

Behavioural and Electrophysiological Correlates of Anticipatory Task-Set Reconfiguration

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Declaration

I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or Institution.

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I dedicate this work to my baby girl who is due to enter the world any day now and to the infinite possibilities the future holds.

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Abstract

The concept of a unitary cognitive control system has increasingly come under question. Numerous paradigms have emerged that aim to dissect cognitive control into its constituent processes, including task-switching paradigms that require alternation between multiple tasks. A switch in task is associated with increased reaction time (RT) as compared to a repeat in task, which is proposed to at least partially reflect processes associated with reconfiguration of the currently active task-set. Previous event-related brain potential studies show a differential positivity emerging prior to a switch in task that appears to reflect anticipatory task-set reconfiguration. Six experiments were conducted that investigated the behavioural and ERP correlates of task-switching, and in particular, the cognitive control processes involved in anticipatory task-set reconfiguration.

Experiment 1 dissociated the effects of passive dissipation of task-set interference from anticipatory task-set reconfiguration. In Experiment 2, it was further verified that the switch-related differential positivity reflects processes associated with anticipatory task-set reconfiguration, particularly initiation of the new task-set. A simplified paradigm was developed in Experiment 3 that maximised engagement in anticipatory task-set reconfiguration, reducing mean RT switch cost. Experiment 4 demonstrated that the RT switch cost and differential positivity in cueing paradigms are associated with task-set reconfiguration rather than a cue repetition benefit. Consistent with previous brain imaging studies, Experiment 5 revealed that anticipatory task-set reconfiguration is associated with increased activation in the prefrontal cortex and parietal lobe.

These findings show that task-set reconfiguration processes are activated when switching between tasks and that this consists of multiple components including the active utilisation of cognitive control processes in anticipatory task-set reconfiguration. Task-switching paradigms are thus a useful tool for investigating control processes in healthy populations and as Experiment 6 demonstrates, in clinical populations that have deficits in control processes, such as patients with schizophrenia.

Publications and Conferences

Publications arising from this thesis¹

Nicholson, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2005). Electrophysiological correlates of anticipatory task-switching processes. *Psychophysiology*, 42(5), 540-554.

Nicholson, R., Karayanidis, F., Bumak, E., Poboka, D., & Michie, P. (2006). ERPs dissociate the effects of switching task-sets and task-cues. *Brain Research*, 1095, 107-123.

Karayanidis, F., **Nicholson**, R., Schall, U., Meem, L., Fulham, R., & Michie, P. (in press). Switching between univalent task-sets in schizophrenia: ERP evidence of an anticipatory task-set reconfiguration deficit. *Clinical Neurophysiology*.

Nicholson, R., Karayanidis, F., Davies, A., & Michie, P. (in revision). Components of Task-set Reconfiguration: Differential Effects of 'Switch-to' and 'Switch-away' Cues. *Brain Research*.

Nicholson, R., Karayanidis, F., Fulham, R. & Michie, P. (in revision). Organization of anticipatory task-switching processes using low-resolution electromagnetic tomography (LORETA). *International Journal of Psychophysiology*.

Conference presentations with published abstracts arising from this thesis

Nicholson, R., Karayanidis, F., Bumak, E., Poboka, D & Michie, P. (2005). ERPs dissociate the effects of switching task-sets and task-cues. 15th Australasian Society for Psychophysiology Conference (ASP), Wollongong, Australia, 8th-11th December. *Journal of Clinical EEG and Neuroscience*, 144.

Nicholson, R., Karayanidis, F., Fulham, R. & Michie, P. (2005). Localisation of anticipatory task-switching processes. 15th Australasian Society for Psychophysiology Conference (ASP), Wollongong, Australia, 8th-11th December. *Journal of Clinical EEG and Neuroscience*, 144.

Karayanidis F, ***Nicholson** R, Michie, P., & Davies, A. (2005). Active Preparation in Task-Switching: Differential Effects of 'Switch-to' and 'Switch-away' Cues. 46th Annual Meeting of the Psychonomic Society, Toronto, Canada, 10th -13th November. *Psychonomic Society Abstracts*, 10, 119.

Karayanidis, F, ***Nicholson**, R, Poboka, D, Davies, A, Heathcote, A, & Michie, P. (2005) Anticipatory cognitive control in task-switching: differential effects of 'switch to' versus 'switch away' cues. 32nd Australian Experimental Psychology Conference (EPC), Melbourne, Australia, 1st – 3rd April. *Australian Journal of Psychology*, 57, 57.

Karayanidis, F., ***Nicholson**, R., & Michie, P. (2004). Differential positivity (D-pos) in cue–stimulus interval reflects anticipatory task-set reconfiguration processes. 12th World Congress of Psychophysiology, **Thessaloniki**, Greece, 18th – 23rd September. *International Journal of Psychophysiology*, 54, 13.

Schall, U., Karayanidis, F., ***Nicholson**, R., & Meem, L. (2004). Preparation in anticipation of a predictable Task-switch in schizophrenia. 12th World Congress of Psychophysiology, **Thessaloniki**, Greece, 18th – 23rd September. *International Journal of Psychophysiology*, 54, 103.

***Nicholson**, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2003). Electrophysiological components associated with preparation for an impending switch in task. 13th Australasian Society for Psychophysiology Conference (ASP), Hobart, Australia, 12-14th December. *Australian Journal of Psychology*, 56 (Supplement), 43.

Davies, A., ***Nicholson**, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2003). Active preparation in task-switching: Effects of 'switching to' versus 'switching away' from a task-set. 13th Australasian Society for Psychophysiology Conference (ASP), Hobart, Australia, 12-14th December. *Australian Journal of Psychology*, 56 (Supplement), 41.

¹ See Appendix for full publications, corresponding experiment numbers in thesis and declarations on the roles and contributions of co-authors. * Presented under maiden name, Rebecca Hannan.

***Nicholson, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2003).** Electrophysiological components associated with anticipatory task-switching processes. 1st NSW State Australian Psychological Society Conference (APS), Newcastle, Australia, 23rd – 25th May, *Australian Journal of Psychology*, 55 (Supplement), 103.

***Nicholson, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2003).** Anticipatory preparation & passive dissipation processes in task-switching: Event-related potential analysis. 30th Australian Experimental Psychology Conference (EPC), Sydney, Australia, 25th -27th April, *Australian Journal of Psychology*, 55 (Supplement), 80.

***Nicholson, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2002).** ERP components associated with anticipatory task-switching processes. 12th Australasian Society for Psychophysiology Conference (ASP) and 6th Australian Functional Brain Mapping Symposium, Sydney, Australia, 29th November – 3rd December, *Australian Journal of Psychology*, 55 (Supplement), 19.

Other conference presentations arising from this thesis

Nicholson, R., Karayanidis, F., Fulham, R. & Michie., P. (2005). Localisation of anticipatory task-switching processes. 4th Postgraduate Student Conference, School of Behavioural Sciences, University of Newcastle, Australia, 24th November.

***Nicholson, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2005).** ERP components associated with preparation for an impending switch in task. International Conference on Attentional Control (ICAC), Chia-yi, Taiwan, 5th-7th January.

Karayanidis, F., ***Nicholson, R., Poboka, D., Heathcote, A., & Michie, P. (2005).** Active preparation in task-switching: Differential effects of ‘switch-to’ and ‘switch-away’ cues. International Conference on Attentional Control (ICAC), Chia-yi, Taiwan, 5th-7th January.

***Nicholson, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2003).** Anticipatory preparation & passive dissipation processes in task-switching: Event-related potential analysis. 2nd Postgraduate Student Conference, School of Behavioural Sciences, University of Newcastle, Australia, 10th October.

***Nicholson, R., Karayanidis, F., Poboka, D., Heathcote, A., & Michie, P. (2003).** Anticipatory preparation & passive dissipation processes in task-switching: Event-related potential analysis. 4th International Conference on Cognitive Science (ICCS) and 7th Australasian Society for Cognitive Science Conference (ASCS), Sydney, Australia, 13th -17th July.

Other publications and conferences

Jamadar, S., Karayanidis, F., **Nicholson, R. & Michie., P. (2005).** Event Related Potential Correlates of Preparation for an Upcoming Switch in Task. 15th Australasian Society for Psychophysiology Conference (ASP), Wollongong, Australia, 8th-11th December. *Journal of Clinical EEG and Neuroscience*, 144.

Poboka, D., Heathcote, A., Karayanidis, F., & ***Nicholson, R. (2005).** An Investigation of Task Switch Costs: Preparation Activation, Timing and Readiness Decay. International Conference on Attentional Control (ICAC), Chia-yi, Taiwan, 5th-7th January.

Poboka, D., Heathcote, A., ***Nicholson, R., & Karayanidis, F. (2003).** Anticipatory preparation & passive dissipation processes in task-switching: Reaction time distribution analysis. 4th International Conference on Cognitive Science (ICCS) and 7th Australasian Society for Cognitive Science Conference (ASCS), Sydney, Australia, 13th -17th July.

Poboka, D., Heathcote, A., Karayanidis, F., & ***Nicholson, R. (2003).** Anticipatory preparation & passive dissipation processes in task-switching: Reaction time distribution analysis. 30th Australian Experimental Psychology Conference (EPC), Sydney, Australia, 25th -27th April, *Australian Journal of Psychology*, 55 (Supplement), 88.

Abbreviations

	Abbreviated \ Symbol Form
Analysis of variance	ANOVA
Analysis of co-variance	ANCOVA
Contingent negative variation	CNV
Cue-stimulus interval	CSI
Differential positivity	D-Pos
Differential negativity	D-Neg
Electroencephalogram	EEG
Electrooculogram	EOG
Event-related brain potential	ERP
Functional magnetic resonance imaging	fMRI
Independent component analysis	ICA
Intelligence quotient	IQ
Late positive component	LPC
Lateralised readiness potential	LRP
Low-resolution electromagnetic tomography	LORETA
Microvolt	μV
Milliseconds	ms
Montreal Neurologic Institute	MNI
National adult reading test	NART
Operational criteria diagnostic system	OPCRIT
Quarter peak latency	QPL
Reaction time	RT
Response-cue interval	RCI
Response-stimulus interval	RSI
Schedule for assessment of negative symptoms	SANS
Schedule for assessment of positive symptoms	SAPS
Wisconsin Card Sorting Test	WCST