

# Shedding light on cognitive control

## Akademisk avhandling

Som för avläggande av medicine doktorexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentligen försvaras i föreläsningssal Arvid Carlsson, Medicinaregatan 3A, den 10 juni, klockan 13.00

av **Simon Skau**

**Fakultetsopponent:**

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## Avhandlingen baseras på följande delarbeten

- I. Skau, S. Bunketorp-Käll, L., Kuhn, H.G., and Johansson, B. 2019. Mental Fatigue and Functional Near-Infrared Spectroscopy (fNIRS) – Based Assessment of Cognitive Performance After Mild Traumatic Brain Injury, *Frontiers in Human Neuroscience*
- II. Skau, S. Jonsdottir, I., Sjörs Dahlman, A., Johansson, B., and Kuhn, H.G. Exhaustion disorder and altered brain activity in frontal cortex detected with fNIRS. *Manuscript*
- III. Skau, S. Bunketorp-Käll, L., Johansson, B., and Kuhn, H.G. Proactive cognitive control, trait mental fatigue and cortical brain activation: an fNIRS study. *Manuscript*
- IV. Skau, S. Bunketorp-Käll, L., Helenius, O., and Kuhn, H.G. Difference in functional activity in frontal and parietal cortex for spatial and written mathematics in primary school children: an fNIRS study. *Manuscript*
- V. Skau, S. Bunketorp-Käll, L., Helenius, O., and Kuhn, H.G. Proactive cognitive control and cortical brain activation in 8- to 9-year old children: an fNIRS study. *Manuscript*

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# Shedding light on cognitive control

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## Abstract

This thesis aimed to investigate the ability to adjust cognitive processes and behavior, i.e., cognitive control, and its related functional activity in the cortex. The optical imaging technique functional near-infrared spectroscopy (fNIRS) was used to detect change in cortical activity during neuropsychological tests of conflict processing and proactive cognitive control

The two first studies used a test-retest design and investigated how prolonged mental activity, neuropsychological testing for two and a half hours, affects cognitive performance and functional activity in the frontal cortex in individuals suffering from pathological mental fatigue after traumatic brain injury (**paper I**) and exhaustion disorder (**paper II**). We were able to show that both patient groups have reduced functional activity during cognitive control, especially in the left ventrolateral prefrontal cortex, and that this reduction was associated with the level of pathological mental fatigue. There was no indication that prolonged mental activity induced a change in functional activity during the test session.

**Paper III** showed that increased trait mental fatigue in healthy adults was associated with a tendency to use cognitive control in a reactive way. The increase in trait mental fatigue was also associated with an increased functional activity in frontal and parietal cortex during reactive conflict processing situations compared to proactive ones.

In the last studies, we brought the fNIRS machine to two schools to investigate functional brain activation during mathematical cognition (**paper IV**) and cognitive control (**paper V**) in children between the age of 8- to 9- years in a school environment. The result suggested that the visual aid in mathematical tasks reduces the cognitive load and the functional activity in the right anterior dorsolateral prefrontal cortex, compared to equivalent tasks without visual aid. Children who tend to be less reactive or more proactive in a conflict processing test involve the right posterior parietal cortex more during reactive situations than proactive ones.

## Keywords

Cognitive control, fNIRS, mental fatigue, exhaustion disorder, TBI, children, mathematical cognition, proactive cognitive control

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