

Cognitive Control: Modulating Conflict Between Competing Responses

Thesis presented

by

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to

Discipline of Psychology

School of Behavioural, Cognitive and Social Sciences

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy (Clinical Psychology)

October 2009

University of New England

Armidale, New South Wales

Abstract

This thesis investigated modulation of cognitive conflict using variants of the face/name Stroop task and electroencephalogram (EEG) measures. Behavioural analyses throughout four experiments focused on reaction times (RT) and accuracy (%). EEG analyses focused on evoked upper alpha event related desynchronisation (ERD) and event related synchronisation (ERS) to assess facilitation and inhibition effects respectively. The principal focus of investigation was whether cognitive conflict is resolved through facilitation, inhibition or both.

Paper 1 used EEG to re-examine findings of an fMRI blocked design face/name Stroop task study which indicated that facilitation alone, without any input from inhibition, resolves cognitive conflict. EEG results convincingly demonstrated that both temporal facilitation (alpha ERD) and inhibition (alpha ERS) take part in resolving cognitive conflict.

Paper 2 used the same stimuli as in blocked task in Paper 1, but, this time arranged in event related rather than blocked design, failed to replicate Paper 1 behavioural and evoked upper alpha ERD and ERS findings, revealing that cognitive control is not a single entity and is heterogeneous process highly sensitive to processing demands.

Paper 3 separated processes involved in modulating perceptual conflict from response conflict again utilising the face/name Stroop task. Participants first viewed the stimulus, which was then followed by the cues instructing them to respond to either face or name. Results demonstrated a particularly robust Stroop interference effect, but, as in Paper 2, provided evidence of multiple, context dependent processes in the temporal resolution of cognitive conflict.

Paper 4 focused on cross validating evoked upper alpha ERD and ERS as measures of facilitation and inhibition using the face/name Stroop paradigm in both go/no-go and oddball tasks. EEG results supported the present use of alpha ERD and ERS as measures of facilitation and inhibition; however, results were more persuasive for alpha ERS than alpha ERD.

EEG evidence suggested that the temporal resolution of cognitive conflict involves both facilitatory and inhibitory processes in a context dependent manner. Control processes in the simple Stroop compared to the Gratton effects appear to operate independently. Study design parameters (event related versus blocked paradigm) and the temporal resolution of neurophysiological measures (EEG versus fMRI) are critical in detecting specific *within task set* or *between task sets* cognitive control effects. Cognitive control cannot be viewed as a singular central resource which is applied in the same way across diverse contexts with differing, specific processing demands.

Key words: conflict, cognitive control, Stroop, Gratton effect, facilitation, inhibition, top down, bottom up, fMRI, EEG, PDP model, evoked upper alpha, ERD, ERS, ACC, PFC, FFA, blocked, event related design, task switching, go/no-go, oddball task

Statement of Original Authorship

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis and all sources used have been acknowledged in this thesis.



October 2009

Acknowledgements

Firstly and mostly of all I would like to thank my family – my husband Guy and our sons Robert and Edward for supporting me for so many years while I completed this degree. Thank you for accepting my constant absences, often including during public holidays, everlasting fatigue and my fervent attachment to the computer even while at home. Thank you for your unconditional love, loyalty and support.

Thank you my in-laws Darrel and Barbara Newby for providing dependable and practical support in every possible way for so many years. Thank you especially for your generous support in looking after Robert and Edward during school holidays.

Thank you my inspirational supervisor Dr Graham Jamieson for your erudition and kindness. Graham was an essential intellectual force in helping me to design, analyse and interpret all experiments. Thank you for your generosity in sharing your knowledge and skills with me in trying to unravel some of the mysteries surrounding the masterpiece of nature – the human brain.

Thank you my co-supervisor Dr Andrew Talk for your help during the completion of this research including your help in preparing research proposal and thesis drafts.

Ačiū Egle, mama ir Tomai už palaikymą ir už tai, kad padedat man neužmiršti mano lietuviškų šaknų. Žemaitiškas užsispyrimas padėjo man nepalūžt.

Thank you Cynthia for helping me access the best scientific journals and for kindness.

Thank you Chris Lisle for all technical support including for helping me to create all photographs used in the experiments. Thank you Richard for editing my thesis.

Thank you all of the participants, including clinical psychology Masters students who, despite their grueling schedules, found time to participate in my experiments. And no, I was not able to read your mind with that EEG device, which might have been a good thing especially towards the end of the experimental session.

Thank you my fellow postgraduates Navjot, Gail, Tamar, Natasha, Paul for support and sense of camaraderie.

Thank you my thesis examiners Dr Tobias Egner, Dr Gregor Thut and Dr Paul Sauseng for expert and valuable advice.

It was an immense sorrow that my dearly beloved grandma Joana Lomsargienė died peacefully on 26 September 2008. You are in my thoughts forever. RIP.

Thesis Format

This thesis conforms to a journal article format as an alternative to the traditional thesis currently in use in the Discipline of Psychology at UNE. In this format quality journal manuscripts suitable for submission to a peer-reviewed journal are bound together and bracketed by overall introduction and conclusions. Since Papers are linked and provide their own introductions and discussions, bracketing sections are brief.

In the body of the thesis, if a reference contains more than two authors it is referenced as first *Author et al* to minimise disruption to the flow of the text and to save resources.

Following guidelines, a consolidated list of references for all chapters is included.

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