Modulation of sensory and pain perception with successive non-invasive brain stimulation

Brookes Gregory Folmli

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Principal supervisor: Prof. Wayne Hing

Assistant supervisors: A/ Prof. Peter Johnson, Associate Prof. Allan Abbott
Abstract

Introduction: Non-invasive brain stimulation techniques are being trialed to induce neuroplasticity for meaningful purposes. Transcranial direct current stimulation (tDCS) is one such brain stimulatory technique, which involves delivering low amplitude direct current (1-2mA) to the brain via scalp electrodes. A review of the literature has suggested that repeated daily tDCS could induce lasting effects in the motor domain in a healthy population and in both the sensory and motor domains in a clinical population (Boggio et al. 2007, Mori et al. 2012, Reis et al. 2009). Of interest was whether increasing tDCS dose could evoke cumulative body sensory system function alteration in a healthy population.

Aims: A systematic review aimed to review the literature most relevant to 1_the effects of sensory cortex tDCS on sensory threshold related outcome measures and 2_the effects of motor cortex tDCS on pain threshold/intensity related outcome measures. Study 1 aimed to investigate the effects of consecutive daily sessions of tDCS on a sensory psychophysical outcome measure in a healthy population. Study 2 aimed to investigate the effects of consecutive daily sessions of tDCS on a series of pain related psychophysical, subjective and objective outcome measures in a healthy population as well as investigate the correlation between the baseline pain related psychophysical, subjective and objective outcome measures in a healthy population.

Methods: A systematic review of the literature most relevant to the aims of studies 1 and 2 was firstly undertaken. Randomised controlled trial
methodology was then utilised in Study 1 to assess the effects of 5 consecutive daily sessions of active (anodal) or sham sensory cortex tDCS on one psychophysical (i.e. vibration detection thresholds) measure in 29 healthy human volunteers. In Study 2, randomised controlled trial methodology was used to assess the effects of 5 consecutive daily sessions of active (anodal) or sham motor cortex tDCS on psychophysical (i.e. electrical, mechanical pressure and thermal detection and pain thresholds), subjective (i.e. electrical, thermal and mechanical pressure pain visual analogue scales (VAS)) and objective (i.e. salivary cortisol) outcome measures in 42 healthy human volunteers. Cross-sectional analysis of baseline data was also used in Study 2 to explore bivariate correlations between examined outcome measures.

**Results:** The review indicated both methodological limitations and heterogenous tDCS induced effects for trials. The review also revealed that repeated stimulation was one area that researchers had failed so far to focus on. Studies 1 and 2 demonstrated that consecutive daily sessions of anodal tDCS could not consistently alter psychophysical, subjective and objective outcome measures compared to sham in a healthy population. Study 2 also demonstrated statistically significant correlations between psychophysical and subjective outcome measures in a healthy population.

**Conclusion:** The results of studies 1 and 2 suggest that increasing tDCS dose does not result in more consistent anodal tDCS induced effects on body sensory/pain perception in a healthy population. As well, the results of Study 2 also may provide further evidence of the clinical utility of different types of pain assessments.
Declararion of original work

This thesis is submitted to Bond University in fulfillment of the degree of Master of Philosophy. This thesis represents my own original work towards this research degree and contains no material which has been previously submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made.

Signed:

_____________________________________________________________________
Brookes Gregory Folmi

Date:
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List of acronyms

ANOVA – analysis of variance
BDNF - brain-derived neurotrophic factor
CPT - cold pressor pain threshold
CTT - cold pressor tolerance threshold
EDT - electric detection threshold
EEG - electroencephalography
ELISA – enzyme-linked immunosorbent assay
EP – experimental pain
EPT - electric pain threshold
EMG- electromyography
FDI – first dorsal interosseous
fMRI – functional magnetic resonance imaging
GABA – gamma-amino-butyric acid
HPA - hypothalamic-pituitary-adrenal
LTP – long-term potentiation
MEP – motor evoked potential
MOR - mu opioid receptor
MRI – magnetic resonance imaging
MRS - magnetic resonance spectroscopy
NaCl – sodium chloride
PPT - pressure pain threshold
rTMS – repetitive transcranial magnetic stimulation
SD – standard deviation
SEP - somatosensory evoked potentials
SPSS – statistical package for the social sciences

SRGPSQ - self-reported general pain sensitivity questionnaire

tDCS - transcranial direct current stimulation

TMS – transcranial magnetic stimulation

TrkB – tropomyosin related kinase B

VAS – visual analogue scale

VDT - vibration detection threshold