rate enhancement during the human voluntary rhythmic movement of finger tapping

by
Anders Emanuelsen

Voluntary rhythmic movements are fundamental during everyday human life. Examples of such movements include walking and other cyclic tasks, such as finger tapping. It has been shown that motor function of voluntary rhythmic movement can be altered through e.g. priming, which can be described as a change in behaviour generated by a preceding stimulus. However, many details of the control and regulation of voluntary rhythmic movements involved in e.g. priming remain largely undisclosed. Thus, an improved understanding of the nervous system's function in general but also for potential medical use and development of e.g. exoskeletons or robotic assistance is useful.

A behavioural priming phenomenon, termed 'repeated bout rate enhancement', has been revealed previously. The phenomenon comprises that the freely chosen tapping rate during voluntary index finger tapping was increased following submaximal muscle activation, in form of finger tapping. It has previously been proposed that finger tapping could be a central pattern generator-mediated rhythmic movement and further that the observed rate enhancement could be the result of a net excitation of the supraspinal centres, the spinal central pattern generator, or a combination of both. The overall aim of this thesis was to increase our understanding of voluntary stereotyped rhythmic movements. More specifically, the main purpose was to investigate and further elucidate the phenomenon of repeated bout rate enhancement during the task of finger tapping. For this purpose, three studies were performed.

In study I, various forms of finger tapping were investigated. It was shown that repeated bout rate enhancement could be elicited following passive tapping, which does not require descending drive. In study II, various durations of the first tapping bout were applied. Here it was revealed that rate enhancement was elicited following tapping durations ranging from 20 s to 180 s in the first bout. The results showed that there was no dose-response relationship between the duration of priming and the magnitude of rate enhancement. In study III, linear and non-linear metrics applied to kinetic and kinematic time series were calculated in an attempt to investigate possible differences in motor variability between responders and non-responders (i.e., individuals showing and not showing repeated bout rate enhancement, respectively). Of note is that a responder was defined as an individual who showed a minimum increase of 3% of the freely chosen tapping rate from the first to the second tapping bout. Here it was revealed that responders and non-responders demonstrated different characteristics of motor variability, primarily related to the complexity in the structure of motor variability.

The present findings are interpreted to suggest that rate enhancement during finger tapping could be the result of an increased excitability of the nervous system, which to a certain extent could be caused by sensory feedback. Furthermore, that a duration of as little as 20 s of priming seems to be sufficient to elicit rate enhancement. Finally, that individuals who show repeated bout rate enhancement could exhibit a greater adaptability in the dynamics of motor control compared with individuals who do not show repeated bout rate enhancement.

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PhD lecture

By

Anders Emanuelsen

Friday 17 January 2020



DEPARTMENT OF HEALTH SCIENCE AND TECHNOLOGY
AALBORG UNIVERSITY

This thesis is based on
Anders Emanuelsen's research work at:

Department of Health Science and Technology
Aalborg University, Denmark

To fulfill the requirements for the PhD degree, Anders Emanuelsen has submitted the thesis: On rate enhancement during the human voluntary rhythmic movement of finger tapping, 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:

Professor John J. Buchanan
Texas A&M University
USA

Associate professor Erik Bruun Simonsen
University of Copenhagen
Denmark

Chairman:
Associate professor Jesper Franch
Aalborg University
Denmark

Moderator:
Associate professor Ernst Albin Hansen
Aalborg University
Denmark

The PhD lecture is public and will take place on:

Friday 17 January 2020 at 13:00
Aalborg University – Room D2-106
Fredrik Bajers Vej 7 D2
9220 Aalborg East

Program for PhD lecture on

Friday 17 January 2020

by

Anders Emanuelsen

On rate enhancement during the human voluntary rhythmic movement of finger tapping.

Chairman: Associate professor Jesper Franch
Moderator: Associate professor Ernst Albin Hansen

13.00	Opening by the Moderator
13.05	PhD lecture by Anders Emanuelsen
13.50	Break
14.00	Questions and comments from the Committee Questions and comments from the audience at the Moderator's discretion
16.00	Conclusion of the session by the Moderator

After the session a reception will be arranged