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CNV resolution effects and inhibition in a Go/NoGo task

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CNV Resolution Effects and Inhibition in a Go/NoGo Task

A thesis submitted in fulfilment of the requirements for the award
of the degree

MASTER OF SCIENCE (HONours)

from

UNIVERSITY OF WOLLONGONG

by

BRUCE W. ODDY, B.Sc., M.Sc.

SCHOOL OF PSYCHOLOGY

2010
CERTIFICATION

I, Bruce W. Oddy, declare that this thesis, submitted in fulfilment of the requirements for the award of Master of Science (Honours), in the School of Psychology, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Bruce W. Oddy
February 2010
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ABSTRACT

This thesis involves two studies using a warned visual Go/NoGo task. The first study investigates the effect of the late contingent negative variation (CNV) on the following post-stimulus event related potentials (ERPs), the N2 and P3, and the following study examines the relationship between the N2, P3 and inhibition.

In an S1–S2 Go/NoGo task the impact of slow potentials following S1, particularly the late component of the CNV, on the following cognitive-processing waveforms to S2 (e.g., N2 and P3) remains unclear. A common method to correct for these confounding slow waves employs a baseline set shortly before S2. The impact of this on ERP measures relating to S2 is debatable. An earlier method of CNV correction, devised to remove its effect on P3 measures by using different baselines for each condition, appears questionable. The first study explored the removal of the CNV from both Go and NoGo waveforms to clarify the sensory and cognitive components elicited by S2. Fifty three undergraduate students participated in the study, with forty of these used as subjects in the final analysis. Principal Components Analysis (PCA) was performed on the ERP means, and a component relating to the CNV was subtracted from each subject’s raw data for each site and condition. Results showed that this effectively removed the CNV without distortion of the S2 ERP morphology. This technique may prove useful in the analysis of the N2 and P3 as indicators of processes involved in response inhibition.

The aim of the second study was to investigate the relationship between the NoGo N2 and the NoGo P3 ERP components with inhibition in social drinkers, using a visual Go/NoGo task. The forty participants from study 1 were divided into three groups on
the basis of their level of alcohol consumption. The two extreme groups, Light and Heavy, each with 13 subjects, were selected for the study. While impaired control over drinking was found in the Heavy group, there were no group differences in anxiety, depression, or locus of control. The Go N2 was slightly smaller centrally and in the midline for the Heavy compared to the Light group, while the Go P3 showed no group differences. The NoGo N2 was slightly smaller centrally, and the NoGo P3 was globally much smaller, in the Heavy group. Only the NoGo P3 reduction was correlated with alcohol consumption. That is, the NoGo P3 was the ERP component reflecting heavy social drinking.

However, this could not be considered as a marker of inhibition deficits, as the groups had similar performance levels in the task. Further consideration of the literature indicated that this is generally compatible with performance results in other studies that have attributed NoGo P3 differences to inhibition deficits, casting doubt on that interpretation. An alternative interpretation in terms of the orienting reflex (OR) is offered. This suggests that individuals with impairments in basic aspects of reflexive OR functioning may be prone to risk-taking behaviours, such as those associated with alcohol/drug abuse.
OVERVIEW

The initial aim of this thesis was to investigate the relationship between the N2 and P3 components and inhibition in a warned visual Go/NoGo task. However, a number of controversial aspects of the ERPs generated in a warned Go/NoGo paradigm required preliminary investigation. One of the main concerns was whether the resolution of the contingent negative variation (CNV), a late slow wave component that develops over the period between the warning stimulus (S1) and the imperative stimulus (S2), affects the measurement (amplitude and/or latency) of the post-S2 ERP components (e.g., N2 and P3). Hence Study 1 used Principal Components Analysis (PCA) in an attempt to remove the CNV waveform from the raw ERP waveform. This procedure endeavoured to extract the post-stimulus (cognitive processing) ERP components for measurement without the preceding slow wave interference that has been problematic in the Go/NoGo Task.

The components related to inhibition, as typically identified in the Go/NoGo task, were examined in Study 2. This research used the PCA-based methodology, developed in Study 1, to compare group differences in the extracted N2 and P3 ERP components between light and heavy social drinkers, as well as individual difference factors using a range of questionnaires. To framework these studies, Chapter 1 begins with fundamental electrophysiology information covering EEG and ERP determinants, followed by a general description of the N2 and P3 ERP components the Go/NoGo paradigm, and then the Go N2/P3 and NoGo N2/P3 components. A discussion follows on the S1-S2 process, negative slow waves and the controversies associated with the Go/NoGo task, assumed to be due to the effects of CNV resolution. This is followed by a discussion on the relationship of the N2 vs. P3 to an
inhibition process, and the issue of topography differences between the Go and NoGo P3. A detailed historical review of the Go/Nogo literature is then presented. This is followed by a section describing an unusual S1 and S2 baseline procedure, introduced by Simson et al. (1977) to control for supposed CNV disparity, and the later emergence of the more commonly used pre-S2 baseline method. This may cause undesirable effects on the measures of the following ERPs, which then leads into a discussion on how the problem may be resolved with PCA methodology.

Chapter 2 presents Study 1, which examined the problems that emerged from the research sketched in the historical literature review. This study used PCA methodology to explore the removal of the low frequency slow wave components from the raw ERP wave, allowing an investigation of the effects of CNV resolution on Go and NoGo P3 topographical differences. The study found that there were no observable CNV resolution differences, indicating no CNV contribution to the post-S2 N2 and P3 ERPs.

Chapter 3 foreshadows a practical application of this PCA extraction methodology, aimed to further the investigation of the assumed relationship of the N2 and/or P3 with inhibition factors. The study proposed to examine group differences between light and heavy social drinkers in a Go/NoGo task, where it was hypothesised that the heavy drinkers would have reduced inhibition skills. The literature review concentrates on studies into the association of the N2 and P3 with inhibition and thence how these relate to alcohol issues that have been typically associated with cognitive disabilities. The notion of “impaired control” over drinking is described, with its probable relationship with inhibition, and its importance in the possible
detection of vulnerability to alcohol addiction.

Chapter 4 provides a brief introduction to Study 2, followed by the results: participant details on drinking history, and behavioural and electrophysiological measures. Reaction time, errors of omission and commission, anxiety, depression and locus of control scales were not found to be significantly different between the groups. The impaired control scale revealed a significantly higher score for the heavy social drinking group compared to the light drinkers. Analysis indicated a greatly-reduced P3 component for the heavy drinking group, which might be taken to indicate the expected inhibition deficiency. However, consideration of the behavioural data argued against this interpretation, suggesting the need for further consideration.

Chapter 5 presents an overall general discussion, including the conclusions and assumptions of the studies involved in this thesis. The first study found that the N2 did not differ in its latency with condition, whereas the NoGo P3 was anteriorly different, with a larger amplitude and longer latency than the Go P3. This result supports the hypothesis of a different generator for each condition. The second study sought inhibition differences between light and heavy social drinkers. The investigation found a considerable reduction in the NoGo P3 amplitude for the Heavy drinkers, but there were no differences in performance evident between the groups, which does not support an inhibition interpretation. Subsequently, it was hypothesised that the differences may be better explained from an orienting reflex (OR) perspective. This proposition is discussed, and then followed by suggestions for future research that may add more clarity in the areas that these studies were unable to investigate.
ABBREVIATIONS

ANOVA: Analysis of Variance
BP: Bereitschaftspotentiale
CDP: Comprehensive Drinker Profile
CNV: Contingent Negative Variation
CPT: Continuous Performance Test
EEG: Electroencephalogram
EOG: Electrooculogram
EROs: Event Related Oscillations
ERP: Event Related Potential
ICS: Impaired Control Scale
ISI: Inter-stimulus interval
KR: Knowledge of Results
LOC: Locus of Control
LPC: Late Positive Complex
LRP: Lateralised Readiness Potential
ms: milliseconds
MRN: Movement-Related Negativity
MRP: Movement Related Potential
OR: Orienting Reflex
PCA: Principal Components Analysis
PMRPs: Preparatory Movement Related Potentials
RP: Readiness Potential
RT: Reaction time
SDM: Standard drinks monthly
S1: Stimulus 1
S2: Stimulus 2
SCR: Skin Conductance Response
SPN: Stimulus-Preceding Negativity
\( \mu V \): microVolt
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