Differential factors related to the cause and duration of attentional bias in the emotional Stroop task

Jessica Marrington

Bachelor of Arts, Graduate Diploma of Psychology, Postgraduate Diploma of Psychology

Submitted in fulfilment of the requirements for the research degree of

Doctor of Philosophy.

School of Psychology,

Australian Catholic University.

September, 2014.

Statement of Authorship and Sources

This thesis contains no material published elsewhere or extracted in whole or in part from a thesis by which I have qualified for or been awarded another degree or diploma. No parts of this thesis have been submitted towards the award in any other tertiary institution. No other person's work has been used without due acknowledgment in the main text of the thesis. The emotional Stroop task was developed using Eprime version 2.0 software, and programming of the task was conducted by an external programmer. All research procedures reported in the thesis received the approval of the relevant Ethics Committee.

Name: Jessica Marrington

Date: 01/09/2014

Signed:

To my parents, Peter and Michelle

Acknowledgements

Completion of this thesis would not have been possible without the encouragement and support of my supervisors, colleagues, family and friends.

I would like to sincerely thank my principal supervisor, Associate Professor Anne Tolan, co-supervisor, Dr Xochitl de la piedad Garcia, and my associate supervisor, Dr Kate Mulgrew, for all your guidance, support and invaluable feedback and assistance in completing this project. Anne, thank you for being a wonderful mentor and for always having faith in my abilities. Xochitl, I am extremely thankful for all the help you have given me, and in particular, I am tremendously grateful for your superior knowledge of excel formulas. Kate, for inspiring my love of cognitive psychology, and more specifically, the emotional Stroop task- I thank you (I think). I would also like to extend my gratitude to my examiners, thank you for your thoughtful comments and corrections.

Thank you to several staff and colleagues at ACU who have provided me with ongoing support throughout my project. In particular, I would like to thank Dr Eric Marx, Dr Helen Aucote and Professor Elizabeth Warren.

To my PhD comrades, I cannot express how fortunate I feel to have shared this journey with you. In particular I would like to express my deepest thanks to Evita March, Kate Witteveen, and Jaclynn Roche. Your support and friendship over the last few years has been invaluable. Evie, to you I owe a tremendous amount of thanks. To say I am indebted to you would be an understatement. To say you know far more about the emotional Stroop task than anyone would ever care to know, is entirely accurate.

To my wonderful family, words cannot express how truly grateful I am, and how privileged I feel to have had your unwavering support throughout not just this part of my life, but always. Mum and Dad, you have been a tremendous source of strength for me and also an inspiration. Without your support, finishing this PhD (let alone commencing it) would not have been possible. Who would have thought that when I started university 10 years ago, I would end up here (I suspect you may be regretting the car you gave me for my 17th birthday with the condition you would finance its maintenance until I finished university... well, I am pleased to say, you are finally off the hook!). To my brothers, Andrew and David, thank you both for always being there for me and remaining ongoing sources of encouragement and entertainment. Andrew, in particular I would like to express my sincerest thanks for programming the Stroop experiments, and also for your words of wisdom regarding the highs and lows of PhD candidature. I would also like to express my gratitude to my sister-in-laws, Kat and Lynda, for their continued love, support and friendship.

Finally, I would like to say thank you to my wonderful friends, in particular, Alana McDonald, my partner Anton Breinl, and Matthew Bond. Alana, I know it must have been difficult living with me at times (particularly due to the odd hours that I keep), but I cannot express how truly grateful I am to have your friendship and support. Finally, Anton, thank you for your continued support and encouragement throughout this journey.

Table of Contents

Statement of Authorship and Sources ii
Acknowledgements iv
List of Tables xiii
List of Figures xiv
Abstract xvi
Chapter 1. The Emotional Stroop Task: A Brief Overview 1
1.1 Introduction and Overview of Thesis 1
1.2 Overview of Chapter 3
1.3 The EST 3
1.3.1 Methodological Variations in the EST 6
1.4 The ESE and Anxiety 10
1.4.1 The ESE in Clinically Anxious Patients 11
1.4.2 The ESE in Non-Clinically Anxious Individuals 12
1.5 Summary of Chapter 13
Chapter 2. Emotion, Attention, and Models of Emotional Stroop Interference 15
2.1 Overview of Chapter 15
2.2 Emotion and Attention 15
2.2.1 Cognitive Accounts of Biased Attention in Anxiety 16
2.3 Modelling Interference in the Emotional Stroop Task 17
2.3.1 The Classic Stroop Effect 18
2.3.1.1 Modelling the classic Stroop effect 19
2.3.2 Theoretical Explanations of the ESE 21
2.4 Methodological Variations in the EST 26
2.4.1 Card Versus Computer Presentation 26
2.4.2 Selection of Stimuli 27
2.4.3 Modes of Responding 28
2.4.4 Testing of Participants 29
2.4.5 Time Between Stimulus Presentations 29
2.4.6 Duration of Stimulus Presentation 30
2.4.7 Reporting the ESE 32
2.4.8 Blocked Versus Random Presentation 32
2.5 Fast and Slow Components of the ESE 34
2.6 Summary of Chapter 34

Chapter 3. Slow effects within the EST 36
3.1 Chapter Overview 36
3.2 Evidence of Slow Effects in the EST....................36
3.3 ITI and the Slow Effect....................48
3.4 A Theoretical Account of Fast and Slow Effects in the EST 49
3.4.1 Wyble, Sharma, and Bowman’s (2008) Neural Network Model....................49
3.4.1.1 Basic architecture of the model 49
3.4.1.2 Modelling fast and slow interference 51
3.4.2 Fast and Slow Effects in State and Trait Anxiety 53
3.4.2.1 Modelling fast and slow components of attentional bias in state and trait anxiety 53
3.4.3 Methodological Issues to Consider when Investigating the Contribution of Fast and Slow Effects....................56
3.5 Summary of Chapter....................57
Chapter 4. Introduction to the Research Program 58
4.1 Overview of Chapter....................58
4.2 Revision of Major Theoretical and Methodological Issues 58
4.3 Overall Rationale for the Research Program 59
4.4 Overall Aims and Hypotheses 61
4.5 Brief Overview of the Experiments in the Research Program....................63
4.6 Summary of Chapter....................64
Chapter 5. Word Selection Study for the ESTs (Experiment 1)....................65
5.1 Introduction....................65
5.1.1 Overview of Chapter 65
5.1.2 Background to the study....................65
5.1.3 Lexical Characteristics of Words which Influence RTs....................67
5.1.3.1 Semantic relatedness....................67
5.1.3.2 Length and frequency 68
5.1.3.3 Valence and arousal....................69
5.1.4 Aims and Conditions for Word Selection 69
5.2 Method....................72
5.2.1 Participants....................72
5.2.2 Design....................72
5.2.3 Materials....................73

5.2.3.1 Demographic questionnaire 73
5.2.3.2 Word rating task 74
5.2.4 Procedure 75
5.3 Results 76
5.3.1 Descriptive Statistics 76
5.3.2 Preliminary Discussion of Word Selection 77
5.3.3 Inferential Statistics 78
5.3.3.1 Frequency 79
5.3.3.2 Valance 79
5.3.3.3 Arousal 81
5.4 Discussion 82
5.5 Summary of Chapter 86
Chapter 6. Fast and Slow Effects in the EST (Experiment 2) 87
6.1 Introduction 87
6.1.1 Overview of Chapter 87
6.1.2 Rationale 87
6.1.3 Aims and Hypotheses 89
6.2 Method 91
6.2.1 Participants 91
6.2.1.1 Anxiety group distribution 92
6.2.1.1.1 Women 93
6.2.1.1.2 Men. 93
6.2.2 Design 93
6.2.3 Materials 93
6.2.3.1 Demographic questionnaire 93
6.2.3.2 State Trait Anxiety Inventory 94
6.2.3.3 Emotional Stroop task 95
6.2.4 Procedure 96
6.3 Results 97
6.3.1 Data Screening 97
6.3.1.1 Questionnaire data 97
6.3.1.2 RT data 98
6.4 Discussion 108
6.4.1 Overview of Aims and Hypotheses 108

6.4.2 Fast Effects 114
6.4.3 Slow Effects 121
6.4.4 Biased Attention and Anxiety 124
6.4.5 Biased Attention and Word Type 126
6.4.6 Biased Attention and Time Pressure 127
6.4.7 Implications of Results 129
6.4.8 Strengths and Limitations 130
6.5 Summary of Chapter 131
Chapter 7. Fast and Slow Effects in the EST (Experiment 3) 133
7.1 Introduction 133
7.1.1 Chapter Overview 133
7.1.2 Rationale 133
7.1.3 Aims and Hypotheses 135
7.2 Method 136
7.2.1 Participants 136
7.2.1.1 Anxiety group allocation 136
7.2.2 Materials 137
7.3 Results 137
7.3.1 Data Screening 137
7.3.1.1 Questionnaire data 137
7.3.1.2 RT data 137
7.3.1.2.1 Low anxious 138
7.3.1.2.2 State anxious 138
7.3.1.2.3 Trait anxious 138
7.3.1.2.4 State-trait anxious 138
7.3.2 Descriptive Statistics 139
7.3.3 Inferential Statistics 142
7.4 Discussion 145
7.4.1 Overview of Aims and Hypotheses 145
7.4.2 Fast Effects 147
7.4.3 Slow Effects 150
7.4.4 Biased Attention and Anxiety 152
7.4.5 Biased Attention and Word Type 153
7.4.6 Biased Attention and Time Pressure 155

7.4.7 Implications of Results....156
7.4.8 Strengths and Limitations....157
7.5 Summary of Chapter....158
Chapter 8. Word Selection Study for Experiment 5 (Experiment 4)....160
8.1 Introduction....160
8.1.1 Overview of Chapter....160
8.1.2 Rationale....160
8.1.3 Aims and Conditions of Stimuli Selection....160
8.2 Method....161
8.2.1 Participants....161
8.2.2 Design....161
8.2.3 Materials....162
8.2.4 Procedure....162
8.3 Results....165
8.3.1 Descriptive Statistics....165
8.3.2 Inferential Statistics....165
8.3.2.1 Length....165
8.3.2.2 Frequency....165
8.3.2.3 Valence....166
8.3.2.4 Arousal....166
8.4 Discussion....166
8.5 Overview of Chapter....168
Chapter 9. Fast and Slow Effects in a Contingency Free Environment (Experiment 5)....170
9.1 Introduction....170
9.1.1 Chapter Overview....170
9.1.2 Rationale....170
9.1.3 Aims and Hypotheses....174
9.2 Method....175
9.2.1 Participants....175
9.2.1.1 Anxiety group allocation....175
9.2.2 Design....176
9.2.3 Materials....176
9.2.3.1 Emotional Stroop task....176
9.2.4 Procedure....177

9.3 Results 177
9.3.1 Data Screening 177
9.3.1.1 Questionnaire data 177
9.3.1.2 RT data 177
9.3.1.2.1 Low anxious 178
9.3.1.2.2 Anxious 178
9.3.2 Descriptive Statistics 178
9.3.3 Inferential Statistics 180
9.4 Discussion 185
9.4.1 Overview of Aims and Hypotheses 185
9.4.2 Fast Effects 187
9.4.3 Slow Effects 191
9.4.4 Biased Attention and Time Pressure 198
9.4.5 Implications of Results 199
9.4.6 Strengths and Limitations 202
9.5 Summary of Chapter 203
Chapter 10 Critical Integration of Fast and Slow Effects 204
10.1 Overview of Chapter 204
10.2 Fast Effects 204
10.2.1 Fast Effects in Experiments 2, 3, and 5 205
10.2.2 Stimuli Utilised in the ESTs 206
10.2.3 Anxiety Levels of Participants 207
10.2.4 Fast Versus Slow Components of the ESE 209
10.2.5 Contingency Effects 210
10.3 Slow Effects 211
10.3.1 Slow Effects in Experiments 2, 3, and 5 213
10.3.2 Theoretical Explanations for the Results 222
10.3.3 Anxiety Levels in Experiments 2, 3 and 5 227
10.4 ITI Manipulation and Biased Attention 228
10.5 Chapter Summary 229
Chapter 11. Concluding Remarks 231
11.1 Overview of Chapter 231
11.2 Summary of the Research Program and Key Findings 231
11.3 Limitations, Strengths and Future Directions 234

11.4 Contributions of this Research Program to the Literature 237
References 239
Appendix A: Human Research Ethics Approval Form 256
Appendix B: Information Letter and Consent Instructions used in Experiments 1 and 3 Word Rating Survey 258
Appendix C: Demographic Questionnaire used in Experiments 1 and 3 260
Appendix D: List of Words Used in Experiment 1 261
Appendix E: Information Letter and Consent Form for Experiment 2, 3, and 5............... 271
Appendix F: Demographic Questionnaire utilised in Experiments 2, 3 and 5 275
Appendix G: Normality Investigation for Experiment 2.. 276
Appendix H: Anxiety Analyses between Participants in Experiments 2, 3, and 5............ 278
Appendix I: Anxiety Analyses between Anxiety groups within Experiments 2, 3, and 5……………………………………………………………………………………..279

List of Tables

Table 5.1: Words Used at Positions 1-5 in Experiment 4 of McKenna and Sharma's (2004) Study....67

Table 5.2: Final Words Selected for the EST in Experiments 2 and 3....83

Table 6.1: Proportion of Error Rates for Each Anxiety Group at the 32 ms, 1000 ms , and 2000 ms Blocks....103

Table 7.1: Proportion of Error Rates for each Anxiety Group at the 32 ms, 1000 ms , and 2000 ms Blocks....143

Table 7.2: Results of the Mixed Factorial ANOVA for Experiment 2....144

Table 8.1: Positive and Negative Words Utilised in the Word Selection Study Including Frequency, Length, Valence, and Arousal Ratings....163

Table 8.2: Neutral Words Utilised in the Word Selection Study Including Frequency, Length, Valence, and Arousal Ratings....164

Table 8.3: Final Words Selected for the EST in Experiment 4....167

Table 9.1: Means and SDs in Trial N+1 as a Function of Valence in Trial N for the Low Anxious and Anxious Groups at the 32 ms, 1000 ms , and 2000 ms Blocks....179

Table 9.2: Results of the 3 x 3 x 3 x 2 Mixed Factorial ANOVA for Experiment 5....181

Table 9.3: Post-hoc Univariate Tests Comparing the RTs of Positive, Negative, and Neutral Words at Trial N+1 that Followed Neutral Words at Trial N, at each ITI....182

Table 9.4: Post-hoc Univariate Tests Comparing the RTs of Neutral Words at Trial N+1 that Followed Positive, Negative, and Neutral Words at Trial N, at each ITI....182

Table 9.5: Post-hoc Univariate Tests Comparing the RTs of Positive, Negative, and Neutral Words at Trial N+1 that Followed Neutral Words at Trial N, for each Anxiety Group....184

List of Figures

Figure 2.1: Cohen et al.'s (1990, p. 336) parallel distributed processing model...19

Figure 3.1: Results from McKenna and Sharma's (2004, p. 389) Experiment 4...43

Figure 3.2: Wyble et al's. (2008, p. 1024) neural network model of emotional Stroop and Stroop interference..50

Figure 3.3: The addition of state and trait anxiety in Wyble et al's. (2008, p. 1039) neural network model of emotional Stroop and Stroop interference..54

Figure 6.1: Average RT (with Standard Error) for the low anxious group at each position, for each ITI block, for positive emotion, negative emotion, and pure neutral sequences..100

Figure 6.2: Average RT (with Standard Error) for the state anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences..100

Figure 6.3: Average RT (with Standard Error) for the trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences..101

Figure 6.4: Average RT (with Standard Error) for the state-trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences...101

Figure 6.5: Average RT (with Standard Error) to words in Positions 1 through 5 for the positive emotion, negative emotion, and pure neutral sequences..105

Figure 6.6: Average RT (with Standard Error) to words in Positions 1 through 5 for the positive emotion, negative emotion, and pure neutral sequences at the 32 ms, 1000 ms, and 2000 more slowly blocks...106

Figure 7.1: Average RT (with Standard Error) at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences. Each plot presents data for one anxiety group..................................140

Figure 7.2: Average RT (and Standard Error) for the trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences...140

Figure 7.3: Average RT (and Standard Error) for the trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences...141

Figure 7.4: Average RT (and Standard Error) for the trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences...141

Figure 7.5: Average RT (with Standard Error) for low anxious, state anxious, trait anxious and state-trait anxious individuals at Positions 1 to 5...145

Abstract

The emotional Stroop task (EST) is a widely used method in demonstrating how emotional material disrupts performance on a simple task through the biasing of attention. The finding that participants take longer to identify the colour of emotional material relative to neutral material is known as the emotional Stroop effect (ESE). The ESE was thought to be relatively fast, occurring on a single trial. However, recent research has suggested that emotional, primarily negative, material may disrupt colour-naming ability beyond the time of its presentation, disrupting performance in subsequent trials. That is, the ESE may be comprised of both fast and slow components. Currently there is no consensus as to the duration of the slow disruption or the mechanisms underlying this form of biased attention. Recently, Wyble, Sharma, and Bowman (2008) developed a computational model accounting for the occurrence of both fast and slow components of biased attention within the EST. The model makes specific predictions regarding the relationship between anxiety and the occurrence of fast and slow effects within the task; however these predictions have not been tested. The purpose of the research was to test these predictions in individuals with varying levels of anxiety. In total, five experiments were conducted; two to select stimuli for use in the ESTs (Experiments 1 and 3; *n* = 250) and three ESTs (Experiments 2, 3, and 5; *n* = 317) whereby fast and slow effects were examined in individuals who were low anxious, state anxious, trait anxious, and state-trait anxious.

Duration of slow effects was examined by manipulating the length of the inter-trial intervals (ITIs) between words in the EST, in addition to tracking reaction times (RTs) over a series of five positions. Furthermore, positive emotion and negative emotion words with comparable arousal ratings were utilised in conjunction with neutral words to determine whether arousal, in addition to valence, played a role in biasing attention. Results showed mixed support for the hypotheses.

The first emotional Stroop experiment (Experiment 2) found no evidence of fast effects. Slow effects were noted at the 32 ms block, albeit in a position later than expected. Slow effects emerged for all individuals on Position 4 between neutral words in the positive emotion sequence versus neutral words in the negative emotion sequence. There were also unexpected patterns of responding to pure sequences of neutral words. Due to the unexpected results, a decision was made to run an additional emotional Stroop experiment (Experiment 3) utilising different neutral stimuli. This experiment found no evidence of fast or slow effects occurring. Based on the inconsistencies in results between Experiment 2 and 3, Experiment 5 was conducted utilising a contingency-free methodology that allowed for the independent assessment of fast and slow effects. Results from Experiment 5 did not find evidence of a fast effect, however, in the anxious group, participants responded to neutral words that were presented after positive emotion words significantly faster than neutral words presented after negative emotion words. Collectively, the results did not find support for a fast component of attentional bias, which was contrary to predictions. Additionally, mixed support emerged for the presence of slow effects. While disruptions in colour-identification were noted on neutral words that followed emotion words, these were generally not in the position expected and did not always implicate the expected word type. The findings of the current study do not support the predictions of the Wyble et al. (2008) model. Implications of the current findings in addition to future directions are discussed.

Chapter 1. The Emotional Stroop Task: A Brief Overview

1.1 Introduction and Overview of Thesis

The purpose of the research in this thesis was to investigate the causes and duration of attentional bias in the emotional Stroop task (EST) for individuals who were low anxious and anxious. Specifically, the primary aim of this thesis was to explore the contribution of fast (i.e., biased attention occurring on immediate trials) and slow (i.e., biased attention sustained over trials) components of attentional bias within the task. The thesis is organised into three main sections. First, a theoretical section is presented, second, an empirical section comprised of the results of two word selection studies and three emotional Stroop experiments, and last, a concluding summary of the research is discussed.

The theoretical component of this thesis spans Chapters 1 to 3. The current chapter presents a brief introduction to the thesis itself, in addition to a general overview of the EST and the use of this task within anxiety related populations. Chapter 2 explores the relationship between attention and emotion, highlighting some of the most influential models of biased attention in general, and more specifically, biased attention within the EST. Additionally, an in-depth examination into the methodological issues to consider when using the EST are presented. Chapter 3 covers a more recent body of literature that has investigated the nature of attentional bias within the task. Specifically, several studies that have used refined methodologies have found a slower form of attentional bias, which for various reasons were largely neglected in previous research. Furthermore, models and theories of EST interference are outlined, including a more contemporary model that proposes an explanation for fast and slow components of biased attention within the task.

Chapter 4 presents a brief overview of the research program. A summary of the major theoretical and methodological issues identified in Chapters 1 to 3 are outlined, followed by the overall rationale, aims, and hypotheses of the research program. Brief descriptions of the experiments that follow in Chapters 5 to 9 are also given.

Chapters 5 to 9 comprise the empirical component of the thesis. Chapter 5 presents Experiment 1, a word selection study that was conducted in order to select stimuli to be used in the subsequent emotional Stroop experiments. Literature regarding the importance of matching for certain lexical characteristics is outlined, followed by the experiment proper and the final list of words selected for Experiments 2 and 3. Chapter 6 presents Experiment 2 which investigated the role of fast and slow components of attentional bias within the EST for individuals who were low anxious, state anxious, trait anxious and state-trait anxious. Chapter 7 outlines a second EST study (Experiment 3), again aimed at investigating the forms of attentional bias within the EST for the aforementioned population, however, utilising different target neutral stimuli. Chapter 8 presents Experiment 4, a second word selection study that normed stimuli for use in the last Experiment (Experiment 5). Chapter 9 is the final empirical chapter of the thesis. Experiment 5 is presented, which utilised a contingency-free methodology in order to investigate fast and slow components of attentional bias independently of one another (which was not possible in the former emotional Stroop experiments presented in Chapters 6 and 7). Additionally, Experiment 5 investigated these forms of biases in individuals who were low anxious compared with individuals who were anxious (without differentiating between those who were state and trait anxious).

The final chapters (Chapter 10 and 11) of this thesis comprise the summary component. While each of the empirical chapters presents possible explanations for the results of each experiment, Chapter 10 critically integrates the findings from each of the studies. Chapter 11 presents the concluding remarks of the thesis, in addition to the strengths, limitations, contributions of the research program and suggestions for future directions.

1.2 Overview of Chapter

The current chapter presents a brief overview of the EST. Specifically, information is outlined regarding some of the key differences in terms of the variations in the task's presentation. Literature is also discussed regarding the use of the task in samples of both clinically anxious patients and individuals with elevated levels of anxiety.

1.3 The EST

The EST is an adaptation of the classic Stroop task (CST; Stroop, 1935) that gained popularity in the late 1970s as a result of increased interest into cognitive accounts of emotion (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Koster, Fox, & MacLeod, 2009; Williams, Mathews, & McLeod, 1996). There are generally two broad methods of investigating biased attention experimentally: the first concerns how performance may be facilitated by the presence of emotional information, and the second demonstrates how the presence of such information may be detrimental to task performance (Williams et al., 1996). An example of the former would be a dichotic listening task whereby performance is facilitated as emotionally disturbed participants are able to detect concern-related stimuli at lower-auditory thresholds than those who are not (e.g., Foa & McNally, 1986). The EST, however, belongs to the second class of methods, demonstrating how performance on a simple task is compromised as a result of biased attention on emotional stimuli (e.g., Amir et al., 1996; Bertels, Kolinsky, Pietrons, & Morais, 2011; Edwards, Burt, & Lipp, 2009).

The EST requires participants to name (or identity) the ink-colour of both emotional (e.g., the word *death* displayed in blue ink) and neutral (e.g., the word *chair* presented in blue ink) words as quickly and accurately as possible, whilst ignoring the content of the words. The difference between the time taken to colour-name the emotional category of words, relative to the neutral category of words, is known as the emotional Stroop effect (ESE). It should be noted that term colour-name generally refers to ESTs where a vocal response has been executed and the term colour-identification refers to ESTs whereby manual (or button-press) responses have been generated. Throughout this thesis the term colour-name is used when discussing theories and models of Stroop and emotional Stroop interference. In other areas of this thesis, the term colour-name is used when discussing studies that utilised a verbal response modality and the term colour-identification is used when discussing studies that employed manual responding. Additionally, while the ESE is also referred to as interference (Larsen, Mercer, & Balota, 2006), it should be noted that this is not necessarily synonymous with "interference indices", which are a specific measure of the ESE.

It has been suggested (e.g., Algom, Chajut, & Lev, 2004) that the term ESE is somewhat misleading, as this term does not reflect the conflicting processes between congruent and incongruent stimuli at the core of the classic Stroop effect (i.e., between the ink-colour of the word and the word itself). Although research has proposed that the term "emotional intrusion effect" is perhaps a more appropriate label for the discrepancy between the time taken to colour-name neutral words relative to emotional words (McKenna & Sharma, 2004, p. 382), generally it is accepted that the term ESE is now well established and thus used in the remainder of the thesis.

The ESE is thought to be an automatic, or preattentive, process whereby attention is allocated to the irrelevant task of word reading, even though the task requires participants to name the colour of the ink in which the words are printed (Williams et al., 1996). The fact that participants continue to generate colour-naming responses indicates that there is some level of control utilised (Bugg, Jacoby, & Toth, 2008). However, the attention allocated to reading the word leads to delayed colour-naming and this delay is affected by the type of stimuli employed in the task (Dalgleish, 2005). This is thought to be due to the ability of certain stimuli to automatically capture attention (Frings, Englert, Wentura, & Bermeitinger, 2009; Williams et al., 1996), with stimuli that more readily capture attention leading to larger colour-naming delays than stimuli that can be more readily ignored. As a result, RTs are slowed on emotional (usually negative or personally relevant) words, in comparison with neutral words.

The ESE has been most reliably found in individuals with clinical levels of particular psychopathologies when disorder relevant words are used (e.g., Johansson, Ghaderi, & Anderson, 2005; Phaf & Kan, 2007; Williams et al., 1996). For example, a patient who has been diagnosed with Bulimia Nervosa may take longer to colour-name the disorder relevant word *binge* than the disorder irrelevant word *cloud*. Additionally, patients with Obsessive-Compulsive Disorder (OCD) have been shown to take longer to colour-name words representing their fear of contamination (e.g., *germs*; Foa, Ilai, McCarthy, Shoyer, & Murdoch, 1993) in comparison with neutral words (e.g., *peach*; Foa et al., 1993). However, the effect has also been detected in various non-clinical samples with the use of personally relevant stimuli (e.g., Wingenfeld et al., 2006), taboo words (e.g., *whore*; MacKay et al., 2004), and general negative emotion words (e.g., *violence*; Frings et al., 2010; Gootjes, Coppens, Zwaan, Franken, & Van Strien, 2011). In addition, the ESE has been documented using smoking related words with smokers attempting to quit (e.g., *tobacco*; Wertz & Sayette, 2001), and also anxiety words with individuals who have elevated, albeit non-clinical, levels of anxiety (e.g., *failure*; Egloff & Hock, 2001). It should be noted that the EST is sometimes referred to as a modified Stroop task when it is utilised in non-clinical populations, such as smokers attempting to quit. The term modified may be preferred over emotional, as the use of emotional words may not necessarily be used but rather population relevant words (e.g., smoking related words), however, for the purpose of this thesis, the term EST was utilised to refer to all these types of research.

1.3.1 Methodological Variations in the EST

In terms of the task's methodology, there are several aspects of the task that can vary in relation to the mode of presentation (e.g., card or computer), the format of trial presentation (e.g., blocked versus random), the type of stimuli employed (e.g., general negative emotion, disorder relevant, etc), the samples that are used (e.g., clinical versus non-clinical), the method of responding (e.g., vocal versus button-press), the time between stimulus presentations (e.g., short, long), and the length of stimulus presentations (e.g., sub-optimal versus optimal). In addition, differences also exist in terms of how the ESE is reported (e.g., interference indices or raw RTs) and how participants are tested (e.g., individually versus in groups). These differences are discussed briefly below, with a more comprehensive overview of these issues presented in Chapter 2.

The EST can be presented by use of card or on a computer. In the card format, words are typically presented in groups of semantically associated words with participants required to vocally respond to the colour of each word in the list (e.g., Kindt, Bierman, & Brosschit, 1996). The time taken to colour-name the words in each list is measured by the experimenter using a stopwatch or voice recorder (e.g., Fox, 1993). In a computer version of the task, words are typically presented one at a time (although they can also be presented in sets e.g., Kindt et al., 1996). Colour-identification and naming responses are recorded for each word using either button-press (e.g., Dresler, Mériau, Heekeren, & van deer Meer, 2009) or vocal responses (e.g., Reinholdt-Dunne, Mogg, & Bradley, 2009), and RTs are measured by the computer.

Presentation of the EST can also vary in terms of whether the sets of word stimuli are presented in a blocked or randomised format. A blocked format involves the presentation of all emotional words in one set and all neutral words in a separate set, and can be done via a card or computer presentation (Phaf & Kan, 2007). In a card presentation all emotion words are presented on one card and all neutral words are presented on a second card. In a computer format, words are either presented all at once on the screen (e.g., Kindt et al., 1996) or individually in semantic sets (e.g., Dresler et al., 2009). That is, all emotion words are presented in a sequence, followed by all neutral words, with a short break separating the blocks. For both the card and computerised blocked-format versions of the EST, the ESE is calculated by deducting the time taken to colour-name all words in the neutral block from the time taken to colour-name the words in the emotional block (Waters, Sayette, & Wertz , 2003).

In a random presentation, words are not presented in semantic sets. The presentation of emotional and neutral words occurs in a single block, but in a random order (e.g., Frings et al., 2010). Average colour-naming times are obtained for each category of words (e.g., negative emotion and neutral) and interference can be calculated in the manner described above (i.e., by deducting the average time taken to colour-name all neutral words from all emotional words). More recently, researchers have developed pseudorandom presentation formats (e.g., McKenna & Sharma, 2004). These presentation formats allow for the investigation of RTs over specific sequences of words. For example, rather than assessing how individuals respond to neutral in comparison with negative stimuli overall, a pseudorandom order allows for potential cumulative or carryover effects of the ESE to be investigated over a series of trials. Specifically, this format of presentation allows for the assessment of whether emotional material disrupts colour-naming ability beyond that of its presentation. This will be explored in greater detail in Chapter 2 and Chapter 3.

In addition to the variations in presentation styles of the task, differences also exist between modes of responding. For example, responses to the colour of ink a word is presented in can be given verbally (e.g., Russo et al., 2006) or by button-press (e.g., McKenna & Sharma, 2004).

Another dimension in which ESTs can vary relates to type of target stimuli selected (generally in all tasks, neutral categories are included for control purposes). The choice of target stimuli is generally related to the population of interest. For example, the EST has been utilised in samples of depressed individuals using depression related words (e.g., *lonely*; Lim & Kim, 2005), anxious patients using disorder relevant words (e.g., *crazy*; Becker, Rinck, Margraf, & Roth, 2001), marijuana smokers using marijuana related words (e.g., *spliff*; Cane, Sharma, & Albery, 2008) and in normal individuals using general negative emotion words (e.g., *attack*; Frings et al., 2010; McKenna & Sharma, 2004). Furthermore, studies also vary in terms of how words are matched between target and neutral categories (once again, this is described in greater detail in Chapter 2 and Chapter 5).

Presentation of the EST can also vary in terms of the amount of time between stimulus presentations. There are considerable differences reported within the literature as to the length of both the inter-stimulus interval (ISI; i.e., the amount of time that lapses between each word) and the inter-trial interval (ITI; i.e., the amount of time that lapses between each trial; Sharma & McKenna, 2001). Generally, all studies report either an ISI or an ITI, with ranges between 0ms and 2200ms. However, due to refresh rates of computer monitors, ISIs or ITIs cannot truly be 0 ms, but rather the smallest reported start around 30ms.

In addition to the duration of time that lapses between stimulus presentations, differences also exist between how long the words themselves are presented for. In sub-optimal (or subliminal) presentations of the task, words are typically presented for very brief periods of time (Phaf & Kan, 2007) and then replaced by a series of Xs to which the participant then colour-names (e.g., Witthöft, Rist, & Bailer, 2007). Optimal formats (or supraliminal) involves the presentation of stimuli for longer periods of time, usually until the participant responds (in some cases, however, the stimulus may time out after a lengthy presentation period e.g., 3000ms; Franken, Kroon, Wiers, & Jansen, 2000).

Another key area where studies differ in regards to the EST relates to the reporting of the ESE. ESEs can be reported as either interference indices (e.g., Egloff & Hock; 2001) or raw RTs (e.g., McKenna & Sharma, 2004). Interference indices are calculated by deducting the time taken to colour-name the emotional set of words from the neutral set of words. For example, an interference index of +30 would indicate that participants responded on average 30 ms slower to emotional words in comparison with neutral words. Alternatively, an interference index of -30 would indicate that on average, participants responded 30 ms faster to emotional words in comparison with neutral words. As the name implies, raw RTs are the times taken to colour-name each category of words used within the task.

When conducting the EST, participants can be tested either in groups or individually. However, many studies do not report this. Despite this, both fast and slow components of attentional bias have been reported in studies that have tested participants individually (e.g., Wilson & Wallis, 2013) and in small groups (e.g., Frings et al., 2010). Each of the factors presented above will be discussed in greater detail in Chapter 2.

Findings from the EST generally indicate that participants take longer to colour-name emotionally salient material than neutral material (e.g., Klein, 2007; MacLeod & Rutherford, 1991; Russo et al., 2006). Although the literature continues to debate exactly what aspects of the emotional material have the ability to capture attention (i.e., valence, arousal, or threat), it is largely assumed that this effect is relatively automatic and occurs on a single trial (Frings et al., 2010; McKenna & Sharma, 2004; Phaf & Kan, 2007). However, with the refinement of methodologies employed when utilising the EST, research has found that emotional words have the ability to disrupt colour-naming performance beyond that of their presentation (e.g., Ashley & Swick, 2009; Frings et al., 2010, McKenna & Sharma, 2004). This finding is referred to as a carry-over or a slow effect, and the primary focus of the research in this thesis. Essentially, the discovery of the slow effect has resulted in the ESE being redefined. That is, the ESE is not a single entity; rather it is comprised of both a fast and a slow component. Literature exploring the ESE is presented in subsequent chapters, with a literature review of studies examining these components of attentional bias presented in Chapter 3. The section below explores findings in relation to the "traditional" ESE.

1.4 The ESE and Anxiety

The primary focus of the research in this thesis was to explore the role of fast and slow effects within the EST. However, anxiety level was also incorporated as a key variable in the investigation. This variable was included because anxiety level has been implicated as an important individual difference factor that plays a role in biased attention in general and more specifically, the ESE. Additionally, slow effects have not been explored previously within this population (i.e., anxious participants), and given the vast amount of research utilising anxious populations when investigating the ESE, such research would significantly add to the existing literature. The rationale behind the choice of this variable is explained in greater detail in Chapters 2 and 3.

While the ESE has been extensively investigated in many different forms of psychopathology, it has perhaps been most comprehensively investigated in both depressive and anxious populations (Williams et al., 1996). For the scope of this dissertation, specific interest revolves around the use of the EST in anxiety related populations.

There are generally two approaches to the analysis of ESE. The first is centred on analysing differences in responding to the same stimuli between individuals who are anxious and those who are not (between-subjects effects). For example, individuals who have received a diagnosis of generalised anxiety disorder (GAD) have been shown to respond more slowly to anxiety related words pre-treatment than a group of non-anxious controls (Mathews, Mogg, Kentish, & Eysenck, 1995). The second approach focuses on differences between kinds of stimuli (within-subjects effects) in groups of individuals who are anxious. For example, research has found that individuals with a spider phobia are slower to colour-name spider relevant words (e.g., *hairy*) versus neutral words (e.g., *potato*; Lavy, Hout, & Arntz, 1993). The literature presented below has documented both within and between differences in regards to the ESE in anxious individuals.

1.4.1 The ESE in Clinically Anxious Patients

The ESE has been well documented in anxiety related disorders including GAD (e.g., Becker et al., 2001), panic disorder (e.g., McNally et al., 1994), post-traumatic stress disorder (PTSD; e.g., Foa, Feske, Murdock, Kozak, & McCarthy, 1992), and specific phobias (e.g., spider and social phobias; Becker, Rinck, Margraf, & Roth, 2001). Although these studies have used varying methodologies (as presented above in Section 1.3), the ESE has generally been robustly reported within these populations when using disorder-relevant words (for an extensive review see Williams et al., 1996, and Phaf & Kan, 2007).

However, several studies have failed to detect the presence of the ESE to emotionally relevant information. For example, Kampman, Keijsers, Verbraak, Naring, and Hoogduin (2002) found that there was no difference in ESEs between patients with panic disorder, obsessive-compulsive disorder (OCD) and normal controls. In addition, Moritz et al. (2008) found that patients diagnosed with OCD did not show colour-naming latencies on disorder relevant words.

Evidence from a recent meta-analysis (Phaf & Kan, 2007) showed that the ESE was particularly robust in clinically anxious patients, specifically in optimal conditions when a blocked format had been employed. These finding are particularly interesting as it demonstrates that biased attention within the EST is not necessarily sample dependent, but rather, the format of the task itself plays an important role. Phaf and Kan (2007) further reported that individuals with elevated levels of anxiety also exhibited an ESE under the same presentation conditions (i.e., optimal blocked formats). However, a smaller effect size was found for the non-clinical anxious individuals relative to the anxious patients.

1.4.2 The ESE in Non-Clinically Anxious Individuals

While the ESE has been most reliably detected in individuals with clinical levels of anxiety, it has also been documented in non-clinical individuals with elevated levels of anxiety. Russo et al. (2006) found that in a blocked presentation format of the task, individuals who were highly trait anxious responded more slowly to threat-related information (e.g., *mutilate*) in comparison with neutral information (e.g., *lobster*). In addition, the anxious individuals also responded more slowly than the non-anxious individuals to threat related information. That is, not only were differences in RTs observed between individuals who were anxious versus non-anxious, but also between the types of words (i.e., neutral versus negative emotional) for individuals in the high anxious group only.

Rutherford, MacLeod, and Campbell (2004) found that emotional Stroop interference was present in individuals who were anxious for both target positive and negative words. Interestingly, state anxiety further biased individuals toward emotional information, particularly negative information. Egloff and Hock (2001) also reported ESEs on negative information for individuals who were anxious, corroborating the research of Rutherford and colleagues that emotional Stroop inference was affected by both levels of state and trait anxiety. Egloff and Hock found that interference increased in participants with high levels of state and trait anxiety, relative to individuals who were solely state anxious. The authors also reported interference effects for trait anxious individuals, although to a lesser extent than with the high state-trait anxious individuals. In addition, MacLeod and Rutherford (1992) reported differences in emotional Stroop interference based on interactive effects of state and trait anxiety. Generally, results showed that participants who were highly trait anxious showed elevations in emotional Stroop inference as state anxiety increased.

Dresler et al. (2009) found that emotional interference in the EST was greater in participants who were state anxious. Additionally, the authors reported that as state anxiety increased, emotional Stroop interference increased for emotional information in general (i.e., both positive and negative words). Of particular interest was that trait anxiety was not implicated in the slow-down of colour-naming emotionally laden words.

These studies provide evidence for ESEs in non-clinical populations of anxious individuals. Moreover, the studies that have examined biased attention within the EST utilising samples of state and trait anxious individuals (e.g., Egloff & Hock, 2001; MacLeod & Rutherford, 1992; Rutherford et al., 2004) have generally found that differential patterns of processing occur based on the individual's level and type of anxiety.

1.5 Summary of Chapter

This chapter presented a general overview of the structure of the thesis. In addition, information was presented regarding the methodology of the EST including several of the differences that exist within the task's methodology. Finally, this chapter presented a brief literature review of the ESE in clinically anxious patients and individuals with elevated levels of anxiety, as this is directly relevant to the questions addressed in this thesis.

Chapter 2. Emotion, Attention, and Models of Emotional Stroop Interference

2.1 Overview of Chapter

The current chapter explores the relationship between attention and emotion. More specifically, cognitive models of emotional disturbance are discussed. Furthermore, models of classic Stroop and emotional Stroop interference are presented, which propose possible causes of the ESE. The chapter concludes with an examination of some of the inconsistent findings in relation to the ESE, and methodological reasons as to why these inconsistent results may have occurred.

2.2 Emotion and Attention

The relationship between emotion and attention is an important one. While these constructs have often been treated as largely independent (Storbeck & Clore, 2007; Yiend, 2010), cognitive accounts of psychopathology highlight the importance of examining these processes together (Beck, 1991). For example, several cognitive accounts of emotional disorders have implicated biases in attention as a possible causal factor in the maintenance of different psychological problems (e.g., Beck & Clark, 1988; Lee & Shafran, 2004; Li, Paller, & Zinbarg, 2008; Matthews & Harley, 1996; Williams, Watts, MacLeod, & Mathews, 1997; Yiend, 2010). While the nature of these disorders varies in many ways, it is thought that they share a common feature of heightened sensitivity to, and preoccupation with, stimuli within one's environment that reflect disorder-specific concerns (Williams et al., 1997). As a result, cognitive models of emotional disorders (e.g., Beck & Clark, 1988; Williams et al., 1997) assume that attentional bias is not simply a by-product of the pathology. Rather, attentional bias is assumed to play a central role in both the causation and maintenance of these disorders, due to the circular nature of the relationship (Mogg et al., 2000; Williams et al., 1997). According to such models, as emotional disturbance increases, disorder-specific material in the environment becomes more salient. This increased salience further biases the perception of danger, increasing the emotional disturbance (Williams et al., 1997).

2.2.1 Cognitive Accounts of Biased Attention in Anxiety

It is important for individuals to be able to rapidly detect threatening information within their environment, as this is a necessary function that facilitates survival (Flykt, 2005; Mathews & MacLeod, 2002; McKenna & Sharma, 2004). There are, however, instances where this function may become problematic. For example, individuals who are anxious have been shown to demonstrate a preoccupation with fear evoking or threatening information (Anderson, 2005; Beck & Clark, 1988; Taake, Jaspers-Fayer, & Liotti, 2009). This preoccupation then biases these individuals towards processing negative information within their environment, which may be largely irrelevant. As a result, the individuals' levels of anxiety are perpetuated (Williams et al., 1997). There have been several prominent theories that provide insight into biased processing of information in anxious individuals.

Perhaps one of the most influential models of emotional disturbance is that of Beck (1976; 1997; Beck and Clark, 1988). Beck proposed that individuals develop schemas that guide the way they interpret the world. Schemas are formed throughout childhood, and existing schemas are adapted into adulthood. Schemas are relatively stable structures that represent experience and knowledge (Beck & Clark, 1988). These structures then guide the way individuals interpret and organise information, however, problems may arise when individuals form maladaptive schemas or "danger schemata", such as in the case of an anxious patient. As a result, these individuals would be interpreting newly encountered information based on their maladaptive schemas. Once maladaptive schemas are activated, the information processing system becomes biased towards attending to and processing material that is consistent with the schema. Thus for an anxious patient, anxiety and threat related material will automatically receive preferential processing (Beck & Clark, 1988). Individuals with developed danger schemata will inadvertently direct their attention toward threat provoking material within their environment (regardless of its relevance). This is problematic because in doing so, maladaptive schemas are reinforced and the system is thereby further biased towards the processing of maladaptive information. This is turn leads to an increase (or the maintenance) of anxiety levels.

Another influential model of cognitive biases was proposed by Bower (1981; 1987). Bower’s model is based on the “spreading activation” between nodes within an associate memory network. Essentially, nodes represent specific emotional states, and emotion nodes become activated when an individual experiences a particular emotional state. Activation then spreads throughout the associate connections, thereby partially activating or priming nodes containing mood congruent information. As a result, when an individual feels a particular emotion, mood congruent information is preferentially processed. As in Beck’s (1976) model, this process is not consciously mediated, but happens automatically.

Beck (1976) and Bower (1981, 1987) explained that biased attention plays a key role in the formation and maintenance of different psychopathologies. These models highlight how emotional disturbance or mood can affect the way an individual attends to and processes information within their environment. A way in which attention and such cognitive biases have been studied experimentally is through the use of the EST. As a result, there have been several models developed designed to specifically account for biased attention within the task.

2.3 Modelling Interference in the Emotional Stroop Task

There have been several models proposed to account for the ESE. In particular, the connectionist model developed by Williams et al. (1996) has been highly influential. The model of Williams and colleagues is based on the innate parallel distributed processing model which Cohen, Dunbar, and McClelland (1990) developed to account for classic Stroop effects. The model developed by Cohen et al. is presented below in section 2.3.1.1. While the current research program was not interested in classic Stroop effects *per se*, an explanation of this model forms the basis for the explanation of subsequent models that were developed to account for ESE.

2.3.1 The Classic Stroop Effect

The classic Stroop task (CST; Stroop, 1935) offers a paradigm for the investigation of attentional processes. In the task, individuals are presented with words or letter strings in different colours and respond as quickly but as accurately as they can to the colour of ink the words (or letter strings) are presented in. The task is comprised of both congruent, incongruent, and control conditions. For example, in the congruent condition, participants are presented with the word *red* in red ink. In the incongruent condition, participants are presented with the word *green* in red ink. In the control condition, participants are presented with letter strings (e.g., *XXXX*) or task irrelevant words (e.g., *chair*) in coloured ink. Results have robustly shown that participants are faster to respond to congruent words than incongruent words (for a full review see MacLeod, 1991). Generally speaking, this finding has been thought to reflect a facilitation process for congruent stimuli, and an interference effect for incongruent stimuli. Additionally, studies that have utilised a control condition with letter strings (e.g., Sichel & Chandler, 1969) have found RTs to be fastest on letter stings in comparison to both congruent and incongruent trials, that is, non-words caused facilitation effects. MacLeod (1991) also reported that participants generally respond faster to task irrelevant words than both congruent and incongruent trials. These findings suggest that even when instructed to name the colour of ink the word is presented in, participants cannot ignore the meaning of the words. If participants could ignore the meaning of the words, then a slow-down would not be noted on incongruent words relative to both control and congruent words. Additionally, participants would not show faster RTs on irrelevant task stimuli than on task relevant stimuli.

2.3.1.1 Modelling the classic Stroop effect. Cohen et al. (1990) postulated that there are separate pathways for processing colours and words that work in parallel. Cohen and colleagues (1990) parallel distributed processing model is presented in Figure 2.1.

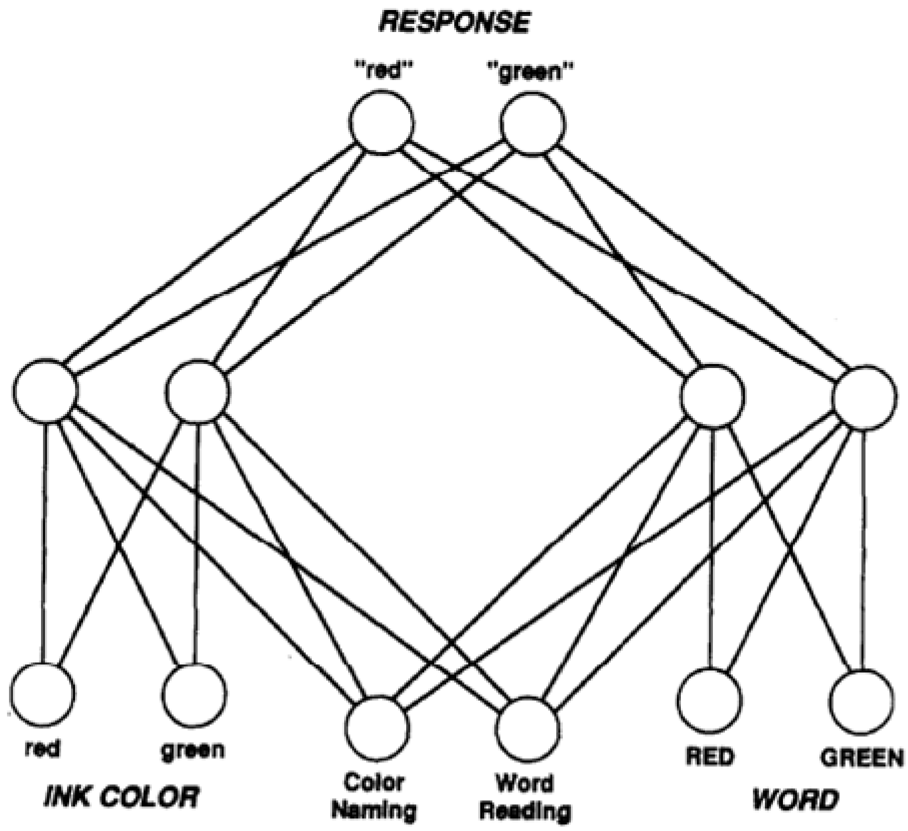

Figure 2.1. Cohen et al.'s (1990, p. 336) parallel distributed processing model.

As can be seen in Figure 2.1, the model is comprised of two pathways, a colour-naming pathway (represented in the left half) and a word reading pathway (represented in the right half). Within each pathway is a network of units. Each unit is a basic information processing device. Units adjust their output based on information received from other units and work in a feed-forward pattern (starting from the bottom progressing upwards).

At the base of the model are two task demand units (centre), one for the colour-naming and the other for the word reading task (Cohen et al., 1990). Additionally, there are input units for both colours and words. The task demand and input units for both colours and words project to intermediate units and then to response units. Processing within the model occurs via spreading activation in both pathways from one unit to another. When activation is strongest within one pathway, a response is executed once the activation at one of the response units crosses a threshold. Interference or facilitation can occur at earlier stages of processing (at the intermediate level) or when executing a response. Whether interference or facilitation occurs is based on the strength and the amount of activation within the pathways. Based on prior research, the Cohen et al. (1990) model assumes that the word reading pathway is stronger than the colour-naming pathway. This is because of practice or expertise, that is, word reading is a more practised task than colour-naming; thus, the word reading pathway has greater strength between units.

Think of the case when, on a congruent trial, a participant is presented with the word *red* in red ink. While both the word reading and colour-naming pathways would be activated, activation would spread quickly through both pathways, with no interference caused as there is no discrepancy between the information that is being processed in either pathway (both pathways lead to the same response). In an incongruent trial however, the presentation of the word *green* presented in red ink would cause a discrepancy between the information processed between the two pathways. As word reading is a more practiced task, this pathway would be more strongly activated by default (as is the case when a congruent word is presented). A response, however, would take longer to execute (than when a congruent trial was presented) as activation would simultaneously spread in the colour-naming pathway with conflicting information in both pathways. Eventually, when activation reaches optimal strength at the response units, a response would be executed.

Due to the conflict of activation occurring between the pathways, however, the response would take longer to cross threshold, manifesting as a longer RT (and more likely lead to an erroneous response compared with a congruent trial).

Essentially at the core of the Cohen and colleagues (1990) model is pathway strength. The strength of a pathway is central to the speed and accuracy of a response, with the degree of strength being a direct function of training (i.e., expertise or familiarity) (Cohen et al., 1990). The model of Cohen and colleagues is a widely accepted model in accounting for the classical Stroop effect (Williams et al., 1996).

2.3.2 Theoretical Explanations of the ESE

While the classic Stroop effect examines the time taken to colour-name congruent stimuli relative to incongruent stimuli, the ESE is the difference in times taken to colour-name emotional stimuli relative to neutral stimuli. Although the model of Cohen et al. (1990) accounts for the data in the CST, in its current form, it does not account for the data of the EST. The reasoning for this is because the model of Cohen et al. was developed in the context of the CST which is interested in the conflicting process between compatible verse incompatible stimuli. The model was not developed to account for differences that may occur in emotionally valenced stimuli (e.g., neutral versus negative words). As a result, there was a need for a model that could take into account the meaning of the word being read (other than when the word was a colour itself).

There have been several theories proposed to explain the ESE. Williams et al. (1996) developed their model of emotional Stroop interference due to the inability of prior theories to adequately explain the effect. Williams et al. highlight three potential artifactual explanations of emotional Stroop interference, providing an argument as to why these explanations independently cannot account for the effect. Each of these explanations is discussed in turn.

The first of these explanations is based on the notion of semantic priming; that is, the effect a word from a particular category (regardless of emotionality) has on the presentation of another word from the same category (Williams et al., 1996). Semantic priming may seem like a logical explanation for the ESE due to the number of studies that have found the effect when using highly-related semantic sets of emotional words versus unrelated sets of neutral words. Despite this, studies that have controlled for the semantic relatedness of neutral words have still reported significant ESEs (e.g., Holle, Neely, & Heimberg, 1997). Thus it does not appear that priming can completely account for the ESE.

Another possible explanation for the ESE could be due to repetition. Many studies have employed relatively small sets of emotional words that are repeated numerous times within the task. For example, Mathews and MacLeod (1985) used 12 target negative emotion words which were repeated eight times in a sample of anxious individuals. However as the number of emotional words and neutral words is generally equal in emotional Stroop experiments, it does not seem plausible that repetition effects could account for the ESE. If this was the case, then no effects would be reported when comparing RTs between emotional and neutral categories of words, as both categories of words would be equally repeated. Additionally, several studies have utilised large pools of words that are not repeated, or repeated once, with findings demonstrating significant ESEs on the emotional words (Williams et al., 1996).

Finally, it is possible that the ESE is due to conscious attention allocated towards emotional stimuli. Although, as evidence from studies that have utilised a subliminal presentation of the task have still reported significant ESEs (e.g., MacLeod & Hagan, 1992; Rutherford et al., 2004), it does not appear the ESE is driven by a conscious allocation of attention towards threatening material (Williams et al., 1996).

2.1.5.1 Modelling the ESE. The connectionist model proposed by Cohen et al. (1990) offers a potentially useful framework in which attentional bias for emotional stimuli may be understood. While this model was initially developed to account for the classic Stroop effect, Williams and colleagues (1996) expanded on this model in order to address the theoretical underpinnings of the ESE.

Using Cohen et al.'s (1990) concept of practice in the CST, Williams and colleagues (1996) implicated stimuli of current concern as central to the speed of responding in the EST, that is, in the model of Williams et al., stimuli that are personally relevant are more highly practiced. For example, in the CST the strength of the word reading pathway is stronger than the colour-naming pathway as reading is a more practised task. The EST does not involve the same type of competition between the word reading and colour-naming pathway *per se*. This is because the content of the words is neither compatible nor incompatible with the colour-naming task (as there is no congruence manipulation). Thus, in order to account for the ESE, Cohen and colleague's model of classic Stroop interference was modified to explain why there would be differential strength activation for emotional versus neutral words. Therefore, in the model of Williams et al. interference is still caused by greater activation within the word reading pathway. The authors, however, suggested that practice is not the only factor affecting this activation and proposed two other factors that affect level of activation. These are the differential resting levels of activation of particular content words and the responsivity of the units (each of these will be explained in more detail below). Thus, even though the task demand unit for colour-naming is activated and projects onto latter units, interference is possible because of the increased activation in the word reading pathway. For example, the following scenario provides a basic overview for what would happen for an anxious individual when they are presented with the words *danger* and *chair* in an EST. Although this is a very simplified example, the word *danger* would be considered more practised (or related to current concern) for an anxious individual than the word chair. Even though instructed to name the colour of the ink these words are presented in, the word *danger* would take longer to colour-name (versus chair) as this word has the ability to cause greater activation within the word reading pathway, and therefore greater interference (as demonstrated by a longer RT to the word) when executing a response.

Although Williams et al. (1996) concurred that practice (or expertise) is an important component in understanding the ESE; the authors believed it was insufficient on its own when explaining the phenomenon. If it were, then it would be expected that patients receiving therapy would show greater colour-naming interference on the task. This, however, is not the case. For example, Cooper and Fairburn (1994) found patients with Bulimia Nervosa were faster in colour-naming disorder relevant words as treatment progressed. Williams et al. also highlighted previous studies that found that as participants became more familiar with emotional and threatening material (during therapy) colour-naming interference was reduced or eliminated. This supports their notion that an increase in familiarity (or practice) is not sufficient on its own to account for the ESE. If it were, greater interference would be expected as familiarity (or practice) increased. Williams et al. concluded that frequency of usage associated to expertise or practice could not adequately explain Stroop interference in emotional disorders. As a result, two additional ways of modelling interference were proposed.

According to Williams et al. (1996), input units for certain words may have a higher resting level of activation (so that they may be activated and recognised more quickly). For example, higher trait anxiety is characterised by frequent rumination on negative themes and worries (Eysenck, Derakshan, Santos, & Calvo, 2007). This in turn increases the resting activation level for input units that represent these worries. As a result, a participant who is highly anxious is more likely to have increased activation levels throughout the word-reading pathway for words representing their concern. Therefore when a concern related word is presented it will result in greater interference with colour-naming. This material of current concern (or personal salience) may be represented in the model through the resting activation level of input units (Williams et al., 1996).

Furthermore, input units previously associated with fear or punishment become “tagged” with threat. If a threat word is presented the responsivity of those units is increased, which causes greater interference in the word reading pathway and thus causes a delay in executing a response (Williams et al., 1996). This delay may be more likely to occur in individuals who are state anxious or temporarily experiencing concerns. For example, an individual who is feeling anxious about giving a speech may respond more slowly to words such as *audience* or *embarrassed* versus a general negative word such as *agony*. The novel component of this prediction is that ESEs are not necessarily categorical for individuals who are temporarily experiencing an aversive emotional state (which would likely occur for trait anxious individuals due to the relatedness of schemata). That is, for individuals who are trait anxious, it would be expected that general threat or negative emotion words cause a disruption in colour-naming; however this might not be the case for state anxious individuals, as they do not have developed “danger schemata”.

Numerous studies have examined these two processes (i.e., relatedness to current concern and threat of material) in an attempt to establish which is best in explaining emotional Stroop interference. In the former, emotional Stroop interference should only be present for material that is personally relevant to current concern (whether negative or positive words; Williams et al., 1996). If the latter of these processes operates, however, instead of or in conjunction with the former, then the negativity (threat) of material would cause additional interference over and above that of personal relevance (Williams et al., 1996). The literature generally suggests that, in non-clinical participants, relatedness to current concern is necessary to explain interference (Williams et al., 1996). In clinical patients, however, this is not sufficient with both relevance to schemata and the negativity of material implicated in determining the extent of colour-naming disruption (Williams et al., 1996).

Although the model of William's et al. (1996) offers a well developed framework for explaining the ESE, the effects are not consistently found within the same populations. For example, studies that have utilised an EST to examine biased attention in patients with OCD have documented both the presence of the ESE (e.g., Kampman et al., 2002) and an absence of the ESE (e.g., Moritz et al., 2008). This on its own, however, is not necessarily problematic for the model as there are several discrepancies between how the task is presented.

2.4 Methodological Variations in the EST

Perhaps one of the key variations in regards to prior use of the EST has been the sample employed. Differences in the presence or magnitude of the ESE may differ depending on the population of interest. For example, the effect has not been as reliably detected in OCD as in GAD (e.g., Kampman, 2002). Although it would be expected that relatively similar results would be found when utilising the task within the same populations, this is not always the case. One key possibility is due to the different formats and presentation styles of the task. An introduction to these variations in the tasks methodology were presented in Chapter 1; however a more comprehensive account is presented below.

2.4.1 Card Versus Computer Presentation

The EST can be presented by either card or computer presentation. Computer formats of the task allows words to be presented individually. Individual presentation of stimuli enables words to be presented in either a blocked or randomised manner (which is discussed in greater detail in section 2.4.8). Additionally, computerised presentations allow RTs to be measured on individual items, and additional features such as the ITI to be controlled. As a result, computer presentation was utilised for the ESTs in this project.

2.4.2 Selection of Stimuli

Word selection for ESTs is an area where studies can differ quite substantially. This is generally for two reasons. First, stimuli are selected based on the population of interest. For example, if the researchers are investigating biased attention in eating disordered individuals, food or exercise related words would be employed (e.g., Cassin & von Ranson, 2005). Similarly, if anxiety and biased attention is being examined then anxiety related or threat related words would be employed. It is not problematic for studies to differ in this way, as stimuli that are concern-related are generally necessary to produce an ESE (Williams et al., 1996). Several other lexical characteristics of words (other than personal concern or negativity), however, have been shown to contribute to the ESE.

The second component of stimuli selection that needs to be carefully considered when selecting words for emotional Stroop experiments relates to lexical characteristics such as length, frequency of occurrence in the English language, arousal, and semantic relatedness within categories. Each of these components has been shown to influence how words are attended to. For example, words that are longer in length attract more attention than words that are shorter in length (Larsen, Mercer, & Balota, 2006). Additionally, words that have a higher frequency of usage are generally responded to faster than words with a lower frequency of usage (Kahan & Hely, 2008). An issue with the use of prior emotional Stroop studies relates to words not being matched on several of these important features between the emotional and neutral categories (Larsen et al., 2006). For example, several studies tend to have emotional words that are longer in length and lower in frequency than their neutral counterparts (Kahan & Hely, 2008). This potentially confounds the interpretation of the ESE, with the slowdown in colour-naming not necessarily caused by the word itself but rather by a combination of the aforementioned characteristics. Additionally, other factors such as orthographic neighbourhood size and initial phoneme have also been implicated in affecting RTs. However, the literature generally suggests that the most important features to control for in emotional Stroop experiments are length, frequency of occurrence in the English language, and arousal (Dresler et al., 2009; Larsen et al., 2006). A more in depth examination of the importance of matching for lexical features between emotion and neutral categories is presented in Chapter 5.

2.4.3 Modes of Responding

Variations also exist in terms of how the colours of words are reported in the EST. A response can be executed either verbally or through a button-press. Verbal responses are recorded by a microphone (e.g., Kampman et al., 2002) whereas button-press responses can either be made on a standard keyboard, by placing coloured stickers over specific keys (e.g., McKenna & Sharma, 2004), or through the use of a response box (e.g., Eprime response box). ESEs have been reported in studies utilising a verbal response (e.g., Waters & Feyerabend; Wertz & Sayette, 2001) and a button-press response (e.g., Cane et al., 2008; Frings et al., 2010; McKenna & Sharma, 2004) in various populations. To date, the magnitude of ESEs using the two response modalities have not been directly compared. Additionally, given the array of methodological dimensions that ESTs differ on (e.g., blocked versus random formats) it is unclear as to whether ESEs would be greater using one modality over another modality. As ESEs have been reported in both verbal and button-press versions of the task, and button-press versions allow for the testing of multiple participants in one session, the response mode selected for the present research program was that of a button-press. In addition, the study of McKenna and Sharma (2004) utilised a button-press response mode, and the current research program aimed to partly replicate their results.

2.4.4 Testing of Participants

Another factor that varies between studies utilising ESTs is whether participants were tested individually or in small groups, which many studies do not report (e.g., Dresler et al., 2008; Sharma, Albery, & Cook, 2001). It is reasonable to assume that ESTs that utilise a vocal response mode would test participants individually (e.g., Ashley & Swick, 2009). However ESTs that use button-press responses can test multiple participants within one session (e.g., Frings et al., 2010). Two recent studies that were conducted to examine the contribution of fast and slow components of attentional bias in the EST were that of Wilson and Wallis (2013) and Frings et al. (2010). Wilson and Wallis tested participants individually and found the presence of both fast and slow effects. Similarly, Frings et al. also reported these effects, however, they conducted their testing in small groups (of up to four people). Based on these results, it is possible to detect fast and slow components of biased attention within the EST regardless of whether participants are tested individually or in small groups. Based on this, the current research program used both methods of testing.

2.4.5 Time Between Stimulus Presentations

Time between stimulus presentations is another key area where studies that employ the use of an EST tend to differ. Generally, most studies report the control or manipulation of either an ISI or an ITI (sometimes also referred to as a response stimulus interval; RSI). Studies that have utilised short (e.g., 32 ms; Sharma & McKenna, 2001) and longer (e.g., 1500ms; Sayette, Martin, Perrott, Wertz, & Hufford, 2001) ITIs have detected the presence of emotional interference within the task. However, Sharma and McKenna (2001) found that ITIs were significant factors in mediating attentional bias within ESTs. The authors found greater interference on negative emotion words with short ITIs (e.g., 32 ms) in comparison to long ITIs (e.g., 1000 ms). The study of Sharma and McKenna highlights the importance of investigating experimental factors that may contribute to interference in the EST, such as the duration between stimulus presentations. The current research program was specifically interested in the duration of attentional bias within the EST. As a result, the ITI was manipulated to see whether this factor contributed to the presence and duration of biased attention within the task. While accounts within the literature differ between the reporting of RSIs, ISIs or ITIs, the current research program reported ITIs. The reporting of ISIs may be preferred if the onset of a trial does not start with the target stimulus. For example, Wertz and Sayette (2001) reported an ISI in addition to an ITI, due to the design of their task. At the onset of each trial a row of asterisks was displayed for 351ms, followed by a black screen for 351ms, at which time the target stimulus was displayed. The stimulus remained onscreen until either a response was made or for a maximum of 1500ms. The next trial commenced after 1500ms. Thus, Wertz and Sayette had an ITI of 1500ms, however, an ISI around 2200ms. In the current research program, the ESTs were designed with a stimulus presented at the onset of each trial, therefore ITI duration was reported. The issue of time between stimulus presentations is also covered in Chapter 3, with a specific focus on how ITI duration may interact with slower forms of biased attention within the task.

2.4.6 Duration of Stimulus Presentation

ESTs can be presented either in an optimal or sub-optimal format. Both versions of the task have been utilised in samples of anxious participants and both versions of the task are capable of producing ESEs. In sub-optimal versions of the task, however, the effect tends to be smaller and is not as consistently reported (e.g., Phaf & Kan, 2001). The premise behind the ESE is that it reflects a fast, automatic bias for threat that occurs subconsciously. Hence, when words are presented in a sub-optimal format of the task, participants should still demonstrate biased attention towards negative (or threat related) information. Phaf and Kan (2007) conducted a meta-analysis on over 70 studies investigating the ESE in anxious and control populations. Their findings did not report an ESE in sub-optimal formats of the task. This result is potentially problematic for the ESE to be conceptualised as an unconscious systematic bias for threat, as it would be assumed that the effect would thus be detectable in less conscious (i.e., sub-optimal) formats of the task. Despite this finding in the meta-analysis, however, several studies have reported the effect to be present (e.g., MacLeod & Hagan, 1992; Mogg, Bradley, Williams, & Mathews, 1993; Mogg, Kentish, & Bradley, 1993; Rutherford et al., 2004).

Phaf and Kan (2007) reported that ESEs are robustly found in blocked formats of the task, when optimal presentation is used, in high anxious or clinically anxious patients. As the role of both fast and slow effects have not been investigated in anxious individuals, the decision was made to employ the use of optimal presentation, as this version of the task has been more reliable in detecting the ESE. Moreover, the findings from Phaf and Kan, in conjunction with several other recent studies investigating the nature of attentional bias in the EST (e.g., Frings et al., 2009; McKenna & Sharma, 2004), seem to support the notion of a slower form of bias emerging in the task. It has been suggested that this bias does not necessarily rely on the fast unconscious effect that is currently assumed to comprise the ESE (thus optimal presentation is better suited to the current investigation; e.g., McKenna & Sharma, 2004).

2.4.7 Reporting the ESE

ESEs can be reported as either interference indices or raw RTs. The preferred method for use in the current research program is raw RTs. The reasoning for this is because how participants respond to different sequences of positive, negative, and neutral words, over a series of positions, was of specific interest. Although possible to calculate interference indices and compare the indices of positive and negative sequences of words, by utilising raw RTs a better understanding can be gained as to how participants responded to all three different types of target sequences. By only looking at interference indices, patterns of responding to the pure sequences of neutral words would not be overly clear. Additionally, the design of the emotional Stroop experiments was in replication of McKenna and Sharma (2004) who also reported average RTs. Additionally, test-retest coefficients for emotional Stroop tasks have been found to be extremely low when interference indices were utilised as opposed to raw RTs (Strauss, Allen, & Jorgensen, 2005).

2.4.8 Blocked Versus Random Presentation

Perhaps one of the most significant dimensions on which EST presentation varies is related to whether words are presented in a blocked or randomised manner. Recently, research has demonstrated that ESEs found in blocked presentation conditions can substantially diminish or disappear in random presentation conditions (Phaf & Kan, 2007; Waters et al., 2003). As a result, research has proposed that the blocked and random Stroop tasks are not psychometrically equivalent (e.g., McKenna & Sharma, 2004; Phaf & Kan 2007; Waters et al, 2003).

Additionally, it has been suggested that the larger effects reported in blocked conditions are a result of emotional lingering (e.g., McKenna & Sharma, 2004; Phaf and Kan, 2007). In a blocked condition, participants' ability to colour-name emotional words could be impaired due to an inability to disengage from the emotionally salient information. Participants may still be ruminating about previous words as they continue to colour-name the subsequent emotion words within that set. Essentially, certain emotional words may have the ability to disrupt performance beyond their presentation (Waters, Sayette, Franken, & Schwartz, 2005). This effect is magnified within the blocked condition as a greater slowdown is caused not just as a function of immediate delay on the execution of the current trial, but as a gradual build up of rumination effects over a series of trials. Therefore, interference appears much greater when the RT of the neutral block is compared to the RT of the emotion block.

If the above proposition is correct, then this inability to disengage from emotional material should be evident in randomised formats of the task. This slower form of bias (i.e., slow effects), should be present on neutral words that follow on from an emotional word, that is, the presentation of an emotional word may disrupt the processing of subsequent neutral words (due to an inability to disengage from the emotional word). This would then result in a longer RT to a neutral word (or neutral words) that follows an emotional word relative to a neutral word (or neutral words) that follows a neutral word. As a result, when the ESE is calculated as the difference in the time taken to colour-name emotional versus neutral words, the difference would appear to have diminished in randomised presentations, as the effects of the emotional words may be carried over to neutral words. For example, Waters and Feyerabend (2000) examined attentional bias using an EST in a sample of non-abstinent and abstinent smokers. Participants from each group were evenly assigned to either a blocked or random format of the task. Within each format of the task participants were presented with a combination of target smoking related words and neutral words. Results showed that in the blocked condition abstinent smokers took longer to colour-name target smoking related words in comparison to neutral words.

In the unblocked condition, however, abstinent smokers colour-named the target smoking related words significantly faster than the neutral words (Waters & Feyerabend, 2000). Although the effect was quite small, these findings highlight the differences in EST results based on style of presentation (i.e., blocked versus random).

In addition, several more recent studies (e.g., Ashley & Swick, 2009; Cane et al., 2008; Frings et al., 2010; Wilson & Wallis, 2013) have also uncovered this slower form of biased attention occurring within the task. These studies are comprehensively covered in Chapter 3. Based on the literature that was presented in section 2.4, the current research program aimed to design emotional Stroop experiments that were methodologically sound and could assess both fast and slow components of the ESE.

2.5 Fast and Slow Components of the ESE

Until relatively recently, the ESE was considered to be a product of an automatic capture of attention due to the ability of certain stimuli to grab attention. However, based on the findings between blocked and randomised presentations of the task, in addition to several studies that have utilised random, or pseudorandom presentations of the task (which are covered in Chapter 3), it appears that the ESE may not necessarily reflect a single component of biased attention. To adequately explore the role of attentional bias within the EST, both fast and slow components of the ESE need to be examined. To assess fast (i.e., interference occurring on a single trial) and slow (i.e., interference persisting over trials) components of attentional bias within the EST, RTs need to be examined on a word-by-word basis. This itemised interference cannot be assessed from blocked Stroop experiments or Stroop studies where the card format is employed.

2.6 Summary of Chapter

The current chapter presented a brief overview of the relationship between attention and emotion. More specifically, several models were explored that have examined the relationship between biased attention in anxious individuals. Additionally, a brief overview of the CST was presented, in addition to Cohen et al's. (1990) model of classic Stroop interference. This model provided the basic structure for the connectionist framework developed by Williams and colleagues (1996) which remains one of the most influential models in terms of explaining the ESE. However, despite the robust finding in relation to the ESE within samples of clinically anxious patients, and individuals with elevated levels of anxiety, there are several dimensions on which emotional Stroop experiments can vary. These were presented with perhaps the most attention paid to the difference between utilising blocked and random versions of the task. ESEs present in blocked versions of the task can substantially diminish or disappear when random formats of the task are employed. This finding has lead to the proposition that the ESE may not be as unconscious and fast as initially thought. In order to assess the slower form of attentional bias occurring within the task, a blocked method cannot be employed. More recent research which has investigated the ESE in various samples using a random or pseudorandom presentation style has uncovered a slower form of bias noted on neutral stimuli that is preceded by emotional stimuli. This literature is presented in Chapter 3.

Chapter 3. Slow effects within the EST

3.1 Chapter Overview

The current chapter presents a body of research that investigated slow, or carry-over, effects within the EST. In addition, the computational model of Wyble and colleagues (2005; 2008) is presented, which offers a theoretical account for the occurrence of both the fast and slow components of attentional bias within the EST. Furthermore, information regarding the duration of the slow effect and ways to investigate the duration experimentally are presented.

3.2 Evidence of Slow Effects in the EST

The presence of fast and slow effects have been documented in several ESTs utilised in drug addiction populations. Each of the studies presented below used a random or pseudorandom presentation of the task, thus allowing for both the fast and slow components of the ESE to be measured. Franken, Kroon, Wiers, and Jansen (2000) found heroin addicts responded more slowly to target heroin related words in comparison to neutral words. Waters et al. (2005) re-analysed the data set of Franken et al. and found that a significant delay was noted on neutral words immediately following target heroin words, in comparison to neutral words immediately following neutral words. Specifically, slow effects occurred on neutral words presented immediately after the target heroin words. This finding supports the notion that fast effects are not the only form of attentional bias occurring within the EST. If fast effects were the sole form of bias, there should be no delay in RTs noted on neutral words following target emotion words, which in this instance were heroin words.

Waters and Feyerabend (2000) reported that abstinent smokers colour-named target smoking related words significantly faster than neutral words in an unblocked format of the EST. Additionally, they also found that the greatest observed slowdown in RTs was on neutral trials that followed the target smoking word *tobacco*. Waters and Feyerabend suggested this slowdown was potentially caused by rumination effects or an increase in stress leading to a general slowing of colour-naming responses.

Wertz and Sayette (2001) also investigated attentional bias for smoking-related stimuli in a group of nicotine deprived smokers. This study utilised target smoking words, neutral words and an additional set of filler words to reduce the overall proportion of smoking words within the task. Filler words were neutral words; however their RTs were not included in analyses. The target smoking words were considered to be semantically homogenous (i.e., they belonged to the same semantic set) whereas both the matched neutral and filler words were heterogeneous (i.e., they were not semantically related within each category). Words were presented a total of four times in a pseudorandom order, in two separate blocks. There were two restrictions placed on word presentation: Two smoking words could not be presented consecutively, and the colour of a word could not be repeated for more than three trials in a row.

Consistent with their hypotheses, Wertz and Sayette (2001) found evidence of fast effects as participants took significantly longer to colour-name target smoking related stimuli. However, as Wertz and Sayette did not analyse RTs of the filler words, Waters et al. (2005) further investigated these data, and found evidence suggesting the presence of slow effects. Waters et al. examined RTs for both the neutral and filler words as a function of the previous words. Analyses showed that participants responded around 10-20 ms slower to both sets of words when the preceding trial was a target smoking related word as opposed to a non-smoking word (i.e., matched neutral or filler). Although, as the order of words in this study was the same for all participants, differences in RTs might be attributed to other factors (such as ordering effects). As a result, Waters et al. used mixed-level modelling in order to control for possible confounds, and analyses showed that non-smoking words appearing after target smoking words were responded to approximately 12 ms slower than non-smoking words following both the neutral and filler words. Target smoking words, however, were still responded to more slowly than both categories of non-smoking words.

Waters et al. (2003) also re-examined the data from Waters and Feyerabend (2000) with a specific focus on examining words as a function of the preceding trial. Similar to Waters and Sayette (2001), Waters and colleagues showed that participants were slower to colour-name neutral words that followed target smoking related words by around 15-20 ms than to colour-name neutral words following neutral words. These results supported the presence of both fast and slow forms of attentional bias within the EST. As a result of these findings, Waters et al. speculated that such carry-over, or slow, effects might be specific to smoking Stroop tasks (i.e., instead of using emotional words, using smoking related words). The authors noted that this is unlikely, however, as similar findings have been reported on general negative emotion words (and not just sample relevant words) and in other addiction samples (e.g., marijuana users; Cane et al., 2008).

Fast and slow effects have also been reported outside of the addiction literature. Sayette et al. (2001) examined the effects of alcohol consumption on levels of stress in a group of social drinkers. Along with several stress-dependent measures, an EST was employed to assess biases of attention for two categories of target stress words (one specific and one general) and two categories of neutral words (one specific and one general). Stress was induced by telling participants they would have to deliver a speech about their physical appearance upon completion of the experiment. The specific target stress words were related to the topic of the speech (i.e., appearance based words) and included words such as *ugly*. The general target stress words were non-specific in nature (e.g., *violence*). The specific neutral words were related to the topic of the speech however were non-threatening in nature (e.g., *shoulder*) and the general neutral words were non-threatening and unrelated to the current stressor. The neutral words were matched for length and frequency of occurrence to the target threat words and were displayed three times throughout the task (totalling 144 trials). Prior to the experiment participants either consumed an alcoholic or a placebo beverage (i.e., a non-alcoholic beverage). Results showed that although there was generally less colour-naming interference for individuals in the alcohol group compared to the placebo group, this difference was not statistically significant. Regardless of alcohol consumption, participants showed evidence of fast effects with RTs most affected by specific target stress words, followed by the general target threat, specific neutral and general neutral words respectively. Waters et al. (2003) re-examined the data set and, in addition to the fast effects reported by Sayette and colleagues, uncovered the presence of slow effects. Waters et al. (2003) reported that while RTs were slowest on the specific target stress words themselves, words following the specific target stress words had slower RTs than words following on from all other word categories. Participants were fastest to respond to the general neutral words that followed general neutral words, and slowest to respond to a specific target stress word that followed a specific target stress word. These slow effects were always noted on the first trial immediately following the target word (i.e., trial N+1). This study was the first outside of the addiction literature to demonstrate the presence of slow ESEs.

The studies examined thus far have demonstrated the presence of both fast and slow effects in several populations. In each of these studies the fast effect was larger than the slow effect, although in some studies the magnitude of slow effects was only slightly smaller (e.g., Sayette et al., 2001). Despite this, McKenna and Sharma (2004) found a different pattern of results when examining the nature of attentional bias in a non-specific sample (i.e., they did not assess potential levels of psychopathology) drawn from the normal population.

McKenna and Sharma (2004) conducted a series of four studies to evaluate the nature of attentional bias in the EST. Specifically, the authors were interested in whether slow effects were the primary form of attentional bias occurring within the task. Participants were undergraduate university students and were not screened for any psychopathologies. Building on their prior research (McKenna & Sharma, 1995) that found participants responded more slowly to target emotional stimuli as opposed to neutral stimuli in a blocked setting, the authors hypothesised that in their current study, mixed blocks (i.e., where both target emotional and neutral material is presented) would be able to assess the relative contributions of both fast and slow effects. In the first experiment, McKenna and Sharma employed a category of neutral words (environmental features such as *meadow*) and a category of target negative emotion words (e.g., *murder*) in a pseudorandom order in a series of mixed blocks. The authors placed the following restrictions on word presentation: Words from one category could not be repeated for more than two trials in a row, and the same word or colour could not be repeated on consecutive trials. There were 10 words within each block, 5 emotion and 5 neutral words, presented four times each. In total, there were 160 trials throughout the experiment. Contrary to their previous findings in a blocked setting (McKenna & Sharma, 1995), results indicated that target emotional words were responded to faster than neutral words. McKenna and Sharma (2004) speculated that neutral words were responded to more slowly than emotion words due to the contribution of a slow effect. However, the authors argued that the design of this experiment did not allow for the contribution of fast effects to be adequately measured. As a result, a second study was performed that used two additional categories of neutral words (N2 and N3) along with the target negative emotion (E) and neutral (N1) words from the prior experiment. Words were presented across five blocks as either sets of completely (or pure) neutral words or mixed neutral words (i.e., half emotion and half neutral). Half the participants completed blocks where N1 was mixed with N2 (i.e., pure neutral) and E was mixed with N3 (i.e., mixed). The other half completed blocks in which N1 was mixed with N3 (i.e., pure neutral) and E was mixed with N2 (i.e., mixed). In total there were 25 words in each category, with 10 different words used in each block (5 from the two categories of interest). This method allowed the comparison to be made between both sets of neutral words in the pure blocks with the neutral and emotion words in the mixed blocks. Results showed that in the pure neutral blocks there was no difference in RTs between the sets of neutral words (878 ms and 881 ms). However, in the mixed blocks RTs were significantly elevated on the neutral words (904 ms) as opposed to the target emotion words (887 ms). Additionally, RTs to the mixed neutral words were significantly longer than on the pure neutral words, and there was no significant difference between the target emotion words and the pure neutral words. The findings from this experiment, in conjunction with their prior experiment (McKenna & Sharma, 2004), not only provided evidence for the presence of the slow effect but also suggested that the slow effect may be the dominant effect within the task (due to the absence of fast effects).

To further investigate the onset and duration of the slow effect, McKenna and Sharma (2004) conducted a third experiment. In this experiment, the authors used two separate blocks of words, and each block presented stimuli in either a mixed or pure sequence. In the mixed sequence, a target emotion word was always presented in Position 1 followed by a set of six neutral words in Positions 2 to 7. In a pure sequence, a target neutral word was always presented in Position 1 followed by a set of six matched neutral words in Positions 2 to 7. For example, in the negative emotion sequence, at Position 1 *death* would be displayed, followed by *field*, *shall*, *today*, *taken*, *whose*, and *quote*. Each sequence of words was repeated six times, with the order of neutral words (in Positions 2 to 7) randomised at each presentation.

If a fast effect were present, RTs would be greatest on target emotion words (which were only presented at Position 1 of the mixed blocks). For example, participants would take longer to identify the colour of the word *death* in comparison to *close* (the matched target neutral word at Position 1 in the pure neutral block). If a slow effect was present, RTs would be delayed on the matched neutral words starting at Position 2. For example, participants would be slowed in responding to one of the neutral words (e.g., *field*) that followed the target emotion word in Position 1 (as opposed to the neutral word following from the target neutral word in Position 1 in the pure neutral sequence).

The experiment included 5 target negative emotion words, 5 target neutral words, and 60 neutral words arranged into sequences of seven. In total the sequences were presented 30 times in each block, with order of block presentation randomised across participants. As hypothesised, there was no evidence of fast effects. At Position 1, the target negative emotion words in mixed blocks were responded to 13 ms slower on average than the target neutral words at Position 1 in pure blocks. However, this difference was non-significant. Interestingly, the difference between neutral words at Position 2 in the mixed versus pure blocks was significant, with participants responding to the neutral words in the mixed block 70 ms slower on average than the neutral words in the pure condition. That is, participants were slower to respond to neutral words that immediately followed a target negation emotion word slower than neutral words that immediately followed a target neutral word. McKenna and Sharma (2004) speculated that these results could be due to participants learning the sequence of word presentation, or to participants' surprise in noticing a salient word. In order to rectify this possible confound, McKenna and Sharma conducted a final study (Experiment 4) with the inclusion of a second emotion category comprised of target positive words. If this slow effect was a product of participants learning the sequence or due to surprise, then the same pattern of results should be noted in the final experiment for words following both the positive and negative emotion words. Figure 3.1 presents the results of McKenna and Sharma's final experiment.

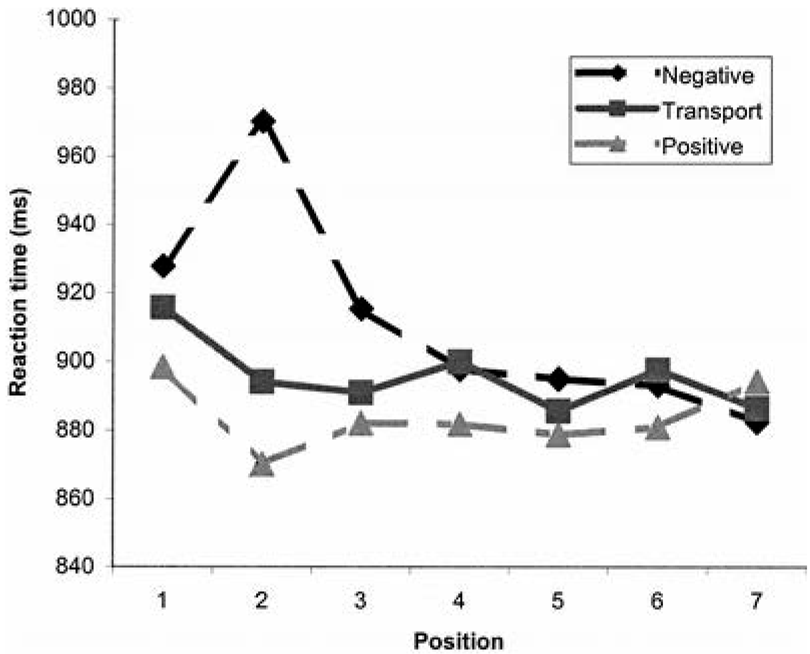

Figure 3.1. Results from McKenna and Sharma's (2004, p. 389) Experiment 4.

As can be seen in Figure 3.1, McKenna and Sharma (2004) found evidence only for slow effects in the sequences starting with a target negative emotion word. The disruption in colour-identification was greatest on the trial immediately following the target negative words presented in Position 1 (i.e., the neutral words in Position 2). There were no significant differences noted on any other neutral word positions (i.e., from Positions 3 to 7). This indicated that the elevations in RTs found on neutral words at Position 2, resulted from the salience of the target negative emotion words presented in Position 1. Additionally, this final experiment provided evidence that slow effects do not seem to be caused by participants learning the presentation sequences, or due to surprise. If this were the case then slow effects would also be noted in the positive emotion sequences at Position 2. Furthermore, McKenna and Sharma did not find any evidence of fast effects as there were no significant elevations in RTs at Position 1 for any of the target emotional words.

Cane et al. (2008) examined attentional bias in groups of smokers, non-smokers, smokers attempting to quit (SATQ), and marijuana smokers. Cane et al. used an almost identical design to that of McKenna and Sharma (2004). Over the course of two experiments, the authors examined the presence of fast and slow effects using target smoking, target negative emotion, target neutral and neutral stimuli. In the first experiment, smokers, non-smokers and SATQ were presented with the target words (whether smoking, negative or neutral) in Position 1, followed by a matched sequence of neutral words at Positions 2 to 7. Fast effects were found for smokers and SATQ on both the target smoking and target negative emotion words, however both groups also showed a slow effect for the neutral words at Position 2 in the negative emotion sequence. Individuals in the SATQ group also demonstrated a slow effect at Position 2 for the neutral words in the smoking sequences.

In the second experiment, Cane and colleagues (2008) tested two groups of individuals: Marijuana smokers and non-marijuana smokers. Cane et al. employed an almost identical design to their first experiment, with the exception of replacing the category of target smoking words with target marijuana words and removed the category of target negative emotion words. Results indicated that marijuana smokers were slower to respond to all words in the marijuana sequences versus words in the pure neutral sequences. All participants responded more slowly to the target marijuana word at Position 1 (a fast effect), and the matched neutral words at Positions 2, 3, and 4 (indicative of a slow effect). This effect, however, was most pronounced in the marijuana group. Prior to this study, no evidence of slow effects beyond Position 2 had been documented. Cane et al. speculated that although slow effects were found regardless of marijuana group, this extended slow effect could be the result of increased anxiety within this sample. The authors suggested that increased anxiety may also account for the finding of slow effects for not only target smoking stimuli but for target negative emotion words in SATQ. This increased anxiety, which has been associated with cessation attempts, may increase attention to negative material allowing a negative stimulus to impede colour-identification ability on successive trials (Cane et al., 2008). Anxiety level, however, was not measured in the sample so it was not possible to test these predictions.

Despite the findings reported above with regards to the co-occurrence of both fast and slow components of biased attention in the EST, Sharma, Albery, and Cook (2001) did not find evidence of slow effects in a group of high drinkers or problem drinkers. Participants were primarily undergraduate university students who were classified into two of the three drinking groups (low and high) based on their scores on the Alcohol Use Identification Test (AUDIT; Saunders, Aasland, Babor, de la Feunte, & Grant, 1993). Participants classified as high drinkers had AUDIT scores that represented harmful yet non-dependent drinking. The third group, who were classified as problem drinkers, were currently receiving treatment for their drinking behaviours at a local community alcohol service. Sharma et al. (2001) used a target category of alcohol words (e.g., *cocktail*) and a control category of neutral words. The findings showed that participants in both the high drinkers and problem drinkers groups were slower to colour-name alcohol related words versus neutral words. Participants within these groups, however, were not slower to identify the colour of neutral words that were presented after target alcohol words. That is, no slow effects were reported. While the design on their study was not necessarily tailored for an investigation of slow effects, one of the blocks presented words in a way that could assess the contributions of both fast and slow effects (i.e., target alcohol words followed by neutral words and neutral words which were followed by target alcohol words).

Ashley and Swick (2009) also examined the relative contribution of fast and slow effects in the EST in a non-specified sample of younger (18-35 years) and older (62-80 years) adults. The design of McKenna and Sharma (2004) was used whereby words were presented either in pure neutral sequences or negative emotional sequences. At Position 1 a target negative or target neutral word was presented, followed by six matched neutral words in Positions 2-7. They also included blocks of pure neutral and blocks comprised only of negative emotion words. For the mixed blocks of pure neutral and negative emotion stimuli, an ISI of 1500 ms was used with words displaying for 500 ms. The results showed that in the blocked format, all participants were slower to colour-name negative blocks in comparison with neutral blocks. In the mixed formats, however, a fast effect was reported on negative emotion words at Position 1 for both the young and older adults. Slow effects, however, were only present for the younger adults. The younger adults were consistently slower (except on Position 3) to colour-name the neutral words in the negative emotion sequences versus neutral words in the pure neutral sequences. Although, unlike the data of McKenna and Sharma (2004) a large increase in RTs on neutral words at Position 2 (average RT = 632 ms) that followed a target negative word at Position 1 (average RT = 638 ms) was not found. That is, while a slow effect was present between the neutral words in the pure neutral sequence and neutral words in the negative emotion sequences, there was only a small change it RTs across the positions in the negative emotion sequences. Despite this, slow effects were still present, at least for the young group of adults.

The findings of the above studies (e.g., Ashely & Swick, 2009; Franken et al., 2000; McKenna & Sharma, 2004; Waters et al., 2003; Waters et al., 2005; Wertz & Sayette, 2001) generally provide evidence that emotional (and also concern-related) words cause disruptions in colour-naming ability for words that follow their presentation.

Additionally, the absence of fast effects noted within McKenna and Sharma's (2004) experiments suggests that the slow effect is possibly the dominant form of attentional bias within the EST, at least within a non-clinical sample. This notion is also supported by Phaf and Kan (2007), who conducted a meta-analysis on the automaticity of the ESE. Specifically, Phaf and Kan compared three separate anxiety groups: Low anxious controls, high anxious individuals and high anxious patients. The patient group was comprised of individuals who had been diagnosed with anxiety disorders such as PTSD, GAD, or OCD. For the purpose of this meta-analysis, studies were only included if they utilised general fear words and not disorder specific words (as these would not be relevant to the non-clinical controls). Results indicated the largest ESEs were present when a blocked presentation method was used in groups of clinically anxious patients, followed by the high anxious group. Within the meta-analysis, studies employing a sub-optimal presentation method (i.e., where words are presented at rapid speeds disallowing conscious processing) were also analysed. Phaf and Kan found only small interference effects for the anxiety patients who completed a mixed optimal task (i.e., where words are generally presented until a response is made) and no interference effects in either the high or low anxiety groups on the sub-optimal tasks. The finding that anxious patients demonstrated emotional Stroop interference with a mixed optimal presentation could be indicative that slow effects are a component of EST interference. These results, however, seem to suggest that fast effects may only be present in clinical samples, whereas slow effects may be present in both clinically anxious patient and individuals with elevated levels of anxiety. Due to the absence of fast effects using sub-optimal presentations, in addition to their findings regarding blocked conditions, Phaf and Kan argued that the ESE does not reflect automaticity. Instead, the authors concluded that within the EST, biases of attention are characterised by a slow disengagement process.

The above studies have demonstrated the co-existence of both fast and slow effects (with the exception of McKenna & Sharma, 2004 and Sharma et al., 2001). The duration and cause of the disruption, however, are still not well understood. Methodological issues such as the length of the interval between words (i.e., the ITI) may contribute to the presence of both fast and slow effects.

3.3 ITI and the Slow Effect

To date, no study has explicitly assessed the role of ITIs in both fast and slow ESEs. Based on the studies reviewed, it is evident that there is little or no consistency in length of ITI. For example, Sayette et al. (2001) and Wertz and Sayette (2001) reported an ITI of 1500 ms, however at the onset of each trial asterisks would appear for 351 ms followed by a delay of 351 ms. The stimulus would then appear, creating an ISI upwards of 2200 ms. Franken et al. (2000) reported an ITI of 1000 ms whereas Waters and Feyerabend (2000) utilised an ITI of 500 ms. McKenna and Sharma (2004) had the shortest ITI with an average of 32 ms (this was the fastest possible due to screen refresh rates). Nonetheless, even though the aforementioned studies utilised differing ISIs and ITIs, each study reported the occurrence of slow effects. Cane et al. (2008) did not report an ISI or ITI however the onset of a trial would begin immediately after a response had been made on the previous trial. Based on this it is highly likely that the ITI would be similar to that of McKenna and Sharma (approx 32 ms). What was most notable about the findings of Cane et al. was evidence of a slow effect occurring up to Position 4 in the group of marijuana smokers (although this effect was strongest on Position 2). Significantly, these results suggest that the slow effect can extend across more than one position, at least when a relatively short ITI is used. As no study has explicitly examined the possible interaction between both trials and time, further research is required in order to gain a better understanding as to the duration of the slow effect.

As the available literature has found the strongest interference occurring on Position 2 regardless of ITI, the slow effect may be trial specific. There is also evidence suggesting that the disruption could extend well past Position 2 (Ashley & Swick, 2009; Cane et al., 2008). Clearly, research needs to be conducted examining the role that time course plays in mediating biases of attention within the EST. This was a primary aim of the current research program and was investigated by manipulating the duration of the ITI. As a result, colour-identification RTs were examined over differing time periods and also across trials.

3.4 A Theoretical Account of Fast and Slow Effects in the EST

3.4.1 Wyble, Sharma, and Bowman's (2008) Neural Network Model

Recently, Wyble and colleagues (2005; 2008) proposed a computational model in order to explain the role of fast and slow components of attentional bias in the EST. This model extends the functionality of past connectionist frameworks of Stroop interference and cognitive control (e.g., Botvinick, Braver, Barch, Carter, & Cohen, 2001; Cohen, Dunbar, & McClelland, 1990; Williams et al., 1996). What separates Wyble and colleagues' (2008) model, however, is the addition of an Adaptive Attentional Control (AAC) unit that regulates task demand.

3.4.1.1 Basic architecture of the model. The model of Wyble (2008) and colleagues is presented below in Figure 3.2. Essentially, this model postulates that the slow Stroop effect is caused by a reduction of cognitive control (specifically top-down processing), and not the emotional valence of the words per se.

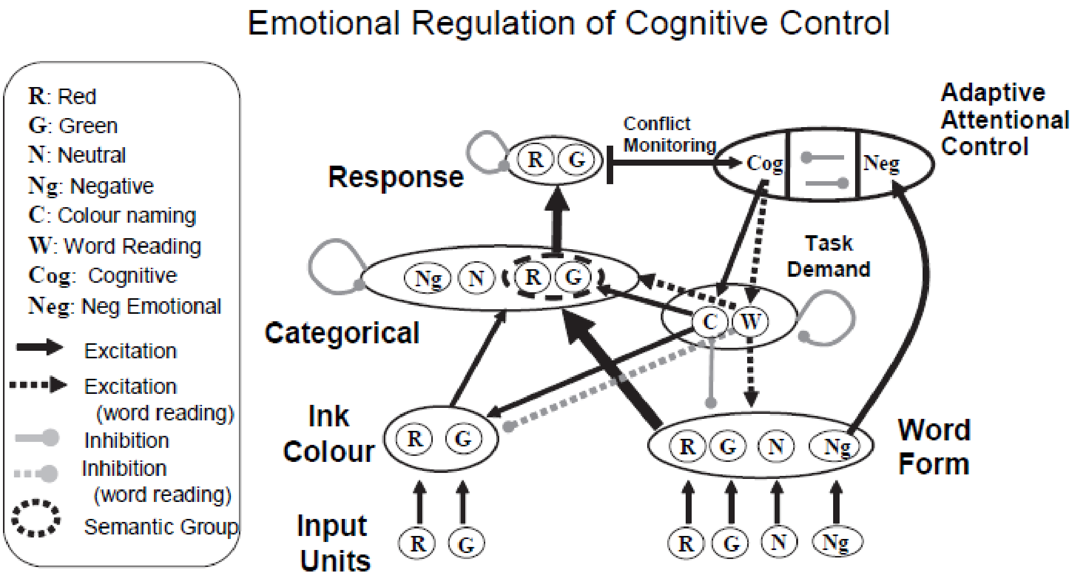

Figure 3.2. Wyble et al's. (2008, p. 1024) neutral network model of emotional Stroop and Stroop interference.

As can be seen in Figure 3.2, the model is organised into a series of layers or categories, represented by ovals. Within the ovals lie neural nodes, which are represented by circles, and each node is labelled according to its type. For example, in the response layer, the R and G circles are representative of the response nodes Red and Green. As can be seen in Figure 3.1, input units project onto layers that activate a specific node. For example, the Ng (negative emotional word) input unit projects onto the word-form layer, activating the Ng unit within that layer. Units within layers then project onto subsequent layers, whereby specific nodes within that layer are activated. Arrows joining layers project to the entire layer, whereas arrows joining nodes project to that specific layer or in some cases, individual nodes. The two nodes within the task demand unit have the ability to project to multiple nodes.

The AAC unit is comprised of two sections: Affective and cognitive. When one component becomes activated, the other is partially suppressed. Likewise, the task-demand module contains a colour node and a word-form node, and when one becomes excited the other is partly suppressed. The AAC regulates activation of the appropriate task-demand node.

3.4.1.2 Modelling fast and slow interference. Similar to Cohen et al. (1990) this model postulates that word and colour information are processed in parallel along different pathways, coming together on common sets of nodes (Wyble et al., 2008). As in previous models of Stroop interference (e.g., Cohen et al., 1990) while the word reading pathway is weighted more heavily than the colour-naming pathway (as reading is a more practiced task than colour-naming), the tendency for reading is overcome through a task-demand system that Wyble and colleagues propose is regulated by the AAC. This causes greater excitation within the colour-naming pathway while suppressing competing information in the word stream. Essentially, the colour-naming task-demand unit excites colour-processing nodes while inhibiting word-form nodes, projecting to the category layer where task relevant nodes are excited (Wyble et al., 2008).

Although the category layer is comprised of both colour and word-form nodes, only the colour nodes project to the response layer. Over the course of a trial, activity builds in the response node until one of the responses (i.e., colours) crosses threshold, causing the participant to respond ending the trial. Once the participant responds and ends the trial, excluding the AAC and task-demand units, all nodes are reset to their initial starting values (Wyble et al, 2008).

When an emotional word is presented, the affective component of the AAC is activated thereby suppressing the cognitive component. This in turn excites the word-form node of the task-demand unit, suppressing the colour-form node. As a result, the importance of colour-naming is decreased as detecting threat becomes a priority (Wyble et al., 2008). As it takes time for these changes to occur throughout the model, a colour-naming response has already been generated on the current emotional trial without delay.

On the next trial, when a neutral word is presented, colour-naming is slowed as the colour-form node within the task-demand unit remains partially suppressed with the system still geared towards detecting threat (i.e., reading takes priority over colour-naming). Wyble et al. (2008) theorise that within a normal population, this momentary withdrawal from the current task (i.e., colour-naming) lasts for only one trial. It should, however, be noted that Wyble and colleagues' (2008) model is based on the premise that the ITI is very short, with almost immediate presentation of a trial occurring after a colour-naming response has been given on the prior trial. As a result, slow effects should only occur on Position 2 after the presentation of a target negative emotion word in Position 1. Furthermore, there will be an absence of fast effects for non-anxious individuals.

The model of Wyble and colleagues accounts for classic Stroop data by proposing (as in previous models of classic Stroop interference) that incongruent trials are colour-named more slowly than congruent trials and neutral words. Interestingly, however, Wyble et al. (2008) stated that when an incongruent trial is presented (e.g., the word *red* presented in blue ink) the cognitive component of the AAC unit is activated, suppressing the affective component. This increases task demand (i.e., the importance of naming colours increases as the colour-form node is activated suppressing the word-form node) strongly biasing the system towards colour-naming. As a result, if an emotional word is presented after an incongruent trial, the emotional content of the word will no longer have the capacity to interfere with the colour-naming task, as the content of the word is neglected with the priority still on naming colours. Therefore, Wyble et al. (2008) predicted that little or no interference would be noted on the target emotional word (i.e., an absence of fast effects). In addition, as no attention is given towards the content of the target emotional word, there should also be an absence of slow effects. If the slow effect is a result of a cognitive control mechanism, an emotional word displayed after an incongruent word will no longer disrupt colour-naming performance, as its presence will be neglected.

3.4.2 Fast and Slow Effects in State and Trait Anxiety

Individual differences play an important role in the way emotional information is attended to within the environment (Wyble et al., 2008). One such difference affecting processing priorities for threatening information relates to an individual's level of anxiety (Mathews & MacLeod, 2002; Williams et al., 1996). The existing literature suggests that it is not only the level of anxiety that can affect processing priorities (e.g., non-anxious, clinically anxious), but also the form of anxiety (i.e., state vs. trait anxiety) (Edwards et al, 2009; Fox, Russo, & Dutton, 2002).

Trait anxiety refers to a chronic condition whereby individuals are perpetually anxious about a particular concern or negative information in general (Speilberger & Sydeman, 1994). In state anxiety, an individual temporarily experiences increased feelings of nervousness, worry, and arousal (e.g., before an important exam) (Speilberger & Sydeman, 1994; Wyble et al., 2008).

Research has shown equivocal results as to the nature of attentional bias in the EST for individuals with elevated levels of state and trait anxiety, and this in part is likely to be attributed to the neglect of investigating such biases in individuals with state anxiety (Bar-haim et al., 2007). At present, no study has looked at fast and slow effects within trait and state anxious groups.

3.4.2.1 Modelling fast and slow components of attentional bias in state and trait anxiety. The model proposed by Wyble et al. (2008) makes specific predictions about the presence of both fast and slow effects within individuals with high trait and individuals with high state anxiety. Similar to Williams et al. (1996), Wyble and colleagues agree that fast effects are the result of automatic vigilance in participants with elevated or clinical levels of anxiety. However, Wyble and colleagues also suggest a qualitative difference explaining the nature of attentional bias between those with state and trait anxiety. Figure 3.3 presented below is an extension of Wyble et al's. (2008) initial model of emotional and classic Stroop interference, developed to account for processing differences between trait and state anxious individuals.

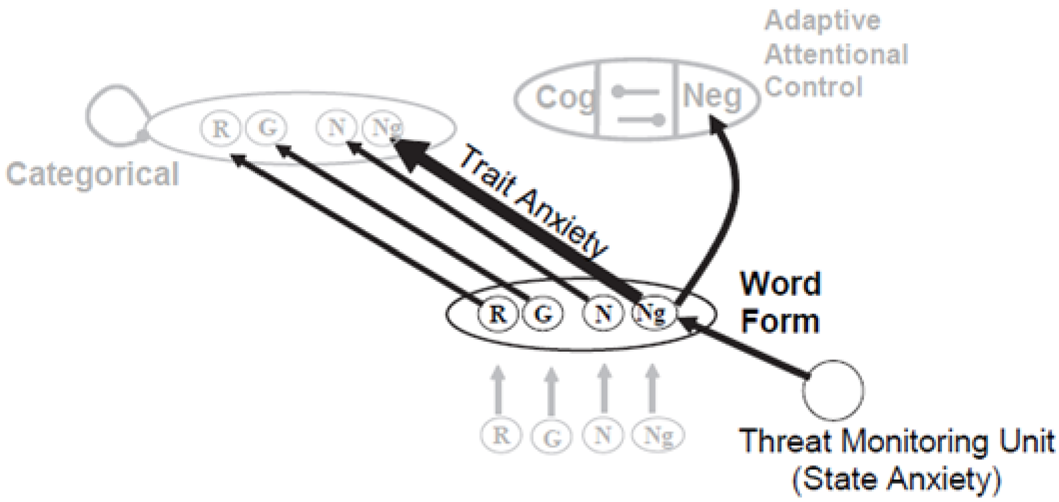

Figure 3.3. The addition of state and trait anxiety in Wyble et al's. (2008, p. 1039) neural network model of emotional Stroop and Stroop interference.

The model in Figure 3.3 suggests that due to increased familiarity with anxiety related material, individuals with trait anxiety process threatening material differently from state anxious individuals. Essentially, this increased practice over a prolonged period of time has led to the permanent restructuring of their information processing system, with strengthened connections from early stages of processing through to later stages (or executing a response) (Wyble et al., 2008). This is depicted in the model by the thick black arrow which connects the Ng word input unit to the categorical layer (see Figure 3.3). As a result, when a trait anxious individual is exposed to threatening material, interference can occur on that trial (i.e., fast effects would be present in addition to slow effects).

In state anxious individuals, certain words will temporarily have the ability to more strongly activate the affective portion of the AAC due to an increase in sensitivity to negative information triggered by their current state of heightened anxiety (Wyble et al., 2008). This is represented in the model by the threat-monitoring unit. This unit enables the Ng word form node to activate the affective component of the AAC. Interestingly, this would mean that individuals with state anxiety would likely show an increase in slow Stroop effects, in comparison to individuals with trait anxiety). The enhanced activation of the emotional word node would cause a stronger excitation of the affective component of the AAC unit, suppressing the cognitive component thus causing greater interference on the following neutral word (Wyble et al., 2008). Therefore, in state anxious individuals slow effects would occur to a greater extent than in low anxious controls. Furthermore, for individuals who are state anxious, slow effects should be the dominant component of biased attention occurring within the task. Although the model does suggest that a modest fast effect may be noted in state anxious individuals, this effect will however occur to a lesser extent than in the trait anxious individuals.

Additionally, based on the model of Wyble et al. (2008), individuals with trait anxiety will likely show a reduced slow effect relative to those with state anxiety. This reduced slow effect is a result of stronger excitation occurring at the word-form node of the category layer, creating lateral competition between colour and word-form nodes, which is in contrast to what would occur for individuals who are state anxious. For these individuals increased excitation occurs at the AAC, resulting in a larger slow effect. Essentially, trait anxious individuals should exhibit a fast effect due to the strengthened connections for negative information in the word-reading pathway (Wyble et al., 2008).

Fundamentally, fast effects in trait anxiety are a result of permanent restructuring of the information processing network, which causes greater interference at the category layer. In state anxiety, however, slow effects reflect transient changes in the activation of certain input nodes, thus giving these input nodes the ability to strongly excite the affective component of the AAC (Wyble et al., 2008). Therefore, the EST may serve as a useful measure for differentiating individuals as state or trait anxious. According to Wyble et al. (2008) for individuals with state anxiety it would be expected to observe a slow effect with a modest fast effect, whilst individuals with increased trait anxiety would likely display both a fast effect and slow effect (albeit a slow effect of a smaller magnitude). In addition, individuals who are low anxious should not exhibit a fast effect, however they should show slow effects. Slow effects however would occur to a lesser extent than in state anxious individuals.

3.4.3 Methodological Issues to Consider when Investigating the Contribution of Fast and Slow Effects

In Chapter 2, several important dimensions on which the presentation of the EST varies were discussed. Two important features to specifically consider when investigating fast and slow components of attentional bias within the EST relates to whether words are presented in a blocked or randomised way, in addition to the length of time between stimulus presentations. Namely, the contribution of fast and slow effects cannot be measured when a blocked presentation is used. In order to assess both fast and slow components of attentional bias, a design must be employed whereby both emotional and neutral words are presented within the same blocks. This form of presentation allows for fast effects to be measured by examining RTs of target emotion words compared with target neutral words. Furthermore, this form of presentation allows for slow effects to be measured by examining the RTs of neutral words that follow target emotional words compared with neutral words that follow target neutral words.

The model of Wyble et al. (2008) suggests that slow effects will last for one trial, occurring on the neutral word immediately following the target emotional word. This suggestion, however, was based on the assumption that stimuli would be presented rapidly, almost immediately after a response had been given. As highlighted in section 3.2, slow effects have been reported with longer ISIs or ITIs. Additionally, the study of Cane et al. (2008), demonstrated a slow effect that remained significant until Position 4 (i.e., on the third neutral word that followed a target marijuana word in Position 1). Furthermore, Ashley and Swick (2009) found slow effects persisting across six positions following the presentation of a negative word in Position 1. As a result, the current research program explicitly investigated the duration of slow effects over a series of trials (as in the study of McKenna & Sharma, 2004), employing a range of ITIs. This then allowed for slow effects to be examined over both trials and time.

3.5 Summary of Chapter

The present chapter outlined a body of research that reported evidence of both fast and slow effects within the EST. In addition, the model of Wyble et al. (2008) was presented, which extended on previous models of Stroop and emotional Stroop interference. The model of Wyble et al. explains how the slow effect occurs in groups of non-anxious and anxious participants. Additionally, the model also makes specific predictions about how attentional bias will differ in individuals who are trait anxious and state anxious. To date, the model of Wyble and colleagues has not been empirically tested. Furthermore, fast and slow components of attentional bias have not been explored in groups of state or trait anxious individuals. Moreover, ITI duration has not been investigated in regards to the potential role it may play in respect to the magnitude or duration of the slow effect. As a result, the current research project aimed to address these gaps in the literature by investigating the role of fast and slow components of attentional bias in the EST for individuals with varying types and levels of anxiety. Additionally, the task was designed in a way that allowed for the effects to be investigated over both trials and time.

Chapter 4. Introduction to the Research Program

4.1 Overview of Chapter

The current chapter presents a brief overview of the research program that is reported in Chapters 5-9. The research program aimed to investigate the nature of fast and slow components of attentional bias within the EST for individuals with varying levels (i.e., low versus high) and types of anxiety (i.e., state and trait). The current chapter provides a brief review of the major theoretical and methodological issues highlighted in the previous chapters. Furthermore, the rationale, general aims and hypotheses, in addition to a brief overview of the experiments that comprise the research program, are presented.

4.2 Revision of Major Theoretical and Methodological Issues

The EST is a frequently utilised method that demonstrates how emotional material disrupts performance on a simple task through the biasing of attention. The task requires participants to name (or identify) the colour of ink words are presented in as quickly and as accurately as possible. Results show that participants generally take longer to colour-name emotional words relative to neutral words, a finding called the ESE. The ESE is commonly larger when disorder relevant words are used with individuals who have clinical levels of that disorder (Williams et al., 1997). Despite this, the effect has also been reported in individuals with elevated levels of particular psychopathologies (e.g., Egloff & Hock, 2001) or when personally relevant stimuli are used (e.g., Wingenfeld et al., 2006). These findings are consistent with cognitive models of psychopathology (e.g., Beck, 1976) that assume biases of attention are not simply by-products of the pathology but rather, they play a central role in the causation and maintenance of the disorder. Additionally, models of emotional Stroop interference generally support the notion that the ESE should be larger in individuals with elevated and clinical levels of disorders, when disorder relevant stimuli are used. It should, however, be noted that the ESE has not always been reliably detected within the same populations (e.g., OCD; Kampman et al., 2002). This finding, however, is not necessarily problematic, as there are several variations in regards to how the task is presented. Perhaps one of the most significant dimensions on which EST presentation can vary is whether trials in the task are presented in a blocked or in a randomised format. Recent evidence has suggested that ESEs reported in blocked versions of the task can substantially diminish or disappear in unblocked (or random) formats of the task. This finding has led to the proposal that emotional words (primarily negative) have the ability to disrupt colour-naming performance beyond that of their presentation. As a result, ESEs calculated from blocked versions of the task may be exacerbated due to participants having difficulty disengaging from the emotional stimuli or due to a gradual build up of rumination effects. Despite the mechanism mediating the effect, based on these findings, it appears that the ESE may not reflect a single component of biased attention. In an extension on previous computational models of EST interference, Wyble and colleagues (2008) propose a model that accounts for both fast (i.e., interference occurring on a single trial) and slow (i.e., interference persisting over trials) components of biased attention within the task. Additionally, the model makes specific predictions regarding the nature of attentional bias in individuals with varying levels and types of anxiety. To date, however, fast and slow components of the ESE have not been examined in individuals with varying levels or types of anxiety.

4.3 Overall Rationale for the Research Program

The EST remains one of the most utilised methods of investigating attentional bias for emotionally salient stimuli (Waters et al., 2005). Although research generally shows that participants take longer to colour-name emotional material in comparison to neutral material, it is unclear how long the disruption in colour-naming lasts.

Until recently, the ESE was assumed to be relatively fast, occurring on a single trial (i.e., a fast effect). However, the use of refined methodologies that allow RTs to be measured on a trial-by-trial basis has found that emotion words have the capacity to disrupt colour-naming performance beyond that of their presentation. Therefore, the ESE is now thought to be comprised of two components: A fast and a slow component. Research has speculated that slow effects may result from an inability to disengage attention from emotional stimuli. Alternatively, Wyble and colleagues (2008) suggested that slow effects may be the result of a reduction of cognitive control. At present, the mechanisms responsible for both the fast and slow disruptions in colour-naming are still unclear (McKenna & Sharma, 2004).

The model of Wyble et al. (2008) proposes the interaction of cognitive and emotional components of attention in an environment of fluctuating task demands. Wyble et al. suggest that fast and slow ESEs are independent, but interacting, phenomena. This model postulates that the slow Stroop effect is not necessarily caused by the emotional valence of words, but rather a reduction of cognitive control. Essentially, the presentation of threatening material can interrupt ongoing activity, and this causes a momentary withdrawal from the current task (i.e., colour-naming), allowing threat to be more readily detected within the environment. In addition, Wyble et al. state that the course of attentional bias will differ between non-anxious and anxious individuals, a finding that has also been documented within the anxiety literature (in regards to the “traditional” ESE; e.g., Edwards et al., 2009; Rutherford & MacLeod, 1992). At present, however, no study has directly investigated fast and slow effects in relation to anxiety level or type.

In order to address this gap within the literature, this project examined EST performance for individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. Specifically, the role of fast and slow effects within the task were examined, and this was investigated not only over a series of trials, but also over differing timeframes. This was achieved through the manipulation of the ITI.

Debate within the literature continues as to what aspect of emotional material has the capacity to disrupt colour-naming performance. Generally, threatening stimuli is believed to have the ability to capture attention in an effort to prepare the individual to scan their environment for subsequent danger (Lee & Knight, 2009; McKenna & Sharma, 2004). Research, however, has suggested that regardless of positive or negative valence, information that has a high arousal value can capture attention (Aquino & Arnell, 2007; Dresler et al., 2009). As this issue has not yet been resolved, the research project utilised both negative emotion words (i.e., threatening material) and positive emotion words, controlling for arousal and other lexical features (a detailed account of stimuli selection is presented in Chapters 5 and 8) such as length and frequency of occurrence in the English language.

4.4 Overall Aims and Hypotheses

Due to the popularity of using the EST, researchers agree that further studies need to investigate the duration and possible causes of attentional bias within this task (e.g., McKenna & Sharma, 2004; Waters et al., 2003; Waters et al., 2005). As a result, the primary aim of this thesis was to investigate the time course and mechanisms influencing attentional bias within the EST. Specifically, this thesis aimed to address whether fast and slow components of attentional bias were present in the EST for individuals with varying levels and types of anxiety.

The time course of attentional bias was investigated through the exploration of fast and slow effects (i.e., interference over trials). The occurrence of fast effects would indicate that emotional stimuli had the capacity to disrupt performance quickly and relatively automatically. The presence of slow effects would indicate whether emotional words disrupted performance beyond their presentation. In addition, the time course of attentional bias was investigated across varying ITIs (i.e., interference over time). The ITI was manipulated to gain a more thorough understanding as to the time course of the slow effect. Three different ITIs were incorporated: One that was brief (32 ms), one that was of a medium duration (1000 ms), and one that was of a long duration (2000 ms). These specific intervals were selected due to the prior research of Sharma and McKenna (2001) who examined the effects of time pressure on the “traditional” ESE. Additionally, as several of the emotional Stroop studies discussed in Chapter 3 utilised ITIs upwards of 2000 ms, the decision was made to include this prolonged interval in the current study.

As anxiety has been linked to differential patterns of processing emotional information, this research program also examined the way in which the nature of fast and slow effects differed between anxious and non-anxious individuals. The model developed by Wyble and colleagues (2008) makes specific predictions regarding the nature of biased attention, and how fast and slow effects will manifest in individuals who are state or trait anxious. To date, however, these predictions have not been tested. Therefore, Experiments 2 and 3 investigated attentional biases in individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. Experiment 5 also examined attentional bias within the EST, however, this experiment utilised a different methodology and compared individuals who were low anxious and anxious.

Specially, the current research program predicted that state anxious, trait anxious, and state-trait anxious individuals would demonstrate an attentional bias to negative emotion words characterised by a fast effect. This effect was expected to be the greatest in the trait anxious and state-trait anxious groups. Additionally, if arousal rather than valence of words could account for emotional Stroop effects, it was predicted that the state anxious and state-trait anxious individuals would show fast effects for positive emotion words in addition to negative emotion words.

It was also expected that all anxiety groups would demonstrate an attentional bias to negative emotion words, characterised by a slow effect. Additionally, if arousal rather than valence of words could account for emotional Stroop effects, these anxiety groups should show slow effects for positive emotion words in addition to negative emotion words. Furthermore, it was expected that the slow effect would emerge on Position 2 and possibly extend to additional positions. Additonally, it was expected that the state anxious and state-trait anxious individuals would report a larger slow effect (as demonstrated by occurring over more positions or of a larger magnitude) than low anxious and trait anxious individuals. It was also expected that differences would occur within anxiety groups with regards to the presence of fast and slow effects. Specifically, it was predicted that the trait anxious individuals would demonstrate larger fast effects in comparison with slow effects. It was also expected that state anxious individuals would demonstrate larger slow effects in comparison to fast effects.

It was also hypothesised that the state-trait anxious individuals would demonstrate both fast and slow effects of the same magnitude. It was also predicted that the magnitude of fast and slow effects (in each of the anxiety groups and to the specific stimuli outlined in the prior hypotheses) would vary depending on the duration of the ITI. It was expected that the magnitude of fast effects would be greatest when the ITI was short. In addition, it was predicted that the duration of the slow effect would differ across positions depending on the ITI, that is, the slow effect may not necessarily be trial specific.

4.5 Brief Overview of the Experiments in the Research Program

The current research program was comprised of five experiments. Two of these experiments were word selection studies (Experiments 1 and 4). These studies were conducted in order to select stimuli that were matched on several important lexical features for the subsequent emotional Stroop experiments (Experiments 2, 3, and 5).

Experiments 2 and 3 were conducted in a similar manner to that of McKenna and Sharma (2004). An important difference, however, was that participant's level and type of anxiety was measured. Participants who were low anxious, state anxious, trait anxious, and state-trait anxious completed an EST in order to determine the relative contributions of fast and slow effects within the task. Additionally, these components of the ESE were assessed over both trials and time. This was done by exploring RTs to target positive emotion, negative emotion, and neutral words in Position 1 and their matched neutral words in Positions 4 to 5. This methodology was maintained in Experiment 3, however, an alternate set of neutral words was employed at Position 1.

Experiment 5 investigated the contribution of fast and slow effects in individuals who were low anxious and anxious. A contingency-free methodology was utilised in order to compute fast and slow components of the ESE independently from one another.

4.6 Summary of Chapter

The current chapter provided a brief summary of the major theoretical concepts and methodological issues in relation to biased attention and the EST that were presented in Chapters 1 to 3 of this thesis. A rationale for the research program was also presented in addition to a general overview of the projects aims, hypotheses, and experiments.

Chapter 5. Word Selection Study for the ESTs (Experiment 1)

5.1 Introduction

5.1.1 Overview of Chapter

Before commencement of the emotional Stroop experiments, it was necessary to conduct a study in order to select stimuli for use in the tasks. The current chapter presents the word selection process for the stimuli that was included in the ESTs. Specifically, a rationale for the word selection study is outlined in addition to the criteria utilised for the inclusion of words. Furthermore, the methodology and results of the study are reported along with the final list of words selected for two of the emotional Stroop experiments (Experiments 2 and 3).

5.1.2 Background to the study

Prior research has demonstrated that attention is influenced by a variety of factors. Specifically, EST performance can inadvertently be affected by the lexical characteristics of words employed in the task (Kahan & Hely, 2008). For example, words that have a lower frequency of usage in the English language tend to attract more attention (as evidenced by slower RTs) than higher frequency words (Balota, Cortese, Sergent-Marshall, Spieler, & Yap, 2004). This is an interesting finding, as based on the model of Williams et al. (1996) it could be argued that higher frequency words cause greater activation within the word reading pathway as they are more familiar or practiced. Therefore, it would be expected that high frequency words take longer to be colour-named than low frequency words. However, Kahan and Hely (2008) report that this is not the case. While it is not entirely clear why low frequency words attract more attention than high frequency words, it is apparent that word frequency is a factor that requires consideration when developing word lists for experiments investigating attention.

Lexical characteristics of words, such as length and semantic relatedness within each category (i.e., target versus neutral), have also been shown to contribute to RTs. As a result, selection of words for use in the ESTs aimed to control for the following factors (which are examined in section 5.3 below): Semantic relatedness within each category, length, and frequency of occurrence in the English language. By ensuring the words only differ in terms of valence and arousal (i.e., between the emotional and neutral words), the relative contributions of fast and slow effects can be determined as a function of these two factors and not other lexical features.

The emotional Stroop experiments outlined in subsequent chapters were initially designed based on the study of McKenna and Sharma (2004). To illustrate how word matching needed to be conducted the words of McKenna and Sharma are presented in Table 5.1. It should however be noted that McKenna and Sharma examined RTs across seven positions, however for the purpose of explanation only Positions 1 to 5 were included.

In the study of McKenna and Sharma (2004), a target word was always presented in Position 1 and was followed by matched neutral words in Positions 2-7. As can be seen in Table 5.1, however, the neutral words in these positions were semantically unrelated. Based on differences that can occur in RTs due to semantic relatedness, the current research project ensured that each of the target categories of words (i.e., positive emotion, negative emotion, and neutral) had their own semantically related theme (as in the study of McKenna & Sharma, 2004). Additionally, the current research program aimed to ensure that the neutral words that appeared in Positions 2-5 also came from categories that were semantically related. This was achieved by developing 12 categories of neutral words, each with their own semantically related theme.

Table 5.1

Words Used at Positions 1-5 in Experiment 4 of McKenna and Sharma's (2004) Study

Position				
1	2	3	4	5
		Negative emotion[a]		
REJECTED	SYMPHONY	QUANTITY	REDUCING	ELECTRON
FAILURE	CLOTHES	KITCHEN	PROJECT	SOMEONE
SUICIDE	BUFFALO	COLLECT	CAMPING	FLOWING
ABUSE	BOOTS	BRICK	CREAM	ESSAY
SAD	ARC	BAG	ERA	ICE
		Positive emotion[b]		
ROMANTIC	COVERING	MOUNTAIN	COMPOSER	SENTENCE
SUCCESS	BALANCE	DEVELOP	OBVIOUS	MANAGER
MIRACLE	ANGULAR	CHANNEL	CONFIRM	FARMING
LUCKY	ALIKE	BRASS	CLOCK	DAIRY
JOY	AIM	ROW	CUP	FLY
		Transport[c]		
AIRPLANE	BASEMENT	EQUATION	THURSDAY	FREQUENT
STATION	COMPLEX	MEASURE	QUICKLY	ATTEMPT
RAILWAY	CABINET	COMBINE	EMBASSY	GRADUAL
FERRY	AWAKE	CHEEK	CROWN	LABEL
BUS	COW	BAY	FED	MUD

[a] Target negative emotion words were presented in Position 1 followed by a sequence of matched neutral words in Positions 2-5.
[b]Target positive emotion words were presented in Position 1 followed by a sequence of matched neutral words in Positions 2-5.
[c]Target neutral words (i.e., Transport) were presented in Position 1 followed by a sequence of matched neutral words in Positions 2-5.

Words were matched at both the category level (i.e., between the target positive, target negative, and target neutral words) and also at the sequence level (e.g., between the words in the target negative emotion categories in Position 1 and the words in the four matched neutral categories which would follow in Positions 2-5).

5.1.3 Lexical Characteristics of Words which Influence RTs

5.1.3.1 Semantic relatedness. Research has shown that selective attention is influenced by the relatedness of words (Green & McKenna, 1993; Waters et al., 2005). For example, research has suggested that ESEs may be exaggerated due to the use of highly related emotive words in comparison to a less semantically related set of neutral words within the task (Waters et al., 2005). Holle et al. (1997) found that individuals with social phobia were slower to respond to a semantically related set of neutral words (e.g., *monkey*, *cheetah*) than a semantically unrelated set of neutral words (e.g., *portion, network*). Overall, Holle and colleagues found that individuals were slower to respond to social threat words (e.g., *stupid*, *failure*) in comparison to both categories of neutral words, however, the results between the neutral categories of words demonstrates the importance of ensuring consistency in regards to semantic relatedness within each category of words.

The findings of past research have highlighted the importance of the selection of semantically homogeneous words within each category of words in the EST, ensuring that only the emotional valence and arousal of the words differ between target and neutral categories. This allows for differences in RTs to be attributed to the emotional content of the words, rather than inconsistencies between categories in semantic relatedness. The present study ensured that each category of words (i.e., target and neutral) had their own distinctive semantically related theme.

5.1.3.2 Length and frequency. In addition to semantic relatedness within each category of words, lexical characteristics such as length and frequency of occurrence in the English language also affect the response times to certain words. Prior research has found that words shorter in length are quicker to process than longer words (as evidenced by faster RTs) and words with low frequencies tend to attract more attention (as evidenced by longer RTs) than high frequency words (Larsen, Mercer, & Balota, 2006).

In the current study, words were matched for frequency using the SUBTL word frequency norms developed by Brysbaert and New (2009). The SUBTL word frequency norms are a standardised measure of word frequency and are the suggested frequency to use as they are independent of the corpus size (Brysbaert & New, 2009). The word frequencies reported in the SUBTL norms are frequencies per million words. Although the norms developed by Kucera and Francis (1967) have dominated the literature when controlling for word frequency, these norms were developed over 40 years ago. Research has suggested it is more desirable to use more recent frequency norms to better reflect the current use of language (Balota et al., 2004; Brysbaert & New, 2009; Larsen et al., 2006).

5.1.3.3 Valence and arousal. Currently, there is no consensus as to what aspect of emotional material interferes with colour-naming speed in the EST. Although research generally has accepted that threatening stimuli (i.e., negative emotion) have the ability to capture attention (e.g., McKenna & Sharma, 2004), a recent suggestion is that arousal is potentially a more significant component in influencing attentional processes (Dresler et al., 2009). Therefore, the present project utilised both negative and positive emotion words while controlling for arousal. Arousal was controlled for by ensuring there were no significant differences between the target emotional (i.e., positive and negative) categories of words or between the target neutral and neutral categories of words.

5.1.4 Aims and Conditions for Word Selection

The current study aimed to select word stimuli for the emotional Stroop experiments. Due to the aforementioned lexical characteristics that required consideration, it was not possible to use a word list from previous research. The main reason for this was due to the amount of semantically related neutral categories of words required for the ESTs. The design of the ESTs used in Experiments 2 and 3 are almost identical to what was developed by McKenna and Sharma (2004) in their Experiment 4. That is, words were presented in sequences over a series of positions. Although McKenna and Sharma also employed the use of a large number of neutral words, these were not divided into semantically related categories at each position (excluding the target categories in Position 1), and thus could not be employed in the current research program.

Word selection from the English Lexicon Project (Balota et al., 2007) and the ANEW (Bradley & Lang, 1999) was also considered. However, these databases could not be used to generate word lists due to issues regarding semantic relatedness and the desired use of more recent word frequency information. Despite this, the inclusion of two word selection studies incorporated in this thesis make additional contributions to the literature, outside of the main purpose for this research program. Experiments 1 and 4 offer word lists that are matched on several important lexical features that have been normed for both arousal and valence in an Australian population.

The specific aim of the current study was to select 75 words that would be used in the subsequent ESTs. These words were separated into 15 categories. Specifically, 3 categories of target words (positive emotion, negative emotion, and neutral) and 12 categories of neutral words were developed. Several categories of neutral words were required due to the design of the ESTs. Full details of the methodology are described in Chapter 6 (section 6.2.3.3), however a brief overview is provided here.

In the EST words were presented in sequences, and each sequence was comprised of 5 words, 1 target word, and 4 neutral words that were presented across five positions. The first word in each sequence was always a target word that was randomly drawn from one of the 3 target categories (i.e., positive emotion, negative emotion, or neutral). Thus, there were three possible sequence types. A target word, presented in Position 1, was always followed by the four same neutral words in Positions 2-5. Each of these neutral words was from a category with its own semantically related theme (e.g., transport, animals). Order of the neutral words was randomised at each presentation. An example of a negative emotion sequence of words would be the word *despise* presented in Position 1, followed by *jupiter*, *cricket*, *sandals* and *freezer*. Each time this sequence was presented, the 4 matched neutral words were randomised. For example, the second time this sequence was presented, *despise* would remain at Position 1, however, the order of the neutral words changed to *sandals, jupiter*, *freezer* and *cricket*.

All target words and their matched neutral words were controlled for in terms of length and frequency of occurrence at the sequence level and also at the category level. This ensures lexical equivalence across sequences of words. For example, *despise* can be considered lexically the same as *freezer*, with the exception of valence and arousal. Additionally, matching between categories of words was also important in order for comparisons to be made between words presented in each position across the different sequences. For example, *despise* could be considered lexically equivalent to *hopeful* (from the target positive category) and *austria* (from the target neutral category of countries), again with the exception of valence and arousal. It should be noted that RTs to individual words were not examined, rather RTs were computed for each category of words in Position 1, and their matched neutral words at Positions 2-5. The examples given above, however, assist in demonstrating how the words were matched. Essentially, each category of words utilised in the emotional Stroop experiments were matched for length, frequency of occurrence in the English language, and have their own distinct semantically related theme (regardless of whether they belonged to a target or neutral category).

In summary, this study was designed to select a list of words for use in the emotional Stroop experiments. Rather than developing hypotheses per se, in order for words to be selected, the following criteria needed to be met. All categories of words would not differ in length and frequency of occurrence in the English language. In addition, each category of target words would differ in valence ratings with the positive emotion words receiving the highest ratings, the negative emotion words receiving the lowest ratings and the target neutral words receiving middle-range ratings. There would be no differences in valence or arousal ratings between any of the non-target neutral categories. Furthermore, the positive and negative target words would receive higher arousal ratings than the target neutral words. There would however be no difference in arousal levels of the positive and negative target words.

5.2 Method

5.2.1 Participants

Two-hundred and eight individuals (145 women, 63 men) with ages ranging 18-55 years (*M* = 30.66, *SD* = 9.09) participated in the study. The sample was primarily comprised of individuals in full-time employment (*n* = 130) with the majority not currently studying (*n* = 145). Participants were predominately recruited using the social networking site “Facebook” in conjunction with a snowball technique.

Selection of participants was based on two criteria. First, participants were required to be between the ages of 18 and 55 years. In addition, participants were requested to have English as their first learnt language. These restrictions were placed on the sample in order to coincide with the restrictions placed on the subsequent emotional Stroop experiments, in an effort to create greater equivalence between the samples. These restrictions were selected as RT speed has been shown to decline after the age of 50 years (e.g., Der & Deary, 2006). Additionally, emotional processing of information has been shown to differ when that information is presented in a language other than the first acquired language (e.g., Harris, Ayçiçeği, & Gleason, 2003). Although more recently, research has demonstrated that this is not always the case (e.g., Eilola, Havelka, & Sharma, 2007).

5.2.2 Design

The design formed a 3 x 5 mixed factorial model. The first independent variable (IV) was sequence type with three levels: Positive, negative, and neutral. This was an independent groups variable. The second IV was position of word within a sequence, with five levels: Position 1, 2, 3, 4, and 5. This was a repeated measures variable. There were two dependent variables (DV) in this study: Valence ratings and arousal level. Additionally, analyses were conducted to ensure there were no differences between the categories of words with regards to frequency of occurrence in the English language.

Initially, 20 categories of words were developed: Three target (i.e., positive emotion, negative emotion, and neutral) and 17 neutral categories (e.g., sports, animals, transport), each with their own distinct semantically related theme. Between 15 and 20 words were selected for each category. Word selection for each category was completed through a process of brainstorming (primarily for the neutral categories) and consultation with prior emotional Stroop literature. All the emotional words selected for the study were taken from the ANEW (Bradley & Lang, 1999). The categories were then refined based on their length and frequency of occurrence in the English language. For example, words that had under four letters and over nine letters were excluded. This was done in an effort to keep word length as consistent as possible. In addition, words that had very high frequencies were automatically excluded (as the bulk of words initially developed generally had frequencies under 10 per million). Words that had approximately the same length and frequency values were retained to form a final list of 10 words per category.

5.2.3 Materials

5.2.3.1 Demographic questionnaire. Basic information pertaining to current age, gender, first learnt language, employment status and study load were collected using a brief questionnaire. A copy of approval for the research project in its entirety from the Human Research Ethics Committee, in addition to the information letter and the demographic questionnaire, can be found in Appendices A, B, and C, respectively.

5.2.3.2 Word rating task. In total 200 words were included in the study with each participant required to rate 44 words on two separate dimensions (arousal and valence). The decision was made to have participants rate only a portion of the total word list in order to reduce the time taken to complete to study. This was achieved by allocating words into one of five lists using a random assignment matrix. Each list was comprised of 8 emotion (4 positive and 4 negative) and 36 neutral words, with their ordering in the list determined by random allocation. All neutral words appeared once in one of the five lists. Target positive and negative words appeared in a total of two lists in an effort to get additional ratings for these categories. Order of words within each list was fixed for all participants with arousal ratings reported followed by valence ratings. The decision to have participants rate the words for arousal first was so their initial reactions (i.e., weak to strong) to the words could be assessed. A list of all words, including their frequency of occurrence in the English language and length can be found in Appendix D, Table D.1.

The format of the word rating task was based on the design of the Self Assessment Manikin (SAM; Lang, as cited in Bradley & Lang, 1994) utilised by Bradley and Lang (1999) when creating the ANEW norms. The SAM is a pictorial assessment technique, designed to measure ratings of pleasure, arousal and dominance (Bradley & Lang, 1994). In the version of the SAM used to create the ANEW, participants were presented with a nine-point scale, alternating between response boxes that were blank or housing a manikin. The current study utilised a nine-point scale based on that of the SAM. Words, however, not manikins were included in the rating scales. For example, when rating for valence using the SAM, the first box was depicted as a frowning manikin, the middle box was depicted as a neutral manikin and the ninth box was depicted as a smiling manikin. In the current study, the same basic principle was employed (i.e., a scale to rate the dimensions of unpleasant to pleasant) with nine possible response points ranging from *unpleasant*, which was written above the first box, to *pleasant*, which was written above the last box.

Words were presented electronically using PsychData®, an online data collection website designed specifically for research in psychology and the social sciences. Responses were made on a nine point Likert scale by selecting the appropriate rating box. For arousal, a rating of one indicated the word was *not arousing/did not produce a reaction* as opposed to a rating of nine which indicated that the word was *very arousing/ elicited a strong reaction*. For valence, a rating of one indicated the word was *negative/ unpleasant* and a rating on nine indicated the word was *positive/very pleasant.*

5.2.4 Procedure

After clicking on the link for the word selection study, participants were redirected to the information letter and consent form. Once consent had been given, participants completed the demographic questionnaire. Participants were then randomly allocated to rate the words in one of the five lists. Initially participants were asked to rate all the words for arousal in the following manner.

> **For each word please rate how much of a reaction this word produces for you.** For example, the word “terrified” is likely to produce a strong reaction/a lot of arousal for most people so would receive a high rating. Similarly, the word “miracle” is likely to produce a strong reaction/a lot of arousal for most people and again, would likely receive a high rating. An example of a low arousing word/a word that does not produce much of reaction for most people is the word “bored", so this word would receive a low rating. Similarly, the word "relaxed” would likely produce low arousal/ little reaction for most people, so this would also receive a low rating. **Remember that you are not rating how positive or negative the word is, you are rating how much of a response the word elicits.**

> **Work at a rapid pace, not spending too much time on any one word. Base your ratings on your first immediate reaction when reading each word.**

Participants were then requested to rate the same words for valence in the following manner.

> For this task you will be presented with the same list of words that appeared in the previous task, however this time, **please rate the valence or emotionality of each word by indicating how positive or negative you believe the words to be.** For example, the word "love" is likely to be classed as a positive word by most people and therefore would receive a rating of 6 and above. Comparatively, the word "cancer" is likely to be classed as a negative word and would therefore receive a rating below 3. The word "square" is likely to fall between the poles and therefore receive a rating between 3 and 6.
>
> **Work at a rapid pace, not spending too much time on any one word. Base your ratings on your first immediate reaction when reading each word.**

At the end of the task participants were thanked for their involvement in the study.

5.3 Results

5.3.1 Descriptive Statistics

Data were imported from PsychData® into SPSS version 19. Mean valence and arousal ratings were computed for each word, and initial word retention was based on the mean valence ratings of the words. Words were classed as negative if they had a mean rating of 3 and below, neutral if they had a mean rating between 3.01 and 5.99, and positive if they had a mean rating of 6 and above. These cut-offs coincide with the classification of the ANEW norms (Bradley & Lang, 1999). For the purpose of this study words were not grouped as low or high arousing using specific cut-offs (which is also consistent with the norms of the ANEW).

Preliminary analyses were conducted on all word categories in order to ensure there were no significant differences between the arousal levels of the target positive and negative words, or between the target neutral and neutral words (a list of all words, including their frequency of occurrence in the English language, length, mean valence and arousal ratings can be found in Appendix D, table D.1). Analyses were also conducted to ensure no significant differences between the frequencies of the words, or valence of the target neutral and neutral categories. All categories of words were matched for length at the sequence level when the initial word pools were developed. As such, there was no need to conduct an analysis to ensure there were no significant differences between any of the categories. These preliminary analyses are not reported, however, analyses on the final selection of words is reported in section 5.3.3

5.3.2 Preliminary Discussion of Word Selection

Before the final categories of words were selected, several words and 2 of the 20 categories were excluded due to exploratory analyses and mean ratings. Based on the valence cut-offs, 2 categories of words assumed to be neutral were excluded as they were rated too positively. The bulk of words in both the flowers and weather category received mean valence ratings above six. Additionally the assumed neutral category of terrain was also excluded as 3 words (*streams, forests,* and *beaches*) were rated too positively. As each of these words were seven letters in length, this category no longer met the length requirements and thus the whole category was omitted.

In addition to the categorical exclusions, 10 other words proposed as neutral were eliminated due to their mean valence ratings. Words excluded due to their valence ratings of above 6 (i.e., positive) were from the categories of countries (*bahamas and jamaica*), space (*eclipse*), animals (*dolphin* and *leopard*), sports (*surfing*), and accommodation (*cottage, resort,* and *mansion*). One word (*sulphur*) from the elements category was also excluded as it received a mean rating below three indicating that it was a negative word.

Of the remaining 17 categories a decision was made to cut the transport and tools categories, as their arousal values did not fit in as well with the other categories due to slightly lower arousal ratings. While the differences were not significant, only a total of 15 categories were required, and there were more suitably matched categories to retain.

As 10 words were piloted in each category and only 5 per category were needed, words were gradually eliminated from categories based on their respective fit (in terms of length and frequency) with the target positive and negative words selected first. The final target positive and target negative words were selected based on their valence ratings. Generally, the lowest rated words were selected for the negative category and the highest rated words were selected for the positive category (arousal ratings were kept consistent during this process). Analyses were then run on the final 15 categories.

5.3.3 Inferential Statistics

A series of mixed factorial ANOVAs was conducted to test the lexical equivalence of words. More specifically, three mixed factorial ANOVAs were run to ensure the conditions of word selection were satisfied in regards to frequency of occurrence, valence, and arousal.

Results for Experiment 1 and all subsequent analyses in the project were interpreted using the univariate approach to the analysis of repeated measures. If sphericity was violated and the Greenhouse-Geisser value was above .75, the Huynh-Feldt correction was applied (Field, 2009). Significant interactions were further examined using simple main effects analyses. In the instance of higher-order interactions, these were further examined using simple interaction effects analyses. Pairwise mean comparisons were corrected using a Bonferroni adjustment.

5.3.3.1 Frequency. In order for the condition regarding word frequency to be satisfied, no significant differences should emerge between the frequency of words, regardless of sequence type or position. That is, no main effects or interaction should be noted in this analysis.

A 5 (position of word) x 3 (sequence type) mixed factorial ANOVA was conducted to determine any difference between the frequency of each sequence type at each position. There was no main effect of position, $F(4, 48) = 0.19$, $p = .942$, $\eta p^2 = .02$, observed power = .09, or sequence type, $F(2, 12) = 0.14$, $p = .875$, $\eta_p^2 = .02$, observed power = .07. Additionally, no significant interaction emerged between position and sequence type, $F(8, 48) = 0.56$, $p = .808$, $\eta p^2 = .09$, observed power = .23.

5.3.3.2 Valence. In regards to valence, it was expected that a main effect of sequence type and a main effect of position would emerge. These results should occur due to the target positive words at Position 1 within the positive sequence receiving higher valence ratings than the sequences of negative emotion and pure neutral words. Additionally, the target negative emotion words at Position 1 within the negative emotion sequences should receive higher valence ratings than the positive and pure neutral sequences, thus contributing to the significant main effects. Due to this, it was also expected a significant interaction between word type and position would emerge. The significant differences, however, should only emerge between the different valence ratings of the target word types at Position 1. There should be no differences in the valence ratings of words in Positions 2-5. Providing the differences are only occurring due to the valence ratings of the target positive and target negative words at Position 1, the main effects and interaction term which are expected would not be deemed as problematic. Follow-up tests were conducted to ensure the word selection conditions were adhered to.

A 5 (position of word) x 3 (sequence type) mixed factorial ANOVA was conducted to determine any differences in the valence of words for sequence type at each position. Results found a main effect of position, $F(4, 48) = 2.64$, $p = .045$, $\eta p^2 = .18$, observed power = .70, however pairwise comparisons revealed no significant differences between any of the positions.

A significant main effect of sequence type was also noted, $F(2,12) = 56.84$, $p < .001$, $\eta p^2 = .91$, observed power = .99. Pairwise comparisons revealed significant differences ($p < .05$ for all comparisons) in the valence ratings of all three sequence types with positive sequences rated the highest ($M = 5.36$, $SE = 0.08$) followed by neutral sequences ($M = 4.98$, $SE = 0.08$) and negative sequences ($M = 4.22$, $SE = 0.08$).

Additionally, there was a significant interaction between valence at each position and sequences type, $F(8, 48) = 78.01$, $p < .001$, $\eta p^2 = .93$, observed power = .99. Follow-up analyses were conducted on the valence of target words at Position 1 (as a significant difference should emerge between these sequence types) and on the matched neutral words at Positions 2-5 for each sequence type.

A between groups one-way ANOVA examining valence ratings of the sequence types at Position 1 was significant, $F(2,12) = 390.40$, $p < .001$, $\eta p^2 = .99$, observed power = .99, with target positive words receiving the highest ratings ($M = 7.82$, $SD = 0.21$), followed by target neutral words ($M = 5.22$, $SD = 0.53$), then target negative words ($M = 1.67$, $SD = 0.21$). Post-hoc analyses revealed significant differences between each of the categories ($p < .001$ for all comparisons).

In addition, a 4 (position of word) x 3 (sequence type) mixed factorial ANOVA was conducted to determine any differences in valence levels between each of the neutral categories in Positions 2-5. Although a main effect of position emerged, $F(3, 36) = 3.23$, $p = .034$, $\eta p^2 = .21$, observed power = .69, pairwise comparisons revealed no significant differences between valence ratings at each position (p >.05 for all comparisons). Additionally, there was no main effect of word type, $F(2, 12) = 1.12$, $p = 3.59$, $\eta p^2 = .16$, observed power = .20, or interaction, $F(1, 12) = 1.45$, $p = .274$, $\eta p^2 = .19$, observed power= .25.

5.3.3.3 Arousal. Analyses of arousal of words should also uncover a main effect of sequence type and a main effect of position. Additionally, a significant interaction should be noted between sequence type and position. These findings should occur due to the same reasons stated above with regards to valence. That is, the differences in arousal levels should only occur between the target emotional words (both positive and negative) and the target neutral words at Position 1. Also, there should be no significant difference in the arousal ratings of the target positive and target negative words at Position 1. Finally, there should be no significant differences in the arousal ratings of neutral words at Positions 2-5.

A 5 (position of word) x 3 (sequence type) mixed factorial ANOVA was conducted to determine any differences between arousal levels for each sequence type at each position. There was a main effect of position, $F(4, 48) = 59.03$, $p <.001$, $\eta p^2 = .83$, observed power = .99. Pairwise comparisons revealed that the difference was emerging due to the high arousal values of the words at Position 1 ($M = 5.05$, $SE = 0.10$). Significant differences ($p < .001$ for all comparisons) were noted between Position 1 and Positions 2 ($M = 3.07$, $SE = 0.21$), Position 1 and Position 3 ($M = 2.45$, $SE = 0.13$), Position 1 and Position 4 ($M = 2.55$, $SE = 0.12$), and Position 1 and Position 5 ($M = 2.51$, $SE = 0.12$). There were no significant differences noted between any other positions.

A significant main effect of sequence type was also found, $F(2, 12) = 22.31$, $p < .001$, $\eta p^2 = .79$, observed power = .99. Pairwise comparisons revealed a significant difference in level of arousal between the positive ($M = 3.35$, $SE = 0.11$) and neutral ($M =$

2.56, *SE* = 0.11) sequences, and the negative (*M* = 3.47, *SE* = 0.11) and neutral sequences ($p < .05$ for both comparisons). No significant difference was found between the arousal ratings of the positive and negative sequences ($p > .05$).

A significant interaction between arousal at each position and sequence type emerged, $F(8, 48) = 7.82$, $p < .001$, $\eta p^2 = .57$, observed power = .99. Follow-up analyses on the arousal of target words at Position 1 and on the matched neutral words at Positions 2-5 for each sequence type was conducted.

A between groups one-way ANOVA examining arousal ratings of the words at Position 1 was significant, $F(2,12) = 90.40$, $p < .001$, $\eta p^2 = .94$, observed power = .99. Post-hoc tests found a significant difference ($p < .001$) between the arousal ratings of the target neutral words (*M* = 3.11, *SD* = 1.48) in comparison to both target positive words (*M* = 5.86, *SD* = 0.22) and target negative words (*M* = 6.19, *SD* = 0.37). There was no significant difference in arousal levels between the positive and negative words ($p = .677$).

In addition, a 4 (position of word) x 3 (sequence type) mixed factorial ANOVA was conducted to determine any differences in arousal between each of the neutral categories in Positions 2-5. While a main effect of position emerged, $F(3, 36) = 3.50$, $p = .025$, $\eta p^2 = .23$, observed power = .73, pairwise comparisons revealed no significant differences between arousal ratings at each position ($p > .05$ for all comparisons). Additionally, there was no main effect of sequence type, $F(2, 12) = 2.69$, $\eta p^2 = .31$, observed power= .43, or interaction, $F(6, 36) = 0.73$, $p = .623$, $\eta p^2 = .11$, observed power = .25.

5.4 Discussion

The aim of the present study was to develop a set of words for use in the subsequent ESTs. The final word list is presented in Table 5.2. Additionally, both individual and categorical ratings of words in regards to length, frequency of occurrence in the English Language, valence, and arousal can be found in Table D.1 (Appendix D).

Table 5.2

Words Selected for the EST in Experiments 2 and 3

	Positive emotion sequences			
POSITIVE	ANIMALS	CONSTRUC.	ACCOM.	ELEMENTS
bliss	camel	fibre	shack	alloy
joyful	badger	lumber	hostel	carbon
radiant	echidna	fencing	chattel	silicon
hopeful	cheetah	granite	caravan	calcium
inspired	squirrel	concrete	barracks	hydrogen
	Negative emotion sequences			
NEGATIVE	SPACE	SPORTS	FASHION	ELECTRICAL
agony	pluto	rugby	scarf	dryer
hatred	meteor	squash	blazer	kettle
enraged	density	archery	mittens	blender
despise	jupiter	cricket	sandals	freezer
rejected	asteroid	climbing	umbrella	keyboard
	Neutral sequences			
COUNTRIES	INSTUMENTS	STATIONARY	FURNITURE	OCCUPATIONS
kenya	flute	clips	bench	valet
greece	violin	folder	stools	tailor
ireland	piccolo	notepad	ottoman	builder
austria	trumpet	pencils	dresser	mailman
colombia	clarinet	scissors	wardrobe	mechanic

Note. CONSTRUC. = Construction; ACCOM. = Accommodation

Specifically, it was important to ensure that the semantically related words within each category were matched for length and frequency of occurrence within the English language. This was achieved in the present study, as words were controlled for length at both the sequence level and category level. Additionally, all words had approximately the same frequency of usage in the English language, with no significant differences emerging between any of the categories of words. Furthermore, the condition that each category of target words (i.e., positive emotion, negative emotion, and neutral words at Position 1) would differ in valence ratings with positive words receiving the highest ratings, negative words receiving the lowest ratings and neutral words receiving moderate ratings, was satisfied. The condition that there would be no significant differences between the valence and arousal ratings of the non-target neutral categories was also satisfied. Furthermore, the condition that positive and negative target words would receive higher arousal ratings than the target neutral words at Position 1 was also satisfied. Lastly, the condition that there would be no differences in the arousal levels of the positive and negative target words was also satisfied.

The current study developed a pool of words matched on several dimensions. Essentially, the words selected for the subsequent emotional Stroop experiments only differ in terms of arousal and valence. All target positive and negative words are more arousing than neutral words, and there are no differences in arousal levels between the neutral categories. In addition, all neutral words have comparable valence ratings falling between the negatively rated words and the positively rated words.

A limitation of the present study relates to the development of semantically related categories, as the present study did not formally have the semantic relatedness of words for each category independently rated. Nonetheless, efforts were made to ensure the words in each category were representative of the categorical theme. In addition, other lexical features of words, such as orthographic neighbourhood size, have been implicated in the processing of word stimuli (e.g., Larsen et al., 2006) and were not controlled in this study. Interestingly, however, Estes and Adelman (2008) suggest that negative word valence accounts for changes in RT within tasks such as the emotional Stroop, regardless of factors such as word length, frequency of occurrence in the English language, arousal, contextual diversity, first phoneme, and orthographic neighbourhood size. Despite this, word frequency for example, has been identified as a key feature to control for in emotional Stroop experiments (e.g., Kahan & Hely, 2008). Additionally, the importance of word arousal has also been identified as a key feature that needs to be considered in terms of stimuli selection in ESTs (e.g., Dresler et al., 2009). As it was not possible to match on all lexical dimensions, a decision was made to match words based on the more readily identified factors (i.e., word length, word frequency, arousal, and semantic relatedness within categories). Due to this, the decision was made not to match words on factors such as orthographic neighbourhood size.

Additionally, due to the large number of neutral words needed for the subsequent ESTs, the word lists in the present study contained an unequal proportion of emotional and neutral words. This, however, is not necessarily problematic as previous studies have also reported unequal distributions of positive emotion, negative emotion, and neutral words (e.g., Bradley & Lang, 1999) or not reported the breakdown of words in each category (e.g., Dresler et al., 2009). Furthermore, given that the majority of piloted words received ratings confirming their suspected valence and arousal levels, it is unlikely that the unequal distribution of words from the emotional and neutral categories adversely impacted word ratings.

Despite these limitations, the present study offers a word list comprising semantically related categories of both emotive and neutral words. These words were been matched on several important dimensions and have been normed on an Australian sample. In addition, newer word frequencies were employed that better reflect the use of current language (Balota et al., 2004; Brysbaert & New, 2009; Larsen et al., 2006). In addition, the criteria utilised for the word selection study ensures that differences in emerging in RTs can be more readily attributed to the emotional content of the words, rather than other lexical features such as frequency of occurrence in the English language.

5.5 Summary of Chapter

The current chapter presented a study where a list of words was developed for use in the subsequent emotional Stroop experiments (specifically Experiment 2 and 3). Initially, 20 categories of words were developed, each with its own semantically related theme (e.g., negative emotion, animals). Each category was comprised of 10 words, creating a pool of 200 words that were matched in regards to average length and frequency of occurrence in the English language. These words were rated on the dimensions of both arousal and valence.

In total, 15 categories of words were selected for use in the latter ESTs. Each category was comprised of 5 semantically related words that did not differ to the other categories in regards to word length and frequency of occurrence in the English language. The only differences between the categories of words are in relation to the experimental words which are presented at Position 1. The emotional words (both positive and negative) were more arousing than the neutral words. In addition, Experiment 1 ensured that each category of words received valence appropriate ratings. For example, positive words were rated positively, negative words were rated negatively, and neutral words were rated neutrally.

Due to the matching of words for length, frequency of occurrence in the English language, valence, arousal, in addition to the creation of semantically related word categories, differences in RTs that emerge in the subsequent Stroop experiments can more readily be attributed to the content of the words themselves (e.g., emotionality) or other individual difference factors (e.g., anxiety type or level) as opposed to differences in the lexical characteristics of words.

Chapter 6. Fast and Slow Effects in the EST (Experiment 2)

6.1 Introduction

6.1.1 Overview of Chapter

The current chapter outlines the rationale for the first EST experiment (Experiment 2). This study aimed to investigate the fast and slow components of attentional bias in the EST for individuals with varying levels and types of non-clinical anxiety. Specific aims of the experiment and the hypotheses, method, results, and discussion of current study are presented.

6.1.2 Rationale

As outlined in Chapter 4, the EST is a frequently utilised method of investigating attentional bias for emotionally salient stimuli (Waters et al., 2005). While research has generally demonstrated that participants take longer to identify the ink-colour of emotional material relative to neutral material, it is unclear as to how long the disruption lasts.

Recently, with the use of refined methodologies that allow RTs to be examined on a trial-by-trial basis, emotion words have been shown to disrupt colour-naming performance beyond the duration of their presentation. As a result, the assumption that the ESE is relatively fast, occurring on a single trial, may not be accurate. Essentially, the ESE is likely comprised of both a fast and a slow component, however, the mechanisms underlying the slow effect have not yet been determined.

Wyble and colleagues (2008) suggest that fast and slow components of the ESE are independent, however, interacting phenomena. The model suggests that slow Stroop effects are not necessarily caused by the emotional valence of words, but rather a reduction of cognitive control. Essentially, when an individual is presented with threatening material, ongoing activity is interrupted. This causes a momentary withdrawal from colour-naming thus allowing for threat to be more readily detected within the environment. Furthermore, the model of Wyble and colleagues makes specific predictions regarding the nature of the ESE in individuals with varying levels of anxiety, however, at present, no study has directly investigated fast and slow components of the ESE in relation to anxiety level or type.

In order to address this gap within the literature, the current experiment examined EST performance for individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. The role of fast and slow components of attentional bias within the task were examined, over both a series of trials and differing timeframes (through the manipulation of the ITI).

The design of McKenna and Sharma's (2004) Experiment 4 was used for the EST, however, instead of presenting words in sequences of seven, the decision was made to investigate RTs over five positions. In the study of McKenna and Sharma, slow effects only extended to the first neutral word following a target negative emotion word. In addition, previous emotional Stroop experiments that examined both fast and slow components of the ESE have generally only reported slow effects occurring on Position 2 after presentation of a target word in Position 1 (e.g., Waters et al., 2005). The only exception to these studies were Ashley and Swick (2009) and Cane and colleagues (2008), who found a slow effect extending to later positions. Based on these findings it was deemed appropriate to investigate RTs over a series of five positions.

This present study utilised both negative emotion words (i.e., threatening material) and positive emotion words, controlling for arousal and lexical features such as length, frequency of occurrence in the English language, and semantic relatedness within categories (a detailed account of stimuli selection for the current experiment was presented in Chapter 5).

6.1.3 Aims and Hypotheses

The aim of the present study was to investigate the occurrence of fast and slow effects in individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. For fast effects to be present, RTs to target negative (or positive) emotion words would need to be longer than RTs to target neutral words at Position 1. For a slow effect to be present, RTs to neutral words which were preceded by negative (or positive) emotion words would need to be longer than RTs to neutral words which were preceded by target neutral words (in Position 2 and possibly beyond). According to the model of Wyble et al. (2008), whether fast and slow effects are present for the different types of target emotional words (i.e., negative or positive) should depend on the type and level of anxiety displayed by an individual. Specifically, the hypotheses predicted differences among the four anxiety groups mentioned above, and also differences between fast and slow effects within the anxiety groups. In addition, it was expected that the magnitude and duration of these effects would likely differ depending on the duration of the ITI. The predictions of the current study were as follows.

Based on the model of Wyble et al. (2008), in addition to the previous literature regarding anxiety and the EST (which was presented in Chapters 1, 2, and 3), it was predicted that state anxious, trait anxious, and state-trait anxious individuals would demonstrate an attentional bias to negative emotion words characterised by a fast effect. It was expected that individuals within these groups would show fast effects due to the ability of the emotional information to travel quickly throughout their information processing systems, thus affecting performance on immediate trials. As trait anxious individuals are more likely to have these strengthened connections, it was also expected that the fast effect would be greatest in the trait anxious and state-trait anxious groups, than in the state anxious group. Additionally, if arousal rather than valence of words could account for emotional Stroop effects, it was predicted that the state anxious and state-trait anxious individuals would show fast effects for positive emotion words in addition to negative emotion words.

It was also expected that low anxious, state anxious, trait anxious, and state-trait anxious individuals would demonstrate an attentional bias to negative emotion words, characterised by a slow effect. Specifically, slow effects would be present for individuals within these groups due to the ability of emotional stimuli to activate the affective component of the AAC unit, which in turn suppresses the cognitive component. This would result in a momentary withdrawal from the current task, whereby participants subconsciously place less importance on colour-identification and greater importance in detecting threat within their environment. This momentary withdrawal, however, does not occur on the immediate trial, but rather on subsequent neutral trials. Additionally, it was predicted that if arousal rather than valence of words could account for emotional Stroop effects, these anxiety groups would show slow effects for positive emotion words in addition to negative emotion words. Furthermore, it was expected that the slow effect would emerge on Position 2 and possibly extend to additional positions. Due to the increased activation of the AAC in state anxious individuals, it was expected that the state anxious and state-trait anxious individuals would report a larger slow effect (as demonstrated by occurring over more positions or of a larger magnitude) than low anxious and trait anxious individuals.

In addition to predictions regarding differences among individuals with varying levels of anxiety (e.g., state anxious versus trait anxious), it was also expected that differences would occur within anxiety groups with regards to the presence of fast and slow effects. Specifically, it was predicted that the trait anxious individuals would demonstrate larger fast effects in comparison with slow effects. Larger fast effects should be present within trait anxious individuals due to the strengthened connections throughout their information processing system causing immediate interference due to greater excitation at the categorical layer.

It was also expected that state anxious individuals would demonstrate larger slow effects in comparison to fast effects. It was thought that slow effects would be stronger within this group due to the ability of emotional information to strongly activate the affection portion of the AAC unit, thereby suppressing the cognitive component.

It was also predicted that the state-trait anxious individuals would demonstrate both fast and slow effects of the same magnitude. This is due to both the activation of the AAC unit and their strengthened connections in their information processing system.

It was also predicted that the magnitude of fast and slow effects (in each of the anxiety groups and to the specific stimuli outlined in the prior hypotheses) would vary depending on the duration of the ITI. Based on the findings of Sharma and McKenna (2001) it was expected that the magnitude of fast effects would be greatest when the ITI was short. In addition, it was predicted that the duration of the slow effect would differ across positions depending on the ITI, that is, the slow effect may not necessarily be trial specific. Although the duration of the ITI has not previously been investigated in relation to slow effects, it was thought that with a longer duration between trials, the slow effect may dissipate as opposed to when there is a brief interval between trials.

6.2 Method

6.2.1 Participants

One-hundred and four participants took part in the study. In total, 98 participants complied with the restrictions placed on the sample (which were outlined in Chapter 5) and were retained for analyses. In addition, participants were required to have normal, or corrected to normal vision. Participants were recruited from Australian Catholic University undergraduate psychology classes, from both the Melbourne (*n* = 55) and Brisbane (*n* = 43) campuses. Students were eligible to receive 1% course credit for participating in the project. The age range of the sample was 18-45 years with a mean age of 22.75 years (*SD* = 5.10). Testing was done either individually (*n* = 28) or in groups (*n* = 70) in a computer laboratory with an experimenter present.

6.2.1.1 Anxiety group distribution. Participants were classified into one of four anxiety groups: Low anxious, state anxious, trait anxious, or state-trait anxious based on their scores on the STAI (Spielberger et al., 1983). This classification of individuals was based on norms reported by Spielberger et al. (1983), and also coincided with previous research investigating these different forms of anxiety in the EST (e.g., Edwards, Burt, & Lip, 2006; Edwards et al., 2009; MacLeod & Rutherford, 1992). As the norms reported by Spielberger and colleagues differ for women and men, the current study employed different cut-offs for assignment into an anxiety group for each sex. Collapsed over gender, the majority of participants were state-trait anxious (*n* = 41), followed by low anxious (*n* = 30), state anxious (*n* = 14), and trait anxious (*n* = 12). The state-trait group had state anxiety scores ranging 39-75 (*M* = 50.61, *SD* = 8.96), and trait anxiety scores ranging 40-75 (*M* = 51.98, *SD* = 9.46). The low anxious group had state anxiety scores ranging 22-38 (*M* = 30.10, *SD* = 5.18) and trait anxiety scores ranging 20-40 (*M* = 31.40, *SD* = 5.88). The state anxious group had state anxiety scores ranging 39-68 (*M* = 49.25, *SD* = 10.62) and trait anxiety scores ranging 29-39 (*M* = 34.64, *SD* = 2.92). The trait anxious group had state anxiety scores ranging 30-38 (*M* = 33.33, *SD* = 2.64) and trait scores ranging 41-63 (*M*= 47.00, *SD*= 6.80). It should be noted that the anxiety group breakdowns reported (including *M*s and *SD*s) were based on the participants included in the final analyses.

6.2.1.1.1 Women. Women with scores at 38 or below on the state scale and 40 or below on the trait scale were grouped as low anxious (*n* = 25). Women with scores at 39 or above on the state scale and at 40 or below on the trait scale were grouped as state anxious (*n* = 12). Women with scores at 41 or above on the trait scale and at 38 or below state scale were assigned as trait anxious (*n* = 7). Women with scores at 39 or above on the state scale and 41 or above on the trait scale were grouped as state-trait anxious (*n* = 36).

6.2.1.1.2 Men. Men with scores at 36 or below on the state scale and 38 or below on the trait scale were grouped as low anxious (*n* = 5). Men with scores at 37 or above on the state scale and at 38 or below on the trait scale were grouped as state anxious (*n* = 2). Men with scores at 39 or above on the trait scale and at 36 or below on the state scale were assigned as trait anxious (*n* = 5). Men with scores at 37 or above on the state scale and 39 or above on the trait scale were grouped state-trait anxious (*n* = 5).

6.2.2 Design

The design was a 3 x 5 x 3 x 4 mixed factorial model. The first IV was sequence of word, consisting of three levels: Positive emotion, negative emotion, and neutral. The second IV was word position ranging from Position 1-5. The third IV was duration of the ITI with three levels: Short (32 ms), medium (1000 ms), and long (2000 ms). These three IVs were within-subject factors. The fourth IV was class of anxiety and comprised four levels: Low anxious, state anxious, trait anxious, and state-trait anxious. This IV was a between-subjects factor. The DV was mean correct RT (measured in ms).

6.2.3 Materials

6.2.3.1 Demographic questionnaire. Basic information relating to age, sex, and occupation (i.e., university student or from general community), was collected using a brief questionnaire (See Appendices E and F for participant information letter and demographics form).

6.2.3.2 State Trait Anxiety Inventory. This self-report questionnaire is comprised of two scales; one that assesses state (S) anxiety and one that assesses trait (T) anxiety (Spielberger et al., 1983). Each scale is 20 items in length and requires participants to respond using a four point Likert scale. Due to copyright reasons it was not possible to include a copy of the STAI in an Appendix; however several examples of items from each scale have been presented below.

The STAI-S scale asks participants to rate how they are feeling *right now, that is, at this moment*. Examples of statements from this scale include *I feel calm*, *I feel nervous*, and *I am presently worrying over possible misfortunes*. Participants are asked to indicate their level of agreement to the statements using *not at all* (1), *somewhat* (2), *moderately so* (3), and *very much so* (4) (Speilberger et al., 1983). The possible range of scores on the S scale is 20- 80, with low scores indicating no or little state anxiety and high scores indicating elevated levels of state anxiety.

The STAI-T scale asks participants to rate how they are *generally* feeling. Examples of statements from this scale include *I feel pleasant*, *I feel like a failure*, and *I feel satisfied with myself*. Participants are asked to indicate their level of agreement to the statements using *almost never* (1), *sometimes* (2), *often* (3), *and almost always* (4) (Speilberger et al., 1983). The possible range of scores on the T scale is 20-80, with low scores indicating no or little trait anxiety and high scores indicating elevated levels of trait anxiety.

Both scales have demonstrated good validity and reliability across both men and women in multiple samples (e.g., working adults and university students; Speilberger et al., 1983). The internal consistency of both the S (Cronbach's alpha = .93) and T (Cronbach's alpha = .90) scales reported by Speilberger (1983) were excellent. In addition to this, the STAI has been repeatedly used in studies that assess these components of anxiety (e.g., Edwards et al., 2009; MacLeod & Rutherford, 1992).

6.2.3.3 Emotional Stroop task. The EST was presented electronically using E-prime version 2.0. The majority of testing utilised Dell computers with a Windows 7 Enterprise operating system. Each word was presented in one of four ink-colours: Red, blue, green, or yellow. Order of colour presentation was randomised with the restriction that the same colour could not repeat on consecutive trials.

Each word was presented one at a time, in the middle of the screen, in 38 point lower case font. In total 75 words were used in the EST: 15 target words (i.e., 5 positive emotion, 5 negative emotion, and 5 neutral) and 60 neutral words. All words were arranged into sequences of 5 words (i.e., one word at each position). These sequences of 5 words remained the same throughout the experiment.

A target word was always presented in Position 1, with the matched neutral words following in Positions 2 to 5. Within each sequence of words, the matched neutral words were randomised at each presentation (i.e., while the target word was always presented in Position 1, the order of the neutral words that follow changed). In addition to this, sequence selection was randomised for each individual (i.e., participants were exposed to the sequences in varying orders) and within each block.

Finally, presentation of sequences occurred in three blocks. These three blocks had differing ITIs (i.e., 32 ms, 1000 ms, and 2000 ms). In the 32 ms block for example, a word was presented until the participant responded, the next word was then presented after a very brief interval of 32 ms. This procedure was identical in the 1000 ms and 2000 ms blocks, however, instead of a 32 ms ITI, a 1000 ms or 2000 ms ITI was utilised (depending on which block was presented). Within each block, each sequence of five words was presented twice (i.e., there was 30 unique sequences per block). A short break of 30 seconds was given to participants after the completion of each block. Order of block presentation was counter-balanced across participants with order randomly assigned as ABC, ACB, BAC, BCA, CAB, or CBA.

In total, participants completed 90 sequences (i.e., 30 sequences per block, with 150 trials in each block), totalling 450 trials. The ink-colour of words did not repeat on consecutive trials.

6.2.4 Procedure

Participants were given an information letter and consent form before commencing the experiment. Testing occurred either individually or in small groups. When group testing occurred, participants were seated spread out across the lab. Participants were informed the task was investigating colour perception and RT. More specifically, participants were told a word would be presented in one of four ink-colours and their task was to respond as quickly but as accurately as possible to the ink-colour of the word whilst ignoring the word. Participants were informed that the task would be presented in three blocks, with each block presenting words at different speed, with the order of block presentation randomised. Participants were told that they should respond by pressing the keyboard key that matched the colour of the word, and were asked to place their first and second fingers on each of these keys (i.e., p, 1, a, q) and leave their fingers in that location throughout the experiment. Participants were given 10 practice trials to familiarise themselves with the task. These practice trials used neutral words that were not used during the rest of the experiment. Additionally, the practice trials were presented with differing ITIs.

Each word was presented in the centre on a black screen and remained until a response was made. After the respective ITI the next word was presented. Following the EST participants were asked to complete the basic demographic questionnaire and the

STAI. The experiment took approximately 20 minutes to complete. Upon completion of the experiment participants were debriefed and thanked for their involvement.

6.3 Results

6.3.1 Data Screening

Data were entered and analysed using SPSS version 20. Data were screened prior to analyses for accuracy of input, missing values, univariate normality, outliers and the assumptions of the omnibus *F* test. There were no out-of-range values and all means and standard deviations were plausible, indicating no problems associated with data entry. Missing values analyses were conducted on the questionnaire data to ensure any missed items were missing at random. There were no RT data missing. Variables with more than 5% of values missing were considered problematic (Tabachnick & Fidell, 2007).

Normality was checked for all anxiety groups on both the questionnaire (i.e., the STAI) and RT data using the Shapiro-Wilk test for normality as each sample size had fewer than 100 participants (Field, 2009). In instances where the Shapiro-Wilk test was significant, indicating the sample did significantly differ from a normal distribution, standardised skew and kurtosis values were examined, using a cut-off of $/z/ = 3.29$, $p < .001$ (Field, 2009). Univariate outliers were identified through the calculation of *z* scores with values of $/z/> 3.29$ considered problematic.

6.3.1.1 Questionnaire data. The internal consistency of both the S (Cronbach's alpha= .94) and T (Cronbach's alpha= .94) scales of the STAI were excellent. A missing values analysis was performed on the STAI revealing less than 5% of missing values on the state (2%) and trait (2%) scale. As these were below the threshold of 5% and the missing values appeared random in nature, they were not deemed as problematic. Due to the small number of values missing the decision was made to replace these missing values using median replacement. In total, this technique was used on five items (16, 18, 26, 36, and 38) across five participants. One participant failed to fill out all items on the trait scale, and as a result their data were omitted from analyses.

The Shapiro-Wilk test for normality was significant for both the state (p = .012) and the trait (p = .032) scales indicating potential problems with normality with both distributions positively skewed. Standardised skew and kurtosis values indicated the breaches in normality were not problematic.

6.3.1.2 RT data. Average mean correct RTs to identify the ink-colour of words were obtained for each participant. This was done for each category of experimental words at Position 1 and for each of the words in Positions 2 to 5 (neutral words). RTs less than 200 ms and greater than 2000 ms were excluded from these averages as to remove excessively fast or slow RTs from the data set. While there are no consistently utilised criteria for determining which RTs to exclude, these cut-offs are similar to previous research. For example, Algom et al. (2004) repeated trials which were responded to slower than 2000 ms or faster than 180 ms; Frings and colleagues (2010) excluded trials above 1412 ms and below 200 ms; Wurm, Labouvie-Vief, Aycock, Rebucal, and Koch (2004) excluded trials above 1000 ms for younger adults and 2500 ms for older adults; and Franken et al. (2000) excluded trials above 3000 ms and below 200 ms. Participants with more than 5% of RTs exceeding these thresholds within one block (i.e., 32 ms, 1000 ms, and 2000 ms) had their data removed from that respective block. There were two participants who met this criterion. One participant responded over 2000 ms on 8% of trials in the 2000 ms block. Another participant responded under 200 ms on 48.67% of trials in the 32 ms block. As a result, data from these participants were removed from that respective block (and thus their data was omitted from all subsequent analyses, including post-hoc analyses, due to the repeated measures design).

Normality of RTs was assessed in each anxiety group. Normality was retained in the low anxious, state anxious, and trait anxious groups. There were breaches of normality in the state-trait anxious group across five variables. Removal of outliers reduced the amount of skew and kurtosis on each of the variables however due to the robustness on the *F* test (Keppel & Wickens, 2004), the decision was made that these breaches in normality were not problematic. For a detailed account of the normality investigation, see Appendix G.

6.3.2 Descriptive Statistics

Prior to commencement of the experiment, an a priori power analysis was conducted using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) in order to determine sample size. The statistical test selected for the power analyses was a repeated measures ANOVA (within-between interaction). The analyses showed that in order to detect a small to moderate effect size (f =.18; Cohen, 1992) with a power of .95 and alpha set at .05, a total sample size of 84 was required. Descriptive statistics for each anxiety group are presented in the Figures 6.1 – 6.4.

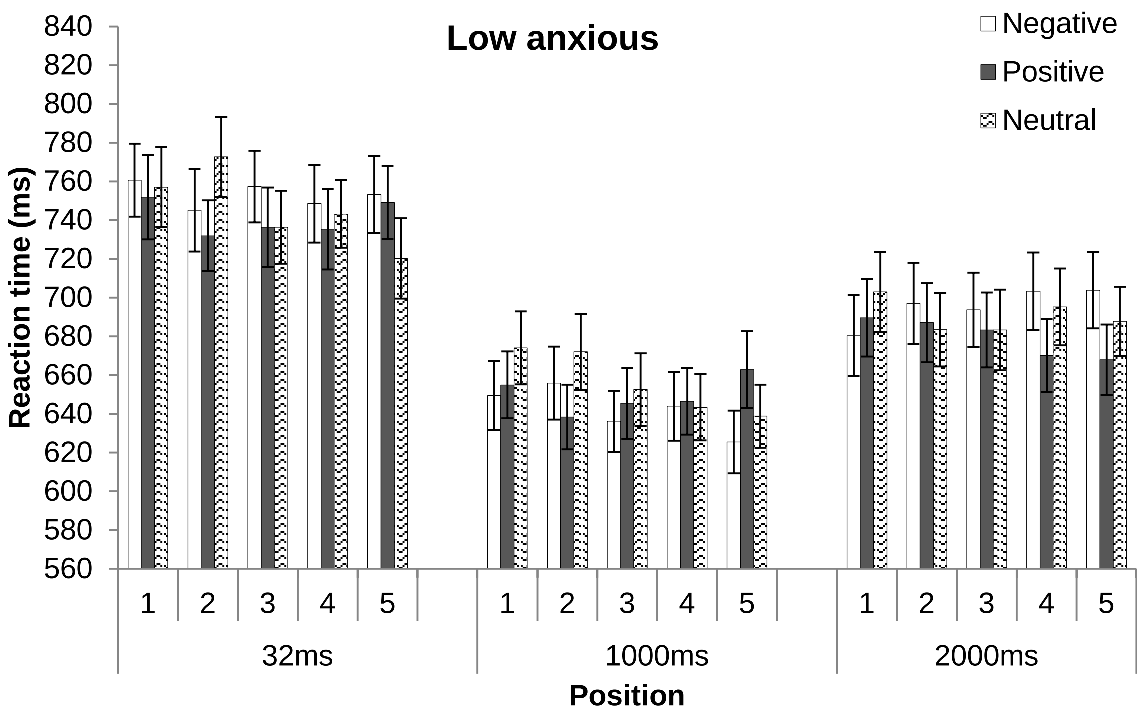

Figure 6.1. Average RTs (with Standard Error) for the low anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences.

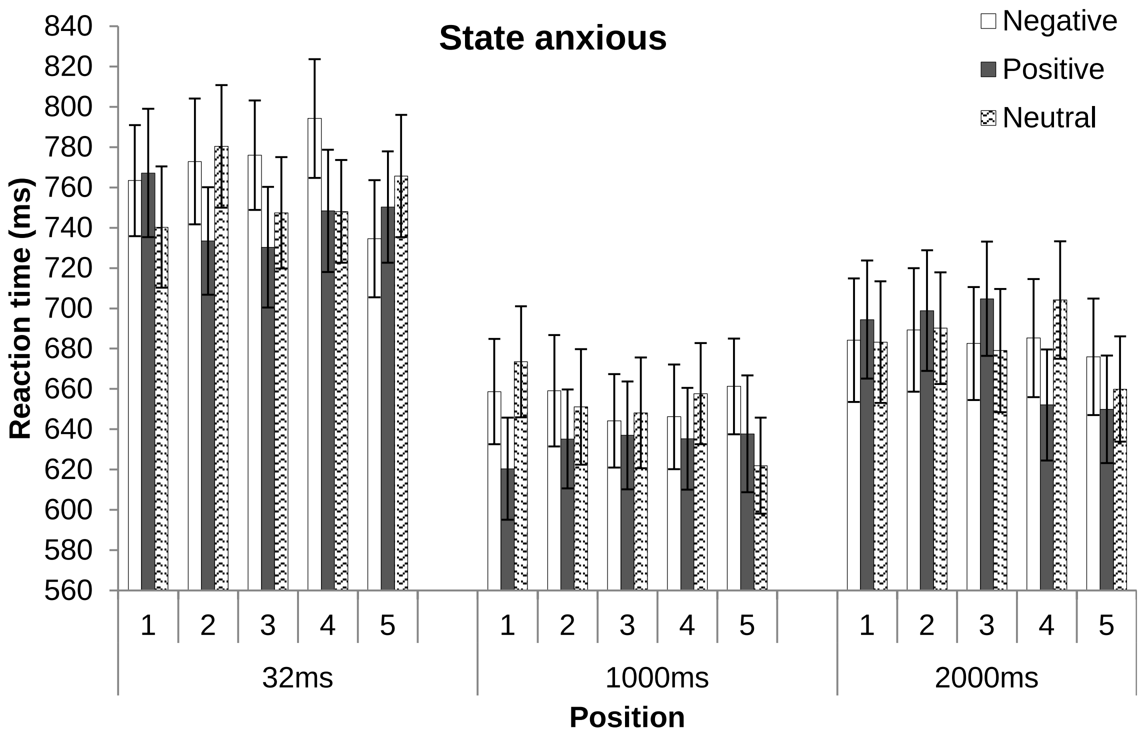

Figure 6.2. Average RTs (with Standard Error) for the state anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences.

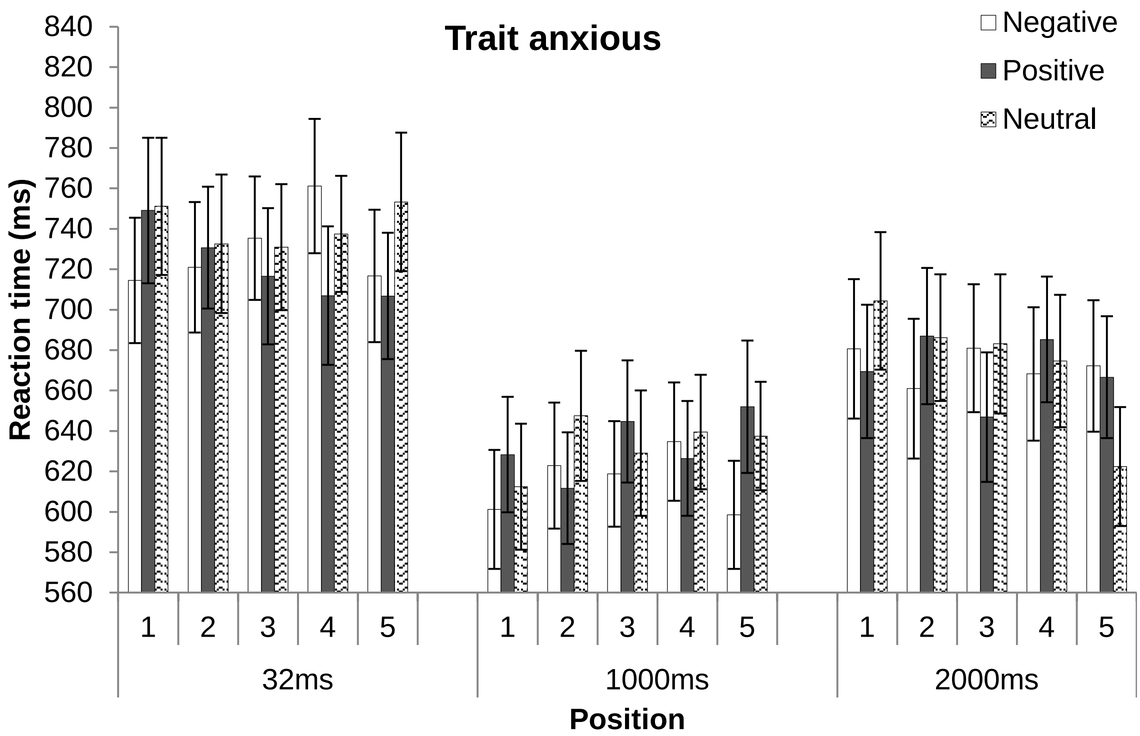

Figure 6.3. Average RTs (with Standard Error) for the trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences.

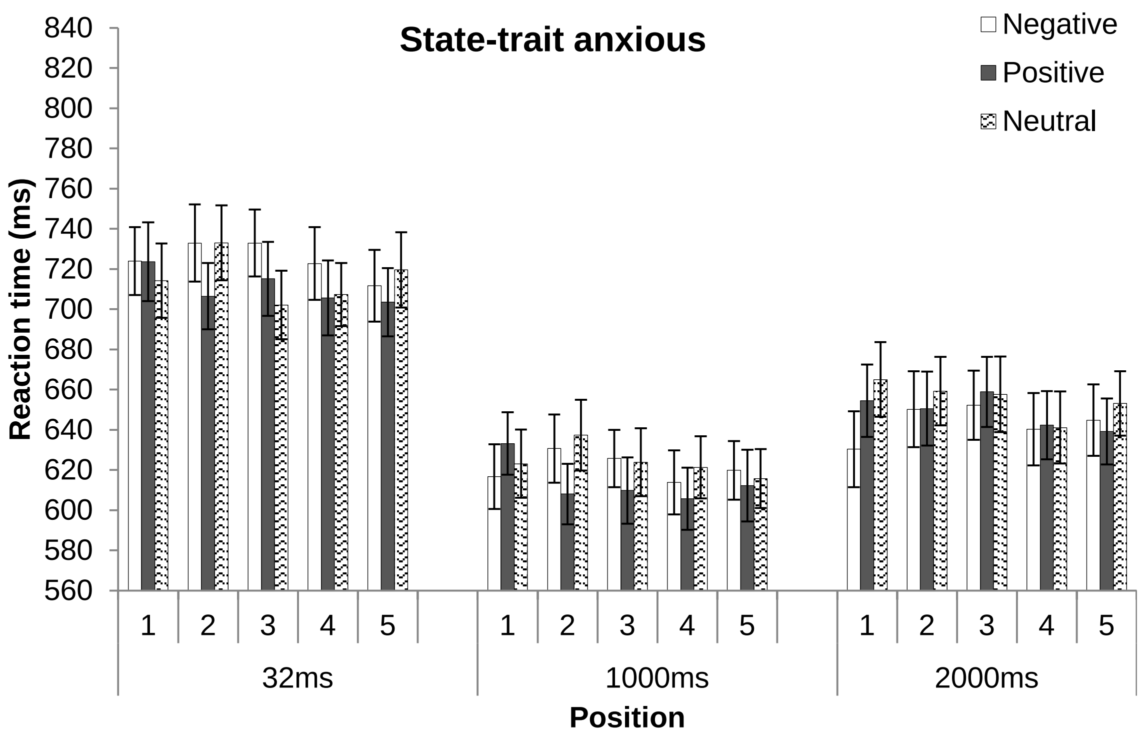

Figure 6.4. Average RTs (with Standard Error) for the state-trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences.

6.3.3 Inferential Statistics

All analyses for the current experiment (and Experiments 3 and 5) were performed on the average RTs for correct colour-identification responses. As stated in Chapter 5, all results were interpreted using the univariate approach to the analysis of repeated measures. When sphericity was violated and the Greenhouse-Geisser value was above .75, the Huynh-Feldt correction was applied (Field, 2009). Significant interactions were further examined using simple main effects analyses. In the instance of higher-order interactions, these were further examined using simple interaction effects analyses. Pairwise mean comparisons were corrected using the Bonferroni adjustment. Unless otherwise stated, homogeneity of variance was met. Throughout this thesis, analyses are reported starting with main effects, followed by the interaction terms.

Before the main analysis of interest was performed, a 3 (ITI: 32 ms, 1000 ms , and 2000 ms) x 4 (anxiety group: Low anxious, state anxious, trait anxious, and state-trait anxious) mixed factorial ANOVA was conducted to examine error rates between the 32 ms, 1000 ms, and 2000 ms blocks for each of the anxiety groups. There were no significant differences between any of the blocks, $F(1.28, 119.29) = 0.37$, $p = .600$, $\eta_p^2 = .01$, observed power = .10, or anxiety groups, $F(3, 93) = 2.52$, $p = .063$, $\eta_p^2 = .08$, observed power = .61. In addition, there was no significant interaction between ITI block and anxiety, $F(6, 186) = 9.38$, $p = .442$, $\eta_p^2 =.03$, observed power = .28. Table 6.1 presents the proportion of error rates for each anxiety group at the 32 ms, 1000 ms, and 2000 ms blocks.

Table 6.1

Proportion of Error Rates for Each Anxiety Group at the 32 ms, 1000 ms , and 2000 ms Blocks

Anxiety group	Block	*M (%)*	*SD(%)*
Low	32 ms	2.73	2.01
	1000 ms	3.40	2.26
	2000 ms	2.96	2.34
State	32 ms	3.10	2.17
	1000 ms	3.76	2.32
	2000 ms	3.33	2.47
Trait	32 ms	6.72	12.74
	1000 ms	4.78	2.74
	2000 ms	4.44	2.04
State-trait	32 ms	3.54	2.87
	1000 ms	4.52	3.14
	2000 ms	4.10	2.91

Fast and slow effects were examined using a 3 (ITI: 32 ms, 1000 ms and 2000 ms) x 3 (sequence type: Positive, negative, and neutral) x 5 (Position: 1-5) x 4 (anxiety group: Low anxious, trait anxious, state anxious, state-trait) mixed factorial ANOVA, with RTs as the DV. Of particular interest was whether the four-way interaction would be significant.

There was a main effect of ITI, $F(1.74, 153.45) = 93.13$, $p < .001$, $\eta_p^2 = .51$, observed power = .99, with the fastest RTs in the 1000 ms block (*M* = 635.71, *SE* = 9.72), followed by the 2000 ms (*M* = 673.20, *SE*= 11.33), and 32 ms (*M* = 737.85, *SE* = 10.55) blocks. Pairwise comparisons revealed that the differences in RTs between each of the blocks were significant (all $p < .001$).

There was a significant main effect of sequence type, $F(2,176) = 4.47$, $p = .013$, $\eta_p^2 = .05$, observed power = .76, with the fastest RTs noted on positive sequences (M = 677.39, SE = 9.99), followed by negative sequences (M = 683.83, SE = 9.61) and pure neutral sequences (M = 685.54, SE = 9.64). Pairwise comparisons revealed the difference in RTs was significant between the positive and pure neutral sequences ($p = .017$). Additionally, a trend towards significance was noted between the positive and negative sequences ($p = .056$)

The main effect of position was significant, $F(4, 352) = 4.03$, $p = .003$, $\eta p^2 = .04$, observed power = .91, with the fastest RTs observed at Position 5 (M = 675.35, SE = 9.75) followed by Positions 3 (M = 681.64, SE = 9.69), 4 (M = 681.83, SE = 9.62), 2 (M = 686.21, SE = 9.77), and 1 (M = 686.24, SE = 10.20). Pairwise comparisons revealed the differences were significant between Positions 1 and 5 (p =.008) and Positions 2 and 5 (p = .010).

There was no main effect of anxiety group, $F(3, 88) = 1.10$, $p = .784$, $\eta_p^2 = .04$, observed power = .29. The state-trait group had an average RT of 662.09 (SE = 13.38). The trait anxiety group had an average RT of 676.86 (SE = 24.56). The low anxiety group had an average RT of 694.86 (SE = 14.86) and the state anxiety group had an average RT of 695.19 (SE = 21.76).

A two-way interaction was observed between sequence type and position, $F(8, 704) = 2.42$, p =.014, ηp^2= .03, observed power = .90. This interaction is demonstrated graphically in Figure 6.5.

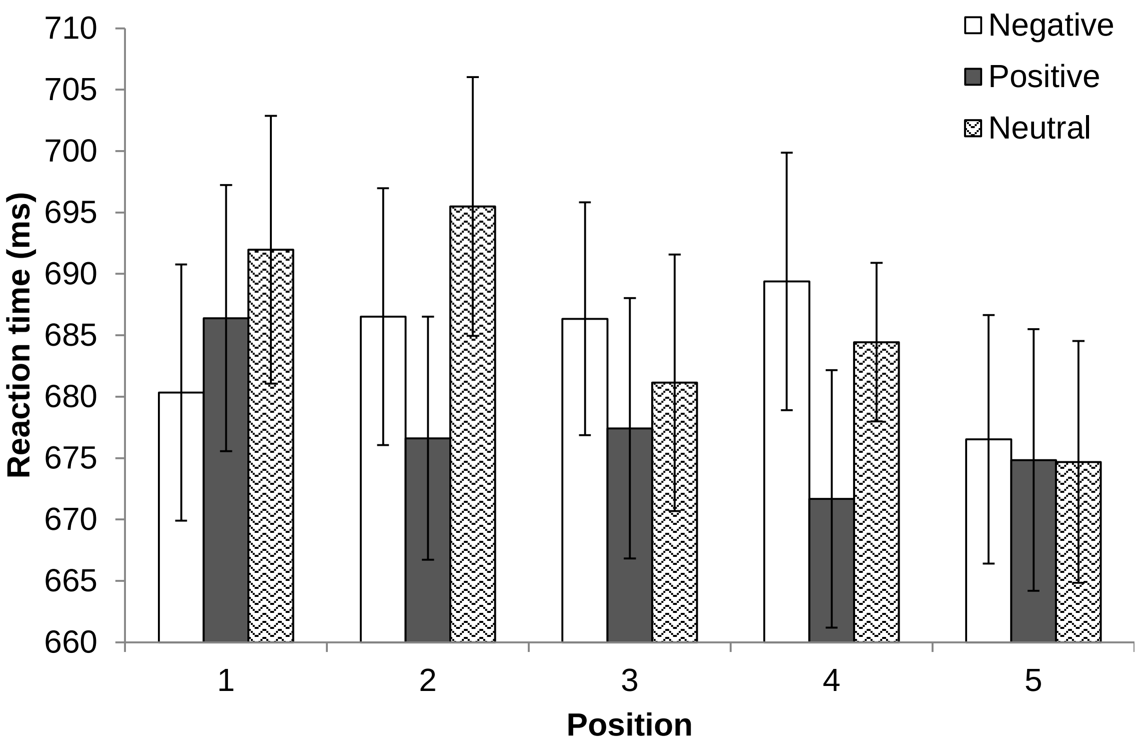

Figure 6.5. Average RTs (with Standard Error) to words in Positions 1 through 5 for the positive emotion, negative emotion, and pure neutral sequences.

Post-hoc tests were used to examine the difference in RTs for each sequence type at each position. Only significant *p* values are reported for all follow-up comparisons. At Position 1, participants responded fastest to target negative words followed by target positive and target neutral words. The difference between RTs to target negative and target neutral words at Position 1 was significant ($p = .044$). At Position 2, participants responded fastest to neutral words in the positive sequences, followed by the negative and pure neutral sequences. The difference between RTs for neutral words in the positive and neutral sequences was significant ($p < .001$). A trend towards significance was also noted between the neutral words in the positive and negative sequences ($p = .078$). No significant differences were noted at Position 3, however, a trend towards significance was noted between the neutral words in the negative and positive ($p =.082$) sequences. At Position 4, participants responded fastest to neutral words in the positive emotion sequences, followed by the neutral and negative sequences. The difference between neutral words in the pure neutral and negative sequences was significant (p =.003). Additionally, there was a significant difference between neutral words in the pure neutral and positive sequences (p =.018). There were no significant differences observed at Position 5.There was a three-way interaction between ITI, sequence type and position, $F(15.27, 1343.48) = 1.83$, p = .026, η_p^2 = .02, observed power = .95. This interaction was followed up by examining the RTs for each sequence of words, across Positions 1-5, for the three ITIs, and can be seen in Figure 6.6.

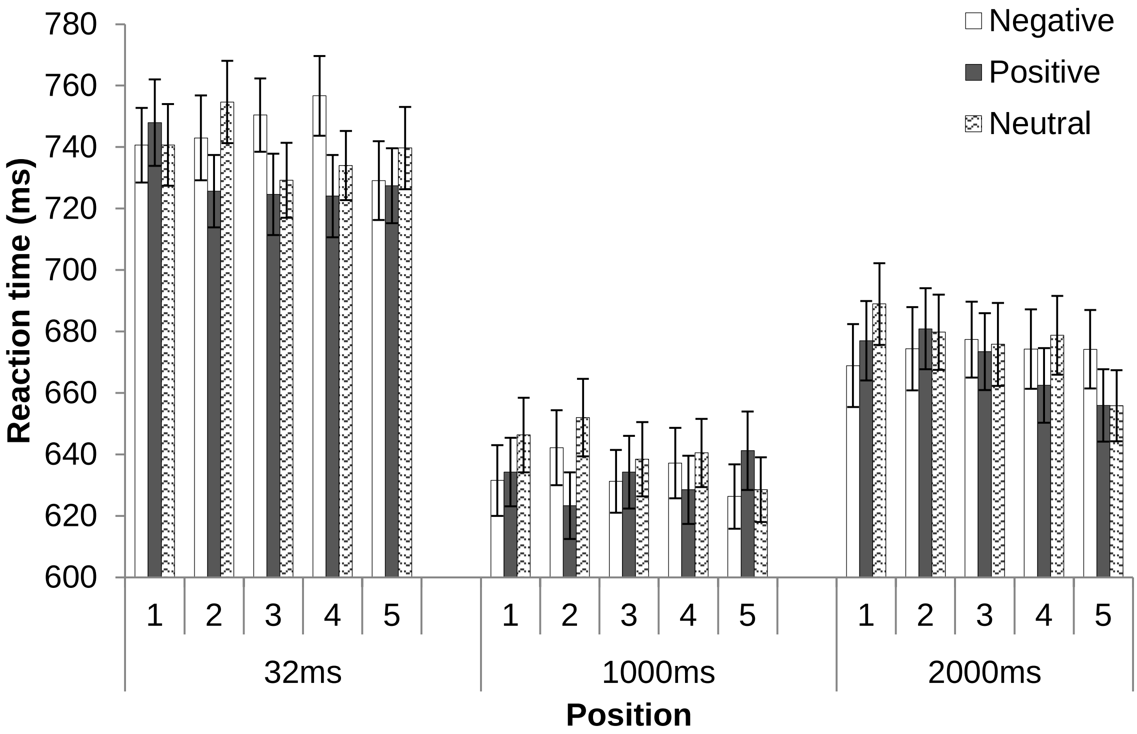

Figure 6.6. Average RTs (with Standard Error) to words in Positions 1 through 5 for the positive emotion, negative emotion, and pure neutral sequences at the 32 ms, 1000 ms, and 2000 ms blocks.

Post-hoc comparisons examined the two-way interactions between word type and position at the 32 ms, 1000 ms, and 2000 ms blocks separately. The three-way interaction was followed up in this way as these analyses would allow for the contributions of both fast and slow effects to be examined at each ITI. Additionally, given the main effect of ITI previously noted, it was evident that RTs were affected as a function of ITI.

In the 32 ms block at Position 1, no significant differences in RTs emerged between the positive emotion, negative emotion, and neutral sequences. At Position 2, participants responded fastest to neutral words in the positive emotion sequence, followed by neutral words in the negative and pure neutral sequences. The difference, however, was only significant between the neutral words in the positive and neutral sequences (p =.014). No significant differences emerged in RTs at Position 3, however, a trend between the neutral words in the positive and negative sequences was noted (p =.072). At Position 4, participants responded fastest to neutral words in the positive sequences, followed by neutral words in the pure neutral and negative sequences. The difference between the positive and negative words was significant (p =.019). No significant differences in RTs emerged between any of the sequence types at Position 5.

In the 1000 ms block at Position 1, no significant differences emerged between the sequence types. At Position 2, participants responded fastest to neutral words in the positive emotion sequences, followed by neutral words in the negative and pure neutral sequences. The difference between the neutral words in the positive and pure neutral sequences was significant (p =.011). Additionally, a trend toward significance was found between the neutral words in the negative emotion sequences and neutral words in the positive emotion sequence (p =.067). No significant differences emerged between any of the sequence types at Positions 3, 4, or 5.

No significant differences emerged at the 2000 ms block between the sequence types at Positions 1 – 5. A trend, however, was present at Position 1 between the target negative and target neutral words (p =.062).

In summary, follow-up analyses of the three-way interaction detected significant differences at the 32 ms block and the 1000 ms block. At the 32 ms block, neutral words in the pure neutral sequence at Position 2, were responded to significantly more slowly than neutral words in the positive emotion sequence at the same position. Additionally, within the 32 ms block, participants responded significantly more slowly to neutral words in the negative emotion sequence at Position 4 in compassion with the neutral words in the positive emotion sequence. At the 1000 ms block, the only significant difference was detected at Position 2 whereby participants responded significantly more slowly to neutral words in the pure neutral sequence in compassion with neutral words in the positive emotion sequence. No other significant interactions emerged from the analyses. Although a four-way interaction between ITI, sequence type, position and anxiety group was anticipated, analyses showed the interaction was non-significant, $F(45.80, 1343.48) = 1.25$, $p = .128$, $\eta_p^2 = .04$, observed power = .99.

6.4 Discussion

6.4.1 Overview of Aims and Hypotheses

The aim of the present study was to investigate the contribution of fast and slow effects in the EST for individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. Generally, the hypotheses were not supported. Evidence of a slow effect did emerge, albeit at a later position than what was expected. Each hypothesis is discussed in turn, in addition to the analyses of interest for that hypothesis. A critical discussion of the findings follows.

It was predicted that state anxious, trait anxious, and state-trait anxious individuals would demonstrate an attentional bias to negative emotion words characterised by a fast effect, with the slowest RTs found at Position 1 on the target negative words. Specifically, it was expected that the fast effect would be greatest in the trait anxious and state-trait anxious groups in comparison with the state anxious group. Additionally, it was predicted that if arousal rather than valence of words could account for emotional Stroop effects, the state anxious, trait anxious, state-trait anxious individuals would likely show fast effects for positive emotion words and negative emotion words. These hypotheses were not supported.

No evidence of fast effects emerged in the current study. For a fast effect to be present, RTs to target emotional words (presented in Position 1) would need to be significantly greater than RTs to target neutral words. Evidence of a fast effect could have emerged in the analysis in one of several ways. Essentially, sequence type and position would need to be implicated in an interaction term, with the significant differences emerging between the target emotional and neutral words at Position 1. More specifically, a three-way interaction should have been present between sequence type, position and anxiety group, with significant differences occurring for the state anxious, trait anxious, and state-trait anxious groups between the different target words at Position 1. This interaction, however, was non-significant.

A significant two-way interaction did emerge between position and sequence type. Follow-up analyses examined the difference between each of the sequence types at each position. A significant difference did occur at Position 1 between the target neutral and target negative words, however this effect was not in the direction expected. Averaged across anxiety group and ITI, participants responded approximately 10ms slower to target neutral words as opposed to target negative words. There was a significant three-way interaction between sequence type, position and ITI, which was followed up by examining the differences between the sequence types at each position for the 32 ms, 1000 ms and 2000 ms blocks. No significant differences, however, occurred at any of the blocks, between the sequence types at Position 1. A critical discussion of the absence of fast effects is presented below in section 6.4.2.

It was also expected that low anxious, state anxious, trait anxious, and state-trait anxious individuals would demonstrate an attentional bias to negative emotion words characterised by a slow effect. This hypothesis was partially supported. In addition, it was expected that if arousal rather than valence of words could account for emotional Stroop effects, these groups would likely show slow effects for positive emotion words in addition to negative emotion words. This prediction was not supported. Furthermore, it was expected that the slow effect would emerge on Position 2, and potentially extend to latter positions. This expectation was partially supported. Additionally, due to the increased activation of the AAC in state anxious individuals, it was expected that state anxious and state-trait anxious individuals would report a larger slow effect (as demonstrated by occurring over more positions or of a larger magnitude) than low anxious and trait anxious individuals. This hypothesis was not supported, as no significant differences emerged between the anxiety groups with regards to slow effects.

For a slow effect to be present, RTs to neutral words following target emotional words needed to be significantly greater than RTs to neutral words following target neutral words. While all the words presented in Positions 2-5 were neutral, they still differed in terms of the target word in Position 1 of their sequence.

Evidence of slow effects could have emerged in the analysis in several ways. Essentially, sequence type and position needed to be implicated in an interaction term. More specifically, a two-way interaction between position and sequence type needed to emerge with increases in RTs occurring between the different sequence types at Positions 2, 3, 4, or 5. However, the differences should be present in each of the anxiety groups (i.e., each group showing a slow effect to target emotional words emerging on the neutral words at Position 2, 3, 4, or 5). However, slow effects could also be demonstrated by a three-way interaction between sequence type, position and ITI. Again, the significant differences needed to occur between the sequence types at Positions 2, 3, 4, or 5, and occur in each of the anxiety groups. Ultimately, in order to have found support for slow effects in each of the anxiety groups, a three-way interaction needed to emerge. This interaction term needed to include sequence type, position and anxiety group. Significant differences should have occurred between the sequences types at Positions 2, 3, 4, or 5, with larger differences noted for the state and state-trait anxious groups.

As discussed above, a two-way interaction did emerge between sequence type and position. Follow-up analyses revealed significant differences occurring on Positions 2 (with participants responding faster to neutral words in the positive sequences versus neutral words in the neutral sequences) and 4 (with participants responding faster to neutral words in the positive sequences than neutral words in the negative sequences).This interaction, however, was superseded by the three-way interaction that occurred between sequence type, position, and ITI. Averaged across anxiety groups, at the 32 ms block, participants responded significantly faster to neutral words at Position 2 in a positive sequence, than neutral words at Position 2 in a neutral sequence. This finding was unexpected as it was hypothesised that while a significant difference would occur on this position, it would be due to slower RTs to the neutral words that were in Position 2 in either the positive or negative sequences, relative to the neutral words in the neutral sequences. A significant difference was also found at Position 4, with participants responding significantly more slowly to neutral words in the negative emotion sequences, versus neutral words in the positive emotion sequences (by approximately 32 ms). This finding is potentially indicative of a slow effect and will be discussed in greater detail in section 6.4.3.

A significant difference was also reported at the 1000 ms block at Position 2 between neutral words in the pure neutral sequences and neutral words in the positive emotion sequences. Participants responded approximately 19 ms faster to neutral words in the positive emotion sequence than neutral words in the pure neutral sequence. This finding was unexpected, as it was predicted that the difference would essentially occur in the opposite direction and also involve the neutral words from the negative emotion sequence.

The interaction of most interest was between sequence type, position, and anxiety group. Although examining the aforementioned interactions allowed for the investigation of slow effects for the sample in general, these analyses did not allow for the differences between anxiety groups to be examined. The current experiment did not find a significant three-way interaction between sequence type, position, and anxiety group. Differences between the groups occurred at a mean level, however, these differences were non-significant. A detailed discussion of slow effects is presented below in section 6.4.3.

In addition to differences occurring between the anxiety groups with regards to fast and slow effects, several predictions were made regarding differences in fast and slow components of attentional bias within the anxiety groups. Specifically, it was predicted that trait anxious individuals would demonstrate larger fast effects in comparison with slow effects. Additionally, it was expected that state anxious individuals would demonstrate larger slow effects in comparison to fast effects. It was also predicted that state-trait anxious individuals would demonstrate fast and slow effects of the same magnitude. The overall analysis found no evidence of fast effects occurring. Additionally, anxiety was not implicated in any significant interaction. It was expected that a three (or a four-way interaction including ITI) would emerge between sequence type, position, and anxiety group, with differences occurring within the different anxiety groups. In addition, the interaction between sequence type, position, anxiety group, and ITI was not significant. As a result, the above hypotheses were not supported. Anxiety was not implicated as a significant factor contributing to differences in RTs.

It was anticipated that the magnitude of fast and slow effects would vary depending on the duration of the ITI. Specifically, it was expected that the magnitude of fast effects would be greatest when the ITI was short. However, this hypothesis was not supported. Furthermore, it was predicted that the duration of the slow effect would differ across positions depending on the ITI, that is, the slow effect was not necessarily trial specific. There was partial support for this hypothesis. The interaction of interest for these hypotheses was between ITI, sequence type and position. As stated previously, this three-way interaction was significant, however no evidence of fast effects emerged at the 32 ms, 1000 ms, or 2000 ms blocks. There were, however, significant differences at the 32 ms and 1000 ms blocks. In both of these blocks at Position 2, participants responded more slowly to neutral words in the pure neutral sequences, in comparison with neutral words in the positive emotion sequences. These findings, however, occurred in the opposite direction to what was expected, and neutral words in the negative emotion sequences were not implicated. As a result, the magnitude of the slow effect potentially observed in Position 2 at the 32 ms and 1000 ms block were not directly compared.

Partial support for the predictions that the duration of the slow effect would differ across positions depending on the ITI comes from the finding that participants in the 32 ms block responded more slowly to the neutral words in Position 4 in the negative emotion sequences, versus neutral words in Position 4 in the positive emotion sequences. This difference did not emerge at the 1000 ms or 2000 ms blocks. This result, however, needs to be interpreted with caution as no significant difference was noted at this position between neutral words in the pure neutral sequences, and neutral words in the emotion sequences. These findings will be discussed in greater detail in section 6.4.3 presented below.

6.4.2 Fast Effects

To date, no study has explicitly assessed the role of fast and slow components of attentional bias in the EST for individuals with varying levels and types of anxiety. ESEs have, however, been robustly reported in samples of clinically anxious patients and individuals with elevated levels of both state and trait anxiety (Phaf & Kan, 2007; Williams et al., 1996). A limitation of these studies is the use of blocked formats of the task, which do not allow for the different components of the ESE (i.e., fast and slow) to be investigated. Additionally, interference has often been examined as the difference between the time taken to colour-name emotion words versus neutral words. In short, as these studies have looked at the ESE in general, it has not been possible to determine the relative contributions of both fast and slow components of the ESE. As a result, it is not clear whether fast effects should be present in anxious individuals.

Based on the model proposed by Wyble and colleagues (2008), the current study predicted that fast effects would be present for individuals who were anxious. Specifically, these effects should have been most pronounced in trait anxious individuals due to the strengthened connections for negative material throughout their information processing system. Essentially, upon presentation of a negative word, the negative word input unit would have projected to the word-form layer (Wyble et al., 2008). Due to the strengthened connection between the word-form layer and the categorical layer in trait anxious individuals, information is immediately projected to this layer, whereby interference is caused as a result of lateral competition between colour and word nodes. In turn, it takes longer for a colour-naming response to cross threshold, thus resulting in slower RTs on the immediate trial (Wyble et al., 2008). In addition, Wyble et al. also postulated that state anxious individuals would demonstrate a fast effect, albeit to a lesser extent than trait anxious individuals, and also of a lesser magnitude than the slow effect that would be observed. Unlike trait anxious individuals, state anxious individuals have not had permanent restructuring of their information processing systems. For state anxious individuals, biases of attention are caused by transient changes in the activity of certain word form nodes. For example, because these individuals are in a temporary state of anxiety, threatening material will have the ability to disrupt performance; however this will not necessarily occur as quickly throughout their information processing system. Despite this, it may still be possible to note a fast effect, in conjunction to a larger slow effect (Wyble et al., 2008).

However, contrary to the predications of Wyble et al. (2008) and the hypotheses of the current study, results indicated that anxiety did not play a significant role in affecting RTs. Moreover, although a trend towards significance was noted at the 2000 ms block between the target negative and target neutral words, this trend was not in the expected direction (i.e., participants' colour-identified target negative words faster than target neutral words).

There are several possible explanations for the absence of a fast effect in the current study. In order to adequately address the hypotheses proposed, these possible explanations should be explored. First, it is possible that the negative emotion words used in the current experiment were not threatening enough to warrant a slowing of attention. Second, it could be due to the sample employed in addition to the stimuli used. That is, the absence of effects may have been caused by an interaction between the current sample and the words used in the EST. Finally, there is the possibility that fast effects do not exist, at least in a non-clinical sample. Each of these reasons will be discussed in turn.

A possible reason for the lack of fast effects in the present study may be due to the words that were selected for the EST. In particular, biases of attention may not have occurred if the negative emotion words were not threatening enough to interfere with colour-identification ability. The words utilised in the negative emotion category were *agony*, *hatred*, *enraged*, *despised*, and *rejected*. These words were selected for use in the EST based on ratings collected in Experiment 1. Each of these words received valence ratings below three, indicating that they were negative words. Additionally, these words (in addition to the positive words) received higher arousal ratings than neutral words, indicating that the words produced more of a reaction than the neutral words. Furthermore, words such as *rejected* tend to be viewed as negative words by the general population (i.e., when rated they have a smaller *SD* than other negative words), as opposed to more ambiguous words such as *tease* (which has a higher *SD*; Larsen, Mercer, Balota, & Strube, 2008). As a result, the negative words selected for this experiment were believed to be appropriate. Despite this, Frings et al. (2010) detected the presence of fast and slow effects in a non-specified sample of individuals utilising similar words to those of the present study (e.g., *hate*, *annoyance*). There are three keys differences, however, between the current study and that of Frings and colleagues.

Frings et al. (2010) utilised ideographically tailored stimuli that may have been more salient to individuals in their sample. Before commencement of the emotional Stroop experiment, participants rated a pool of words for arousal and valence (words were rated for both arousal and valence using a similar system to that of Experiment 1). Generally, negative words that received a valence rating under three were selected, and neutral words that received valence ratings between four and six were shortlisted. From the short list of negative stimuli, the five words with the highest arousal values were selected. From the short list of neutral words, the five words with the lowest arousal values were selected.

Based on the model of Williams et al. (1996), it is possible that fast effects found in the study of Frings et al.'s study were due to the increased personal salience of the negative word stimuli selected, as words which are more personally relevant may have the capacity to cause greater interference within the colour-naming pathway.

Larsen et al. (2008) reported that automatic vigilance (that would manifest as a fast effect in the EST) tends to decrease on negative words with a high arousal value. It is possible that the words utilised in the current experiment had higher arousal values than those employed by Frings et al. (2010), and this could potentially explain why fast effects were present in their EST but absent in the current study. This, however, was not possible to examine as Frings et al. did not report the arousal levels of their words. Although, as their study utilised negative emotion words that did receive high arousal values from their participants, this explanation does not seem particularly plausible, and therefore other possible reasons for why fast effects did not occur should be considered.

The second key difference between the current experiment and that of Frings and colleagues (2010) was the design of the EST. Frings et al. utilised a random presentation format of the task, as opposed to the pseudorandom format (e.g., McKenna & Sharma, 2004) that was used in the current EST. Although, this may not necessarily account for the different findings (this is explored in greater detail in Chapters 7 and 9).

Another possible explanation is related to the sample used in the current experiment compared with the sample used by Frings et al. (2010). Three possible arguments could be made regarding differences in the samples of the two experiments. First, it could be argued that the samples are roughly equivalent in regards to anxiety level. Second, it could be argued that participants in the current study were more anxious than participants in the study of Frings et al. Last, it could be argued that participants in the current study were less anxious than in the study of Frings et al. It is not possible, however, to determine this, as Frings and colleagues did not measure levels of anxiety. While the current experiment was interested in the role of anxiety type and level on components on attentional bias within the EST, the sample was recruited from a university population. Frings et al. also recruited their participants from a university population. The assumption could be made that the only difference between the samples is that the current study actually measured levels of anxiety. Recently, Ozen, Ercan, Irgil, and Sigirli (2010) investigated the prevalence of anxiety in a large sample (*N* = 4850) of university students, specifically, measuring levels of state and trait anxiety. Results found that approximately 29.6% of the sample had state anxiety scores above 45 points, and 36.7% had trait anxiety scores above 45. In essence, results of Ozen and colleagues (2010), in addition to the findings of the present experiment, suggest that elevated levels of anxiety are quite prevalent within university populations. Given this, out of the three possible arguments that could be made, the most plausible is that the participants in the study of Frings et al. did not have dissimilar anxiety levels to the sample in the current study experiment. Thus, it is more likely that differences that emerged between the results of the present study, and that of Frings et al., are not due to sample characteristics but rather, other factors (such as the differing designs of the tasks or the stimuli employed).

Another consideration as to why fast effects were not reported in the current study may relate to the sample used in conjunction to the stimuli. Based on models of emotional Stroop interference (e.g., Williams et al., 1996; Wyble et al., 2008;) it was expected that fast effects should be present for anxious individuals. The current sample did use individuals with varying levels (i.e., low and high) and differing types (i.e., state and trait) of anxiety; however the sample was non-clinical. Therefore, the absence of fast effects reported may be due to the fact that participants did not have high enough levels of anxiety for biased attention to occur. Thus, while the stimuli selected were appropriate, the anxiety levels of participants was not elevated enough for these words to interfere with colour-identification performance. Specifically, it may be possible that the trait anxious individuals in the present study were not anxious enough to have warranted a restructuring of their information processing system. If this were the case, then a fast effect would not be evident as the emotional material was not relevant to the participant's anxiety (presumably negativity) schemata, and as a result, greater interference would not occur in the colour-naming pathway, and there would be no delays in RTs.

Furthermore, fast effects may not have been detected due to an interactive effect between high levels of state and trait anxiety. For example, Egloff and Hock (2001) reported that when individuals have high levels of state anxiety and low levels of trait anxiety, threat related material may be avoided in an effort to protect the self from experiencing a further aversive state (i.e., a slowdown in colour-identification would not be noted on target emotional words relative to target neutral words). Additionally, they also reported that the ESE is exacerbated when individuals have high levels of both state and trait anxiety. Based on these predictions, one could potentially argue that the state anxious group would display no fast effects. This possibility, however, should still result in biases of attention for individuals who are state-trait anxious, and this was not observed in the current study. A key difference between the current study and that of Egloff and Hock, however, is that they used a blocked format of the task, which does not allow for fast and slow components of the ESE to be measured. That is, fast effects may not be present for anxious individuals, rather biased attention within the EST may manifest as a slow effect.

It is possible that slow effects are the dominant form of biased attention in the EST. Prior to the current study, however, the role of fast and slow forms of the ESE had not been explored. The ESE that has previously been reported in the literature may be indicative of a slower form of attentional bias, which is why the effect is most robustly reported in blocked formats of the task (e.g., Dresler et al., 2009; Egloff & Hock, 2001; Phaf & Kan, 2007). Although, given the current experiment did not reliably detect the presence of slow effects (and no significant differences emerged between anxiety groups), this theory does not seem plausible. In addition, the majority of studies that have explored the role of fast and slow effects in addiction related populations have found evidence of both fast and slow effects occurring (e.g., Cane et al., 2008; Franken et al., 2000; Wertz & Sayette, 2001). This, however, does not necessarily mean that both these effects should be present in anxious populations. Even within the addiction literature, discrepancies remain in relation to whether fast and slow effects co-exist. For example, Sharma, Albery, and Cook (2001) did not find evidence of slow effects on neutral words that were preceded by alcohol related words in a group of high alcohol drinkers and problem drinkers. Participants exhibited a fast effect on target alcohol related words relative to control words, however, the effect did not extend for more than one trial. Furthermore, although fast and slow effects have been reported in several studies, the magnitude of fast effects are generally larger than slow effects. Therefore, the evidence suggests that the ESE is not necessarily comprised of a dominant slow effect. Although, there are two exceptions to this (Frings et al., 2010; McKenna & Sharma, 2004).

McKenna and Sharma (2004) and Frings and colleagues (2010) investigated the role of both fast and slow effects in non-specified samples (i.e., no measures of potential psychopathology were administered). McKenna and Sharma only found evidence of a slow effect occurring on a neutral word in Position 2 that followed a target negative emotion word in Position 1. Frings and colleagues, however, found evidence of both fast and slow effects, with the size of the effects similar in magnitude (the slow effect was approximately 6 ms longer than the fast effect). Although the model of Wyble et al. (2008)

suggests that fast effects would not be present in a normal population, the findings of Frings and colleagues do not support this notion. Given that Frings et al. used personally salient stimuli, biased attention can be explained as a reaction to words that were more personally relevant. Although, Ashley and Swick (2009) also reported fast effects in both younger and older adults, using general negative emotion words.

The final predictions of the current study with regards to fast effects related to the duration of the ITI. Specifically, it was predicted that fast effects would be larger when the ITI was short, that is, the effects would occur to a larger magnitude in the 32 ms block, in comparison with the 1000 and 2000 ms blocks. As no evidence of fast effects emerged, this prediction was not supported. A more comprehensive discussion regarding ITI duration is presented in section 6.4.6.

6.4.3 Slow Effects

Although there was an absence of fast effects in the present study, evidence of slow effects did emerge at the 32 ms block, albeit a position later than expected. It was predicted that if a slow effect emerged, it would likely emerge on Position 2, however, the slow effect could potentially extend to later positions. In addition, it was expected that slow effects would be present for the low anxious, state anxious, trait anxious, and state-trait anxious groups. Moreover, it was expected that slow effects would be noted on neutral stimuli that followed target negative or target positive emotion words, versus neutral stimuli that followed target neutral words.

Regardless of anxiety group, RTs to neutral words that followed a target negative emotion word in Position 1 gradually increased from Position 2 to Position 4 (although no significant differences between the sequence types emerged until Position 4). The difference occurred between neutral words in the negative emotion sequence, only in comparison with neutral words in the positive emotion sequence (see Figure 6.6).

Irrespective of this, however, the findings potentially suggest that it is possible for certain words to disrupt colour-identification performance beyond that of their presentation.

Although the current study anticipated that the slow effect would occur in Position 2, this is not the first study to report slow effects at a later position. For example, Cane and colleagues (2008) found marijuana related words had the ability to disrupt colour-identification performance across four positions in marijuana smokers. A key difference, however, between the current findings is that Cane and colleagues found that the slow effect emerged on Position 2 and gradually decreased until Position 4 (although still significant at this position). In addition, Cane and colleagues did not examine an anxious sample (however anxiety was measured), but rather a group of marijuana smokers. Despite this, the study of Cane et al. was the first to demonstrate a slow effect occurring over several positions. In addition, Ashley and Swick (2009) found evidence of the slow effect persisting across multiple positions in the negative emotion sequence. Although, the bulk of studies that have examined the fast and slow effect, report the slow effect occurring on Position 2 (that is, the first neutral trial following the target emotional stimulus; e.g., Franken et al., 2000; McKenna & Sharma, 2004; Sayette et al., 2001; Waters et al., 2005; Waters & Feyerabend, 2000; Wertz & Sayette; 2001).

An unexpected finding of the present study relates to differences that emerged on Positions 2 in both the 32 ms and 1000 ms blocks. In each of these blocks, at Position 2, participants responded faster to neutral words that followed target positive words versus neutral words that followed target neutral words. This finding was not anticipated, as it was not expected that participants would show elevations in RTs to neutral words that followed target neutral words. This unexpected result is difficult to account for, as this only occurred at Position 2 in the pure neutral sequences. Given that the neutral words presented from Position 2 to Position 5 occurred in a random order (and were matched on several lexical characteristics with the neutral words appearing in the same positions after both the positive and negative emotion words), the findings cannot be attributed to a specific set of words at Position 2, as the same category of neutral words did not always appear at this position. Additionally, if RTs were slowed on neutral words in general, it would be expected that elevations in RTs would have also been noted at different positions (rather than just occurring on Position 2). A possible explanation for this result could involve the target neutral words that were presented at Position 1 in the neutral sequence.

Although a word selection study was conducted in order to ensure the lexical equivalence of words for the current experiment, it is still possible that the target set of neutral words employed at Position 1 caused a subsequent disruption in colour-identification ability. The words selected for this position came from the category of countries. In Experiment 1, no significant differences emerged between this category and the other categories of words in terms of length and frequency of occurrence in the English language (Brysbaert & New, 2009). At a mean level, this target category did receive slightly higher valence ratings (indicating a more positive valence) than the other categories of neutral words. Despite this, the pattern of responding to pure sequences of neutral words did not mimic that of the positive sequences. In addition, given that the differences in valence ratings between this category of words and the other neutral categories of words (and given this category received significantly different valence ratings from both the positive and negative categories), it is unlikely these words disrupted colour-identification ability due to their slightly elevated valence.

Another difference between the target neutral category of words utilised at Position 1 was that it was comprised solely of proper nouns while the target positive emotion, target negative emotion, and neutral categories were comprised of a combination of word types (e.g., verbs, adjectives, common nouns). Previous research has suggested that proper nouns are processed differently from that of other word stimuli (e.g., common nouns; Peressotti, Cubelli, & Job, 2003). Peressotti et al. (2003) examined how proper and common nouns were responded to using a dot-probe task. Results showed that when proper nouns were presented with a lowercase first letter (as opposed to an uppercase first letter), no differences in RTs emerged between this category of words and a category of common nouns (regardless of whether the common nouns were presented with an upper or lower case first letter).Therefore, it is unlikely that the use of proper nouns in the current study resulted in the elevation in RT on subsequent neutral words at Position 2.

Another interesting finding of the current study was that the disruptions in colour-identification performance that occurred at both the 32 ms and 1000 ms blocks were no longer evident at the 2000 ms block. This could potentially indicate that the slow effect is a combination of both trials and time, as the effects were most evident at the 32 ms block followed by the 1000 ms block, dissipating at the 2000 ms block. These results, however, must be interpreted with caution as the slow effect in the 32 ms block at Position 4 was significant due to the delayed response to the neutral words in the negative emotion sequence versus the neutral words in the positive emotion sequence (and not neutral words in the pure neutral sequence). In addition, the slow effects reported at 1000 ms block occurred in the opposite direction to what was predicted (i.e., responses at Position 2 were delayed on neutral words in the pure neutral sequences as opposed to on neutral words in the positive or negative sequences). The slow effect is discussed in greater detail in sections 6.4.4, 6.4.5, and 6.4.6.

6.4.4 Biased Attention and Anxiety

Contrary to predictions, the current study found no significant differences in the nature of attentional biases for individuals based on their anxiety level. It is, however, interesting to note that at a mean level, there did appear to be differences between the anxiety groups, and this can be seen in Figures 6.1 – 6.4.

The current study predicted that low anxious, state anxious, trait anxious, and state-trait anxious individuals would show an attentional bias for negative (and positive emotion) words characterised by a slow effect. At a mean level, there was no evidence of slow effects occurring for the low anxious group. For the state anxious group, however, there was generally an increased slowing of RTs for the negative emotion sequence, peaking at Position 4 (only at the 32 ms block). This pattern was also evident for the trait anxious individuals. It was expected that the state anxious individuals would show a greater slow effect than the low anxious and trait anxious individuals (due to increased activation of the AAC), however, results did not suggest this. At a mean level, the state anxious participants did show slowing on neutral words presented after target negative emotion words, this also occurred for the trait anxious group. As a result, it is unlikely that the state anxious participants had an increase in the activation of the AAC unit. Additionally, in the state-trait anxious group, this pattern was not evident. For these individuals, the pattern of responding to the negative emotion sequence at the 32 ms block was dissimilar to that of the state anxious and trait anxious participants. In the latter two groups, there was an elevation in RTs on Position 4 for the negative emotion sequence at 32 ms. In the high state-trait anxious group, however, the elevation in RTs to the neutral words in the negative emotion sequences increased on Position 2. Although the overall analyses may be non-significant, it is still interesting to note the differential patterns of responding that occurred between the groups, namely at the 32 ms time period.

As suggested previously, it is a possibility that anxious individuals avoided threat related material in an effort to protect themselves from experiencing further levels of anxiety; however this might only be expected for the state anxious individuals (e.g., Egloff

& Hock, 2001). It is important to note that studies utilising the EST in investigating biased attention in state and trait anxious individuals are not always consistent. Dresler et al. (2009) found that biased attention was exacerbated in individuals with high levels of state anxiety for both positive and negative stimuli. This finding was not reported for the trait anxious individuals, and there did not appear to be interactive effects between high levels of both state and trait anxiety. Contrary to these results, Egloff and Hock (2001) found an opposite pattern of responding, with emotional Stroop interference exacerbated by high levels of state and trait anxiety. Both studies employed a blocked presentation of the task, however, differences were present between stimuli used (e.g., Dresler et al., 2009, included positive words matched to negative words for arousal). In sum, these studies highlight the divergent findings in relation to the ESE in state and trait anxious individuals.

It should be noted that both the state and the trait anxiety groups in the current experiment had relatively small numbers of participants (14 and 12 respectively). This may have impacted upon the lack of significant findings in relation to anxiety, an issue which is explored in more detail in section 6.4.8.

6.4.5 Biased Attention and Word Type

It was also predicted that if arousal, rather than valence of words, could account for emotional Stroop interference, participants would likely show slow effects for positive emotion words in addition to negative emotion words. This was based on recent research that found biased attention to both positive and negative words with similar arousal values (e.g., Dresler et al., 2009; Larsen et al., 2008). Fast effects, however, were not reported on either target positive or negative words. In addition, the slow effect that was found on Position 4 at the 32 ms block only occurred on neutral words in the negative emotion sequence versus neutral words in the positive emotion sequence. Based on this finding, it would appear (at least in this sample) that arousal of words does not contribute to slow components of the ESE. Additionally, given the finding at Position 4, a potential conclusion could be that the valence of the target words presented at Position 1 led to very different patterns of processing. Essentially, although arousal of material can play a role in the biasing of attention (e.g., Dresler et al., 2009), the threat of material may be key in disrupting colour-identification performance, particularly in random (or pseudorandom) formats of the EST. This is consistent with several theories regarding processing biases in anxiety (e.g., Beck and Clark, 1988; Mathews & MacKintosh, 1998) and in the EST (e.g., Wyble et al., 2008).

The findings of the current study demonstrate that regardless of anxiety group, some words seem to affect colour-identification performance beyond that of their presentation. As this was not always in the direction or on the position expected, further investigations are required. An unexpected result from the current study was how participants responded to the pure neutral sequences of words (namely at the 32 ms and 1000 ms blocks). This may have occurred for a variety of reasons. Although all words for Position 1 were selected based on a word norming study (as presented in Chapter 5), it is possible that something about these particular words caused unexpected patterns of responding. Based on the results of the present study, it was clear that a further investigation into the role of fast and slow components of biased attention was required in order to adequately explore the aims and hypotheses of the current research program.

6.4.6 Biased Attention and Time Pressure

Another interesting finding that emerged from the present experiment relates to the main effect of ITI, with participants responding fastest to words in the 1000 ms block, followed by the 2000 ms and 32 ms blocks respectively. Sharma and McKenna (2001) investigated the role that time pressure plays in the EST (in terms of the ESE in general) and found that RT speeds up as the ITI is extended. These findings indicated that with an

ITI of 32 ms, RTs to negative words were on average 945ms versus 903ms on neutral words. When the ITI was extended to 1000 ms, RTs decreased on both negative (699 ms) and neutral (688 ms) words. Interestingly, not only were decreases in RTs noted between the 32 ms and 1000 ms blocks, but there was also a decrease in the size of the ESE (from 42 ms in the 32 ms block to 11 ms in the 1000 ms block).

The results of the present study are somewhat in line with those of Sharma and McKenna (2001) in terms of a general decrease in RTs from the 32 ms to 1000 ms block. The present study, however, found that the fastest RTs were noted on the 1000 ms condition followed by the 2000 ms, and 32 ms conditions respectively. Sharma and McKenna did not investigate RTs using an ITI as long as the one employed in the current experiment (2000 ms). Based on the results of Sharma and McKenna, it might be assumed that RTs would be fastest in the 2000 ms block, and then slow down in both the 1000 ms, and 32 ms blocks. Results of the current experiment, however, do not support this. One possibility for these findings is that there is something unique about the 1000 ms block that allows for an optimal RT. For example, the 32 ms block could cause greater time pressure resulting in slower RTs. The 2000 ms block may cause disinterest in participants due to the lengthy wait period between trials, and this may result in slower RTs than in the 1000 ms block, but faster RTs than in the 32 ms block. The 1000 ms block elicited the quickest RTs. Accuracy of responses, however, did not appear to be compromised at this block and therefore it does not seem plausible that the speeded RTs were due to a speed versus accuracy trade-off. Additionally, Sharma and McKenna reported a reduced ESE in the 1000 ms block versus the 32 ms block. In summary, when exploring the presence of fast and slow effects, it might be optimal to utilise brief ITIs.

Another interesting finding of the current study relates to the differences in the speed of RTs at the 32 ms blocks (738 ms) versus Sharma and McKenna's (2001) study

(924 ms). On average, participants from the current experiment responded 186 ms faster at the 32 ms block then what was found by Sharma and McKenna. In the Sharma and McKenna study, interference effects on negative emotion words decreased as RTs sped up during the 1000 ms block. This raises the question as to whether this general increase could have affected the presence of fast and slow effects occurring in the current experiment.

A potential explanation for the speeded RTs in this experiment may relate to the high number of participants within the sample who reported elevated levels of anxiety. Prior research has demonstrated that anxiety can affect RT (e.g., Phaf & Kan, 2007; Williams et al., 1996) which may have been evident in this experiment as a generic decrease in the time taken to colour-identify all words. Although the general proposal is that elevated levels of anxiety would cause a slowdown in colour-identification, MacLeod and Hagan (1992) found that state and trait anxious individuals demonstrated an ESE to threat stimuli in a sub-optimal presentation of the task, however, once an optimal format was employed, interference was no longer reported in the trait anxious individuals. MacLeod and Hagan suggested that trait anxious individuals may be able to override the automatic processing of threat related information when this material can be consciously identified (which it may be in optimal presentations of the task). In the current study, however, there was no main effect of anxiety group which might be expected if the speed of RTs were attributable to anxiety level.

6.4.7 Implications of Results

The current findings did not detect the presence of fast effects in the EST. A slow effect was noted in the 32 ms block for neutral words at Position 4 in the negative emotion sequence. Althoguh, the difference was only significant between neutral words at position 4 in the positive emotion sequence. Despite this, results seem to indicate that emotional material has the ability to disrupt colour-identification performance beyond that of its presentation. If this was not possible, then no elevation in RTs on neutral words in the emotional sequences would have been noted. Interpretation of this finding, however, is somewhat compromised by the unusual pattern of RTs to the pure sequences of neutral words. Namely, at the 32 ms and 1000 ms blocks, participants consistently responded more slowly to neutral words in Position 2 in the pure neutral sequences. This finding was unexpected and somewhat difficult to interpret. A possible explanation for this result was attributed to the target neutral words utilised at Position 1. Althoguh, stimuli were carefully selected (Experiment 1) for the emotional Stroop experiments, so this is perhaps an unlikely explanation, although warrants further investigation.

6.4.8 Strengths and Limitations

A limitation of the current experiment relates to the sample that was utilised. First, participants were all university students, and although not necessarily problematic, the study would perhaps be more generalisable if participants were drawn from the wider community. Despite this, participants were recruited from campuses in both Victoria and Queensland, which increased the representativeness of the sample.

Another limitation of the sample relates to the unequal representation of men and women, and the unequal distribution of participants within each of the anxiety groups. An uneven number of men and women is not necessarily problematic as the study was not interested in sex differences between attentional bias in the EST. It may have been ideal, however, to have a more equal representation of participants in each anxiety group. Based on the a priori sample size calculation, it was hoped that groups would have around 21 individuals in each. Although the sample size of the current study surpassed what was necessary (in order to detect a small to medium effect), it is possible that due to the small sample size of the trait and state anxiety groups, power was compromised. Although, given that the four-way interaction of interest reported a small effect size, with a high power, this was not necessarily problematic (even though it was non-significant). Additionally, the main effect of anxiety group was also non-significant, however, power and effect size were both very small, indicating that there was likely not a significant effect to be detected, even if power were increased.

Despite these potential limitations, this experiment was the first to investigate the presence of both fast and slow effects in low anxious, state anxious, trait anxious, and state-trait anxious individuals. In addition, this was the first study to explicitly examine the slow effect over trials and time.

6.5 Summary of Chapter

This chapter presented an experiment that aimed to investigate the nature and time course of attentional bias in the EST for low anxious, state anxious, trait anxious and state-trait anxious individuals. No evidence of fast effects emerged for any emotional word type. Participants did, however, respond to target neutral words at Position 1 in the pure neutral sequences, significantly slower than target negative words. This interaction was superseded by the three-way interaction that occurred between ITI, position and sequence type. From this interaction, evidence emerged which suggested that negative emotion words had the ability to disrupt colour-identification performance beyond that of their presentation. While this difference only reached significance at Position 4, RTs to neutral words in the negative emotion sequence gradually increased over Positions 2 and 3. The significant difference, however, emerged between neutral words in the positive emotion sequence (rather than neutral words in the pure neutral sequences).

In addition, findings of this study potentially indicate that an ITI of 32 ms is optimal in detecting the presence of slow effects. Despite this, however, differences were noted at the 1000 ms timeframe and a trend toward a fast effect emerged at the 2000 ms time period (although in an unexpected direction). An unexpected result of the present study was that anxiety did not play a significant role in EST performance. Although, at a mean level differential patterns of responding by anxiety groups occurred particularly at the 32 ms block on the negative emotion sequences. Additionally, there were unexpected patterns of responding to the pure sequences of neutral words. Due to the aforementioned results, a decision was made to re-run the experiment with a different set of target neutral words in a new (and hopefully more evenly distributed) sample of low anxious, state anxious, trait anxious, and state-trait anxious individuals. This study is presented in Chapter 7.

Chapter 7. Fast and Slow Effects in the EST (Experiment 3)

7.1 Introduction

7.1.1 Chapter Overview

The previous experiment reported an unexpected pattern of results for neutral words that followed target neutral words. Due to this finding, the category of target neutral words (presented at Position 1) were changed to determine whether the particular stimuli used in the previous experiment contributed to the unexpected findings. In this chapter, the methodology, results, and discussion of the findings from the current experiment are presented.

7.1.2 Rationale

Results from the previous experiment generally did not support the hypotheses. Contrary to predictions, significant findings did not emerge in relation to the nature of attentional bias and anxiety type. Regardless of anxiety group, however, evidence of a slow effect did emerge in the negative emotion sequences at the 32 ms block, albeit on a position later than expected (Position 4; see section 6.3.3). In this block, RTs to neutral words that followed a target negative word gradually (albeit non-significantly) increased over Positions 2 and 3, before reaching significance at Position 4. This was in comparison with the neutral words in the positive emotion sequences. The most unusual result that emerged from Experiment 2 was the pattern of responding that occurred to the pure sequences of neutral words. These patterns were inconsistent with predictions, as participants demonstrated slower RTs on neutral words in Position 2, following a target neutral word in Position 1. In addition, results from the two-way interaction between sequence type and position showed that individuals responded slowest to target neutral words at Positions 1, with RTs continuing to increase in the pure neutral sequences at Position 2. Although this interaction was superseded by the three-way interaction that emerged between sequence type, position, and ITI, this interaction was still unexpected, and essentially this finding was in direct opposition to what was expected. Based on the findings of Experiment 2, the decision was made to replace the target set of neutral words at Position 1 and conduct the experiment again.

In the previous chapter, several theories were explored with regards to why the unusual patterns of responding were observed on the pure sequences of neutral words. One of these explanations was due to the category of words employed for the target neutral sequence at Position 1. Specifically, two features of this category were discussed, the valence ratings of the words and the use of proper nouns within this category. Both these possible explanations were, however, dismissed as while this category of neutral words received a slightly higher mean valence rating than the other categories of neutral words, the difference was non-significant. Furthermore, participants did not respond to these words in the same manner as the positive emotion words (which would be expected if the unusual pattern of responding was due to a valence effect). Additionally, as each of the words within this category (and for the entire research program) were presented with lowercase first letters, the fact that proper nouns were utilised within this category was not deemed as problematic. Despite this, the pattern of responding noted on the pure sequences of neutral words was unexpected. As a result, the decision was made to replace this category of words in order to determine whether there was something unusual about the neutral words employed in the study that contributed to the lack of support for hypotheses in Experiment 2.

It was expected that the replacement of this category of words could have two possible outcomes. If the results of Experiment 2 were replicated, this may be indicative that non-clinical levels of anxiety do not play a significant role in the nature of attentional bias in the EST. Additionally, this would support McKenna and Sharma’s (2004) findings that fast effects are not the primary form of attentional bias within the task (at least for non-clinically anxious individuals). Finally, if a slow effect was found on Position 4, this would suggest that target negative words may have the ability to disrupt colour-identification performance beyond that of Position 2, which is inconsistent with the findings of McKenna and Sharma.

Alternatively, different findings may be indicative that fast and/or slow effects do exist in this population of individuals, but that the neutral stimuli employed in the prior experiment confounded these effects. Although the words were carefully selected for use in the EST, the countries category that was employed at Position 1 in the pure neutral sequences received slightly higher positivity ratings than the other categories of neutral words (although the difference was non-significant).Although, participants did not respond to this set of neutral words in a similar pattern to the positive emotion words, so this explanation seems unlikely. Despite this, by conducting another experiment using a different category of target neutral words, a greater understanding could be gained as to the nature of attentional bias in the EST for individuals with varying levels and types of anxiety. This is particularly important given that prior to Experiment 2, this had not been investigated. By conducting this additional experiment that employed the same design as McKenna and Sharma (2004) the replicability of the effects (or lack of) of Experiment 2 can be examined.

7.1.3 Aims and Hypotheses

The present study aimed to investigate the nature of both fast and slow effects in the EST for low anxious, state anxious, trait anxious, and state-trait anxious individuals. The same hypotheses as outlined in Experiment 2 were retained for the current experiment. Additionally, the design, materials, and procedure were identical to that of Experiment 2, excluding the target neutral categories of words that are listed below (section 7.2.2).

7.2 Method

7.2.1 Participants

The sample was comprised of 114 individuals. In total, 107 participants met with the requirements of the present study, which were identical to Experiment 2. Participants were recruited in the same manner as Experiment 2 from both the Melbourne (*n* = 68) and Brisbane campuses (*n* = 39). Students were eligible to receive 1% course credit for participating in the project. The age range of the sample was 17-55 years with a mean age of 22.04 years (*SD* = 8.41). Testing was done either individually (*n* = 3) or in small groups (*n* = 104) in a computer laboratory with an experimenter present.

7.2.1.1 Anxiety group allocation. Using the same criteria as Experiment 2, participants were classified into one of four anxiety groups (see section 6.2.1.1 for a detailed explanation). The majority of participants were state-trait anxious (*n* = 41; women *n* = 35, men *n* = 6), followed by low anxious (*n* = 32; women *n* = 26, men *n* = 6), trait anxious (*n* = 23; women *n* = 21, men *n* = 2), and state anxious (*n* = 11; women *n* = 9, men *n* = 2) respectively. Low numbers in the state anxiety group were acknowledged, however, the decision was made to retain this group.

The state-trait group had state anxiety scores ranging 37-68 (*M* = 44.77, *SD* = 6.86) and trait anxiety scores ranging 39-66 (*M* = 49.82, *SD* = 7.38). The low anxious group had state anxiety scores ranging 20-35 (*M* = 27.54, *SD* = 5.04) and trait anxiety scores ranging 23-38 (*M* = 32.13, *SD* = 4.11). The trait anxious group had state anxiety scores ranging 22- 36 (*M* = 32.09, *SD* = 3.62) and trait scores ranging 39-57 (*M* =43.73, *SD* = 5.69). The state anxious group had state anxiety scores ranging 37-63 (*M* = 44.18, *SD* = 7.53) and trait anxiety scores ranging 22-38 (*M* = 34.36, *SD* = 4.84). It should be noted that the anxiety group breakdowns reported (including *M*s and *SD*s) were based on the participants included in the final analyses.

7.2.2 Materials

The EST was conducted in the same manner as in Experiment 2, with the exception of one of the categories of words used. The target neutral category of countries was replaced with a transport category which included the words *trains*, *bicycle*, *ferries*, *taxis*, and *vehicles* (information letter to participants and demographics form can be found in Appendices E and F).

7.3 Results

7.3.1 Data Screening

7.3.1.1 Questionnaire data. The internal consistency of both the S (Cronbach's alpha = .91) and T (Cronbach's alpha = .91) scales of the STAI were excellent.
A missing values analysis was performed on the STAI, revealing fewer than 5% of missing values on all questionnaire items. Missing values were replaced using median replacement across seven items for four participants.

As the sample was comprised of over 100 individuals, the Kolmogorov-Smirnov test for normality was used on the S and T scales of the STAI (Field, 2009). The Kolmogorov-Smirnov test for normality was significant for the T scale (p = .037) indicating potential problems with normality. Although the distribution was positively skewed, standardised values indicated this was not a significant breach. Normality was retained on the S scale (p = .090).

7.3.1.2 RT data. Average mean correct RTs were obtained for each category of words at each position in an identical manner to Experiment 2. One participant had their data excluded from the 32 ms and 1000 ms blocks, due to responding over 2000 ms in each block on more than 5% of trials (6.7% and 12.7% respectively) and thus their data was omitted from all subsequent analyses, including post-hoc analyses, due to the repeated measures design. Additionally, due to computer error, data from one participant was lost.

Removal of participants data in the screening process (which is further detailed in sections 7.3.1.2.1 – 7.3.1.2.4) resulted in the loss of one participant from the low anxious group (*n* = 31), one participant from the trait anxious group (*n* = 22) and two participants from the high state-trait anxious group (*n* = 39).

7.3.1.2.1 Low anxious. The Shapiro-Wilk test for normality indicated potential problems with normality across 15 variables. Standardised skew and kurtosis checks revealed normality was not a problem across 12 of the variables. Skew and kurtosis problems, however, remained present on three variables (Position 5 for the negative emotion sequence at 1000 ms, Position 3 for the neutral sequence at 2000 ms and Position 2 for the positive emotion sequence at 2000 ms). An examination of outliers revealed extreme scores on each of these variables. Once these outliers were removed, normality was retained on all variables.

7.3.1.2.2 State anxious. The Shapiro-Wilk test for normality indicated potential problems across three variables. Standardised skew and kurtosis values revealed normality was potentially problematic on Position 5 for the positive emotion sequence at 1000 ms due to a slightly leptokurtic distribution. No outliers were identified.

7.3.1.2.3 Trait anxious. The Shapiro-Wilk test for normality indicated potential problems with normality across five variables. Standardised skew and kurtosis values revealed potential problems with skew and kurtosis on three of these variables (Position 5 for the negative emotion sequence at 2000 ms, and Positions 1 and 5 for the positive emotion sequence at 2000 ms). Outliers (two participants) were identified on each of these variables. Removal of these outliers revealed that normality had been retained.

7.3.1.2.4 State-trait anxious. The Shapiro-Wilk test for normality indicated potential problems with normality across five variables. Standardised skew and kurtosis values revealed potential problems with kurtosis on Position 5 for the negative emotion sequence at 2000 ms. No outliers were identified on this variable.

7.3.2 Descriptive Statistics

Prior to commencement of the experiment, an a priori power analysis was conducted using G*Power (Faul et al., 2009) in order to determine sample size. The statistical test selected for the power analyses was a repeated measures ANOVA (within-between interaction). The analyses showed that in order to detect a small to moderate effect size (f =.18; Cohen, 1992) with a power of .95 and alpha set at .05, a total sample size of 84 was required.

Figures 7.1-7.4 depict the mean RTs for each anxiety group for all sequence types at Positions 1-5 at the 32 ms, 1000 ms, and 2000 ms blocks. As can be seen in Figures 7.1-7.4, there were different patterns of responding for each anxiety group, and these patterns changed for each ITI block. Although there were elevations in RTs for certain word types at specific positions, these elevations did not occur in a consistent manner. As in Experiment 2, participants consistently responded fastest to the 1000 ms block, followed by the 2000 ms, and 32 ms blocks.

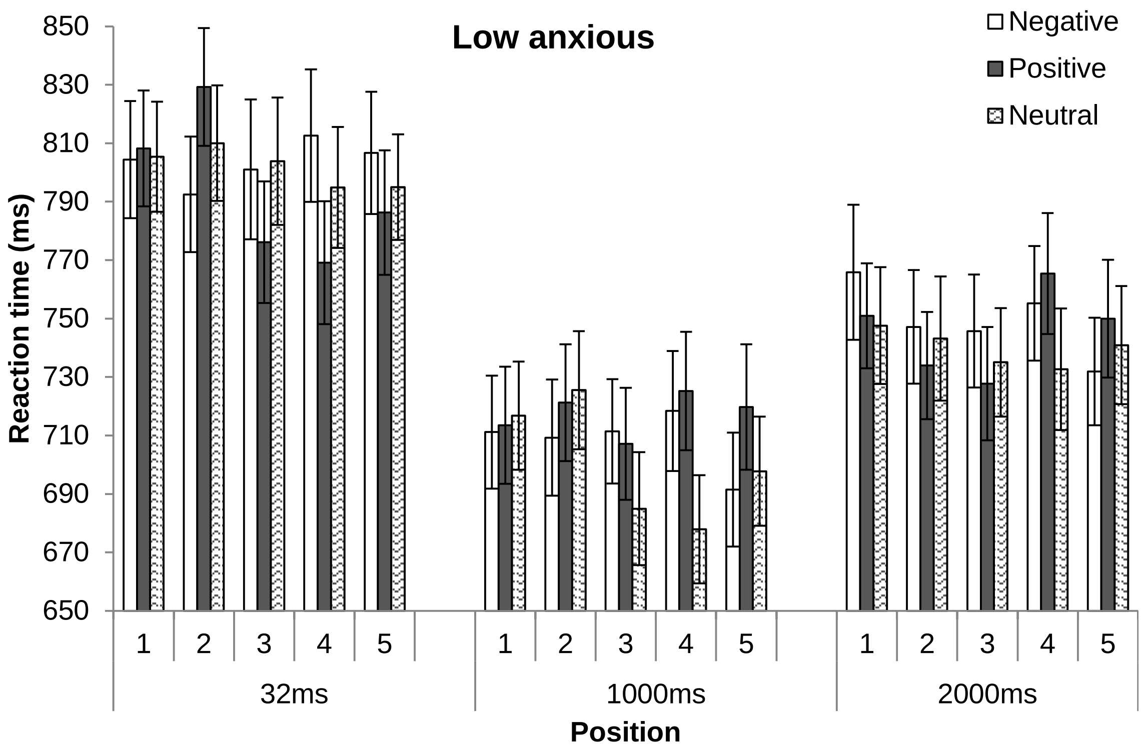

Figure 7.1. Average RT (and Standard Error) for the low anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences.

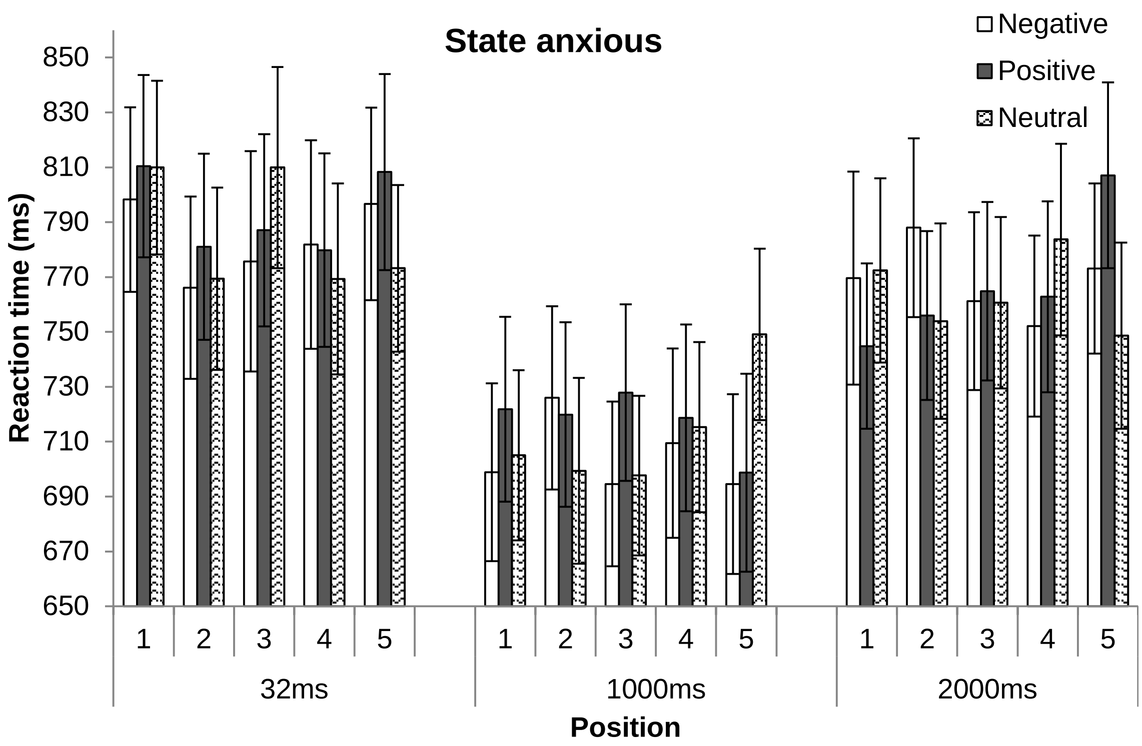

Figure 7.2. Average RT (and Standard Error) for the state anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences.

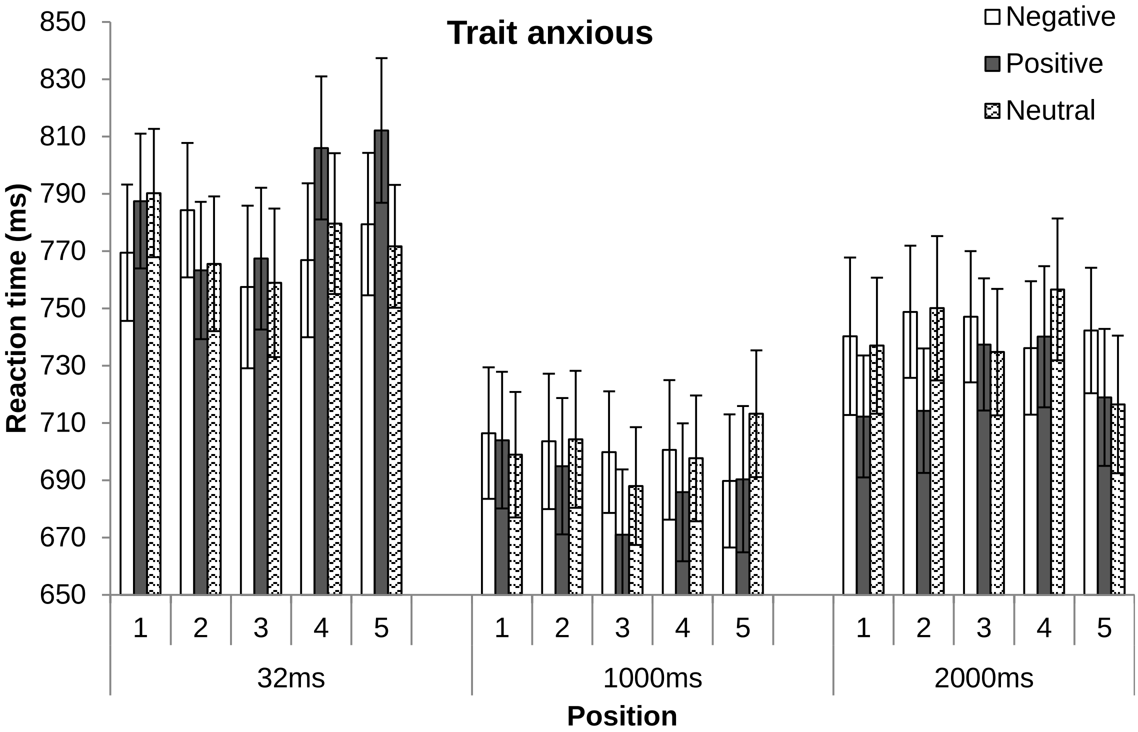

Figure 7.3. Average RT (and Standard Error) for the trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences.

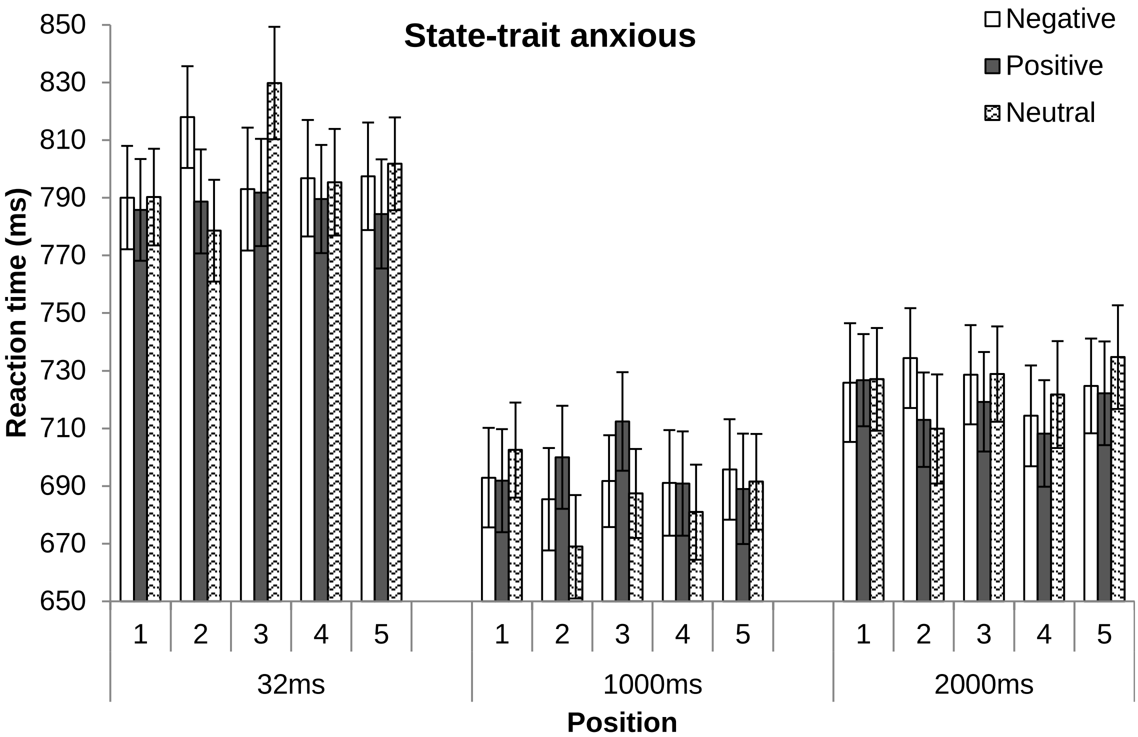

Figure 7.4. Average RT (and Standard Error) for the state-trait anxious group at each position, for each ITI block, for positive emotion, negative emotion and pure neutral sequences.

7.3.3 Inferential Statistics

Before the main analyses of interest was performed, a 3 (ITI block: 32 ms, 1000 ms, and 2000 ms) x 4 (anxiety group: Low anxious, state anxious, trait anxious, and state-trait anxious) mixed factorial ANOVA was conducted to examine error rates between the 32 ms, 1000 ms , and 2000 ms blocks for each of the anxiety groups. There was no significant main effect of ITI block, $F(1.92, 195.81) = 2.63$, $p = .077$, $\eta_p^2 = .03$, observed power= .51, or of anxiety group, $F(3, 102) = 1.12$, $p = .345$, $\eta_p^2 = .03$, observed power= .29. In addition, there was no significant interaction between ITI block and anxiety group, $F(5.76, 195.81) = 1.44$, $p = .203$, $\eta_p^2 = .04$, observed power = .54. Table 7.1 presents the proportion of error rates for each anxiety group at the 32 ms, 1000 ms, and 2000 ms blocks.

Fast and slow effects were examined using a 3 (ITI: 32 ms, 1000 ms and 2000 ms) x 3 (sequence type: Positive, negative, and neutral) x 5 (Position: 1-5) x 4 (anxiety group: Low anxious, trait anxious, state anxious, state-trait anxious) mixed factorial ANOVA, with RTs as the dependent variable. Of particular interest was whether a four way interaction would occur between ITI, sequence type, position, and anxiety group. Results of the main analyses are presented in Table 7.2.

Table 7.1

Proportion of Error Rates for each Anxiety Group at the 32 ms, 1000 ms, and 2000 ms Blocks

Anxiety group	Block	*M (%)*	*SD(%)*
Low	32 ms	2.65	3.14
	1000 ms	2.85	2.32
	2000 ms	2.27	2.01
State	32 ms	2.42	1.67
	1000 ms	3.33	2.17
	2000 ms	2.12	2.02
Trait	32 ms	2.87	2.51
	1000 ms	3.54	3.04
	2000 ms	3.97	3.31
State-trait	32 ms	3.27	2.71
	1000 ms	3.55	2.33
	2000 ms	3.18	1.92

As can be seen in Table 7.2, there was a main effect of ITI. The fastest RTs were noted in the 1000 ms block (M = 702.15, SE = 10.18), followed by the 2000 ms (M = 742.56, SE = 10.69), and 32 ms (M = 790.05, SE = 10.25) blocks. The differences between each of the blocks were significant ($p < .001$ for each comparison). There were no other significant main effects.

Table 7.2

Results of the Mixed Factorial ANOVA for Experiment 2

	df	*F*	Sig.	*η*p²	Observed Power
ITI	2, 198	76.83	< .001**	.44	1.00
ST	2, 198	0.17	.843	.00	0.08
Position	3.90, 386.15	1.02	.394	.01	0.32
Anx	3, 99	0.28	.842	.01	0.10
ITI * ST	4, 396	0.75	.558	.01	0.24
ITI * Position	8, 792	0.47	.876	>.01	0.22
ST * Position	8, 792	0.66	.730	.01	0.31
Position*Anx	11.70, 386.15	2.13	.016*	.06	0.94
ITI * ST * Position	15.06, 1491.40	1.63	.060	.02	0.91
ITI * Position * Anx	24, 792	1.19	.244	.03	0.90
ST * Position * Anx	24, 792	1.35	.121	.04	0.94
ITI * ST * Position * Anx	45.19, 1491.40	1.03	.411	.03	0.97

Note. * *p* <.05; ***p* <.001; ST = sequence type; Anx = Anxiety

There was a significant two-way interaction between position and anxiety group (for statistics see Table 7.2). This interaction is demonstrated graphically in Figure 7.5. Follow-up comparisons using the Bonferroni adjustment were used to examine differences in RTs for each anxiety group at Positions 1-5. The analyses indicated a significant difference (*p* = .020) in RTs of state-trait anxious individuals between Positions 3 (*M* = 743.64, *SE*= 13.91) and 4 (*M* = 732.11, *SE*= 14.72). There were no other significant interactions (all *p* > .05).

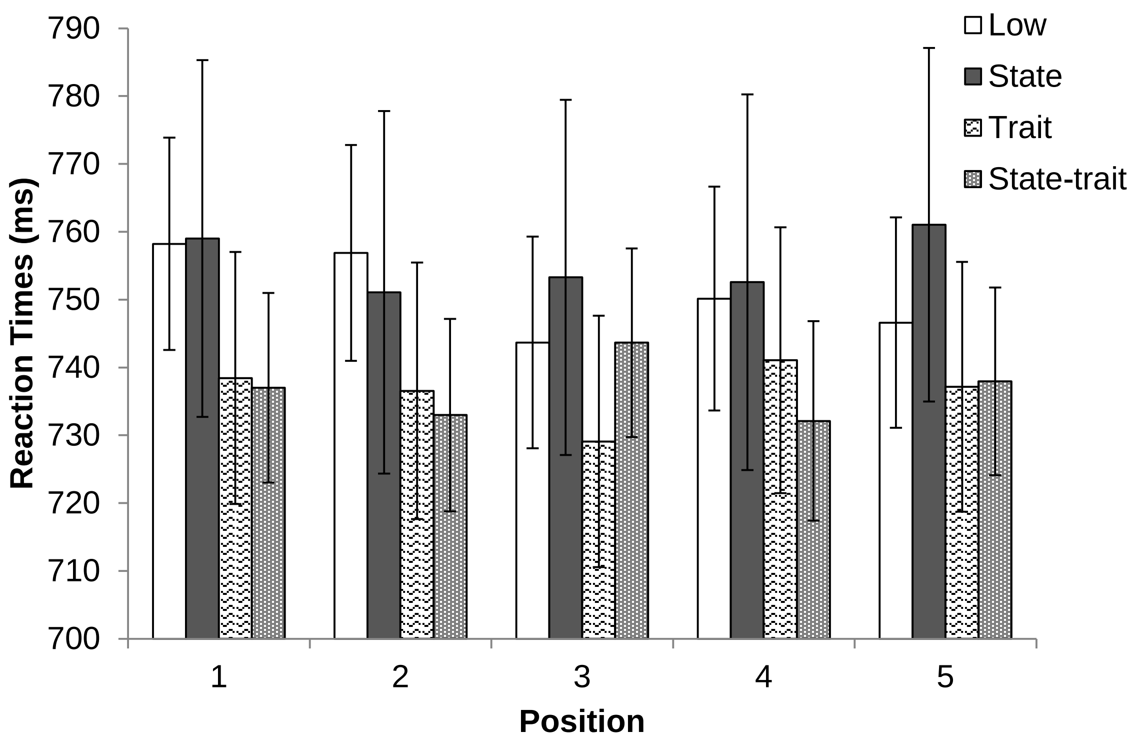

Figure 7.5. RT (and Standard Error) for low anxious, state anxious, trait anxious and state-trait anxious individuals at Positions 1 to 5.

This interaction was also investigated by comparing the RTs of each anxiety group at Positions 1-5. Follow-up comparisons using the Bonferroni adjustment indicated that there were no significant differences between any of the anxiety groups at each of the positions (all $p > .05$).

7.4 Discussion

7.4.1 Overview of Aims and Hypotheses

The aim of this study was to investigate the nature of attentional biases in the EST for individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. The hypotheses were tested in the same manner as in Experiment 2. Due to this, the analyses and interaction terms that tested each hypothesis are not outlined in depth in the current chapter, however, this information can be found in Chapter 6, section 6.4.1. Results of the current experiment did not support the hypotheses. Additionally, results from

Experiment 2 were not replicated, with the exception of the main effect for ITI. Each of the hypotheses is discussed in turn.

It was predicted that state anxious, trait anxious, and state-trait anxious individuals would demonstrate an attentional bias to negative emotion words characterised by a fast effect. Specifically, it was expected that the fast effect would be greatest in the trait anxious and state-trait anxious groups, in comparison to the state anxious group. It was also predicted that if arousal rather than valence of words could account for emotional Stroop effects, then state anxious, trait anxious, and state-trait anxious individuals would likely show fast effects for target positive emotion words in addition to target negative emotion words. These hypotheses were not supported. For a fast effect to be present, a significant interaction between sequence type and position should have emerged. These terms, however, were not implicated in any significant interactions.

It was also expected that low anxious, state anxious, trait anxious, and state-trait anxious individuals would demonstrate an attentional bias to negative emotion words, as characterised by a slow effect. In addition, it was expected that if arousal rather than valence of words could account for emotional Stroop effects, these groups would likely show slow effects for neutral words in the positive emotion sequences in addition to neutral words in the negative emotion sequences. Furthermore, it was expected that the slow effect would emerge on Position 2, and would also potentially extend to latter positions. Finally, it was hypothesised that due to the increased activation of the AAC in state anxious individuals, the state anxious and state-trait anxious individuals would show a larger slow effect (either occurring over more positions or of a larger magnitude) than low anxious and trait anxious individuals. Results did not support these hypotheses. As with fast effects, for evidence of slow effects, an interaction including both the sequence type and position variables would need to emerge, and this interaction was not found in the present experiment.

The current study also predicted that differences would emerge within the state, trait, and state-trait anxiety groups in regards to the presence of fast and slow effects. Specifically, it was predicted that trait anxious individuals would demonstrate larger fast effects in comparison to slow effects. Additionally, it was expected that state anxious individuals would demonstrate larger slow effects in comparison to fast effects. It was also predicted that state-trait anxious individuals would demonstrate both fast and slow effects of the same magnitude. As a significant interaction between sequence type, position and anxiety group was not found, these hypotheses were not supported. A significant two-way interaction between position and anxiety group was found. This interaction will be discussed in detail in section 7.4.4.

It was also expected that the magnitude of fast and slow effects would vary depending on the duration of the ITI. Specifically, the current study predicted that the magnitude of fast effects would be greatest when the ITI was short. Furthermore, it was predicted that the duration of the slow effect would differ across positions depending on the ITI (i.e., the slow effect was not necessarily trial specific). These hypotheses were not supported, as no interaction between ITI, sequence type, and position was reported. There was a main effect of ITI, which is discussed in section 7.4.5.

7.4.2 Fast Effects

The current experiment did not find any evidence of fast effects. RTs for target negative emotion words and target positive emotion words were not significantly slower than the RTs for their target neutral counterparts. In fact, there were no significant differences between the RTs for the target negative, positive and neutral words at Position 1. Low anxious individuals were not expected to demonstrate biases on emotional words at

Position 1; however it was expected that fast effects may have been present for trait anxious, state anxious, and state-trait anxious individuals.

The current study found no differences in RTs at Position 1, and this is contrary to the results of the Experiment 2 where participants were slower to identify the ink colour of target neutral words in comparison to target negative words at Position 1. This result, however, emerged out of the two-way interaction between sequence type and position, which was superseded by the three-way interaction between sequence type, position, and ITI. When this interaction was examined, there were no significant differences reported between any of the target word types at Position 1 (in any of the blocks). In sum, no fast effects were found.

As outlined in the discussion of Chapter 6, previous research has found that individuals with higher levels of anxiety, or clinically anxious patients, tend to show delays in colour-naming emotionally laden words within the EST (e.g., Becker et al., 2001; Egloff & Hock, 2001). Specifically, these words tend to be negative emotion words that are threat provoking, or words that are disorder relevant (Phaf & Kan, 2007; Williams et al., 1996). This effect has most frequently been reported in studies where a blocked presentation format has been employed. For example, Egloff and Hock (2001) found individuals with higher levels of trait anxiety, or a combination of high state-trait anxiety, showed greater colour-naming interference on negative emotion words. This interference was not reported for individuals who were state anxious, or who had moderate levels of state-trait anxiety. Although the current experiment and Experiment 2 used similar groups of participants as assessed by Egloff and Hock, the current task was not presented in a blocked trial format. This differentiation in presentation may account for the differences between the current results and results of Egloff and Hock. Another important difference to be considered is that Egloff and Hock trichotomised trait anxiety groups into low, medium, and high, and this was not done in the present study. The range of scores in their high trait anxiety group (40-70, $M = 47.43$), however, is comparable to that of the trait anxiety group in the current study (41-64, $M = 47.43$), and the means were identical.

The present results, including the absence of fast effects, are consistent with McKenna and Sharma's (2004) study. In line with their research, Experiment 2, in addition to the current experiment, presented words in a pseudorandom order with a series of neutral words following on from a target emotional word (or target neutral word) for four consecutive trials. This particular presentation style has previously been used in a small group of studies in different populations. That is, two samples of non-specified individuals (Ashley & Swick, 2009; McKenna & Sharma, 2004), one in marijuana smokers and a control group (Cane et al., 2008), and another in restrained and non-restrained eaters (Wilson & Wallis, 2013). Cane and colleagues (2008) and Wilson and Wallis (2013) both noted the presence of fast and slow effects, and although these findings differ from that of McKenna and Sharma, varying samples were assessed. The results of Ashley and Swick (2009), however, are not consistent with McKenna and Sharma as fast effects were noted in addition to smaller slow effects whereas McKenna and Sharma found a large slow effect (and an absence of fast effects). Based on these findings, it seems likely that fast components of attentional bias do exist in the EST, however, research remains unclear as to the conditions in which they emerge.

The current study did not report fast effects, a potential explanation for this relates to the design of the task itself, and this warrants further investigation. There is a small pool of published studies that have examined fast and slow components of biased attention in general, and even less of these have utilised the same pseudorandom format as McKenna and Sharma (2004). This is not to say that the design of their task was necessarily problematic, and that researchers have opted for other, optimal methods, however, many of the studies (particularly in the addiction literature) that have examined fast and slow effects did not initially set out to do so. Rather, after the experiment was conducted (and in several cases published) sequences within the data were re-analysed that allowed for the detection of both effects to be measured. This is explored in greater detail in section 7.4.6.

7.4.3 Slow Effects

The current study did not find evidence of slow effects emerging. It was predicted that slow effects would likely occur for neutral words that followed target emotional words. More specifically, it was expected that these effects would be evident in individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. It was also predicted that slow effects would likely occur to a greater extent in the state and state-trait anxiety groups.

The absence of slow effects does not corroborate the predictions of the model proposed by Wyble et al. (2008). This model suggests that slow effects should be present in state anxious individuals, due to the increased activation of the AAC. A possible reason why the results of the current study do not support Wyble et al.'s (2008) model is that the emotional words utilised in the present study were not able to cause activation of the AAC on the emotional trial, and thus slow effects did not emerge. Although, as outlined in Chapter 4, results from Experiment 1 show that the words selected for this study conform to the same requirements as words used in prior research that have examined the ESE in general (e.g., Dresler et al., 2009; Isenberg et al., 1999; Sharma & McKenna, 2001). Therefore, the absence of slow effects cannot be adequately explained by the stimuli that were used.

In order to determine why slow effects were not found in the current experiment, the studies that had previously documented the occurrence of the effects were examined. It was possible to divide the results of these studies into several categories, based on the samples that were utilised. The bulk of studies that have reported the occurrence of fast and/or slow effects examined these biases in addiction related populations (e.g., Cane et al., 2008; Sharma et al., 2001; Water et al., 2003; Waters et al., 2005). With the exception of Sharma et al. (2001), both fast and slow components of attentional bias emerged. It is likely individuals in addiction samples would preferentially attend to and processes addiction relevant information, as it is highly salient to them. The argument could be made that within these samples, the highly relevant addiction words are more able to cause disruptions in colour-naming interference as they cause greater activation within these individuals word reading pathways. This argument could also be made in relation to the study of Wilson and Wallis (2013) and Sayette et al. (2001).

While differences in the results of the addiction literature and that of the current experiment, may be attributable to sample, it would be expected that similar results would be found between this experiment and that of McKenna and Sharma (2004), Frings et al. (2010), or Ashley and Swick (2009). As previously argued, the current sample is not necessarily different from what was utilised in the aforementioned studies. The difference however was that in the current research program, anxiety levels were measured. Based on this, other avenues needed to be explored in order to explain the lack of findings. Namely, if the samples could potentially be considered as somewhat equivalent, what other factors could be contributing to the differences between the results. There were no real differences between the methodology of the current study and that of McKenna and Sharma or Ashley and Swick. There were, however, differences between the results in each of these studies. While McKenna and Sharma reported a large slow effect on Position 2 in the negative emotion sequences, the slow effect which emerged in the study of Ashley and Swick could be interpreted as more of a general slow-down in colour-naming of all words (regardless of negative or neutral) within the negative emotion sequences. While the current study found differing results in regards to the occurrence of slow effects, differences also exist between other similar studies that have investigated these biases of attention (e.g., McKenna & Sharma, 2004; Ashley & Swick, 2009).

Frings et al. (2010) also reported the presence of fast and slow effects using a non-specified sample. The design of their study was different from that of McKenna and Sharma (2004), Ashley and Swick (2009), and the current research program (at least Experiments 2 and 3). Frings et al. argued that the design on McKenna and Sharma's study could not adequately detect the presence of fast effects, due to the contingency created by the pseudorandom presentation style. Given the divergent findings between McKenna and Sharma and Ashley and Swick in regards to the occurrence of fast effects, a clearer picture of the role that fast and slow components of biased attention play in the ESE could be gained by employing a differing methodology (i.e., the design employed by Frings et al., 2010). This is explored in greater detail in section 7.4.6.

The current study did not expect slow effects to occur in the 1000 ms and 2000 ms conditions. The study did, however, predict that slow effects would be detectable in the 32 ms condition. Although no evidence of fast or slow effects emerged, the different ITI conditions did elicit a change in RTs for all individuals, regardless of word type, position, and anxiety group. Additionally, a significant interaction was noted between anxiety group and position. These significant findings will be discussed in turn.

7.4.4 Biased Attention and Anxiety

The present study did not detect any significant group differences occurring in terms of fast or slow effects; however a significant interaction between position and anxiety group emerged. Follow-up analyses revealed the significant difference was within the state-trait anxiety group between the RTs of Positions 3 and 4. Averaged across sequence type and ITI, these participants showed an elevation in RTs on Position 3, which then decreased on Position 4. Furthermore, although mean differences emerged between the anxiety groups on several of the positions, these differences were non-significant.

As can be seen in Figure 7.1, the state-trait anxiety group and low anxious individuals had an opposite, almost mirrored pattern of responding. Additionally, the RT patterns of the trait and state anxiety group also resembled a mirror image. Based on Figure 7.1, it is evident that RTs varied between the anxiety groups. As the difference was only significant for the state-trait anxiety group between Positions 3 and 4, these differences do not appear to be overly meaningful as they were non-significant between the groups.

7.4.5 Biased Attention and Word Type

Dresler et al. (2009) suggested that valence of words might not be as important in the disruption of attention as the arousal of words. Essentially, findings from their study indicated that word arousal is capable of producing interference in colour-identification, independent of the valence of the word. Therefore, when using word stimuli in experiments, words should be selected based on both arousal and valence. This suggestion was adhered to in the current and prior experiment (Experiments 2). Based on the suggestion of Dresler and colleagues (2009), the current study predicted that fast effects would be present on both target positive and negative emotion words, in comparison with target neutral words. Furthermore, that slow effects would be observed as longer RTs both on neutral words that followed a target positive emotion word, and on neutral words that followed a target negative emotion word. This is because both target positive and target negative words were selected to have the same arousal values, which were higher than the arousal of the target neutral and neutral words.

Contrary to predictions, there were no fast effects or consistent evidence of slow effects in the current experiment or in Experiment 2. In relation to the target negative emotion words, this result is somewhat unexpected; however this finding is not entirely surprising for the positive emotion words. Dresler et al. (2009) demonstrated that arousal is an important predictor in EST interference, however, the role that arousal plays in regards to both fast and slow components of the ESE has not previously been investigated. The model of Wyble et al. (2008) predicts that fast effects are essentially caused by the ability of threatening stimuli to receive preferential processing in individuals with elevated anxiety (namely trait anxious individuals), thus causing a delay in colour-naming on the immediate threatening trial. Additionally, this model postulates that slow effects are caused by activation of the AAC from a negative or threatening emotional word. Wyble et al.'s model does not, however, comment on the effects of word arousal on colour-naming capacity. In the current study, the target positive and negative categories were matched in regards to their arousal levels. It is, however, a possibility that arousing positive words, unlike negatively valenced words, may not necessarily signal threat to individuals. As a result, fast effects would not occur for target positive emotion words at Positon 1, as high arousing words may not receive preferential processing within the information processing system, as positive words are not related to the individuals "danger schemata". Additionally, arousing positive words may not have the ability to activate the AAC, and as such no slow effects would eventuate on neutral words that followed positive emotion words. Given that no evidence of fast or slow effects emerged in the current study, it remains unclear as to what role arousal may play in fast and slow components of biased attention. Although, as arousal levels were controlled for between the target positive and negative emotion words, and the target neutral and neutral words, the null results cannot be attributed to levels of arousal in the different categories.

The finding that no fast or slow effects emerged in the current experiment is not considered to be the result of the words selected. Rather, it is possible that results were influenced by a methodological artefact, which is explained in greater detail in section 7.4.6.

7.4.6 Biased Attention and Time Pressure

It was predicted that the magnitude of fast and slow effects would vary depending on the duration of the ITI. Specifically, it was expected that the magnitude of fast effects would be greatest when the ITI was short, and the duration of the slow effect would differ across positions depending on the ITI. These hypotheses were not supported, as no evidence of fast or slow effects emerged.

The finding that participants responded fastest to the 1000 ms block, followed by the 2000 ms and 32 ms blocks replicated results of Experiment 2. Additionally, at a mean level, the present study found that participants responded approximately 134ms faster at the 32 ms block, in comparison to the equivalent ITI condition in Sharma and McKenna's (2001) experiment. Given that in the Sharma and McKenna study, ESEs decreased as RTs sped up (although accuracy was not compromised) during the 1000 ms block (versus in the 32 ms block), this raises the question of whether the overall general increase in the speed of responding (i.e., faster RTs) in the current study could have affected the presence of fast and slow effects (as in Experiment 2).

As in Experiment 2, the present study had a high proportion of anxious individuals in the sample. Based on this, it was suggested in Chapter 6 that global RTs could have sped up as a result of the increased anxiety in the sample. This did not, however, seem plausible in Experiment 2 as there were no main or interactive effects involving anxiety. Although results revealed a significant two-way interaction between position and anxiety, this interaction emerged only due to an effect involving the high state-trait anxious group responding slower to all words in Position 3 versus Position 4.

Although the 1000 ms block elicited the fastest RTs, accuracy of responses was not compromised. As there were no significant differences in the proportion of error rates between any of the blocks, it does not appear that the speeded RTs were due to a speed versus accuracy trade-off.

7.4.7 Implications of Results

Based on the results of both Experiment 2 and the present experiment, there does not appear to be strong evidence to support the occurrence of fast and slow effects within pseudorandom formats of the EST (at least for these samples of individuals). While previous research has documented ESEs in populations of individuals with elevated and clinical levels of anxiety (particularly trait anxiety), these have not been reliably found. The strongest effects are found in blocked formats of the task as opposed to when random formats are used (Phaf & Kan, 2007).

In a random format of the task, there is 50% chance that a word which occurs in the current trial, comes from the same category of words that occurred in the previous trial. As the slow effect should be noted on trials that follow from an emotional stimulus, it may be difficult to detect their presence as the effect would likely dissipate over subsequent trials if the words are from different categories. If words that follow a negative word are constrained so that they come from a different category of words (rather than coming from the same category of words) then the probability that an effect will be detected is increased from .50 to .75. Therefore in sequences whereby a negative word is always followed by a neutral category of words, the conditional probability on an effect being detected on the neutral trial (or trials) in increased. This therefore biases the pseudorandom format of the EST to detect a slow effect on neutral stimuli in the current trial. In addition, Frings et al. (2010) suggested that participants may become aware of the contingency that a neutral trial is preceded by a negative word, and a negative word is preceded by a neutral word. As a result, neutral trials may signal negativity (hence slow effects would be noted) and negative trials could signal neutrality (thus a fast effect would not result). This is therefore problematic given the already increased probability that slow effects would be detected relative to fast effects.

To rectify any possible limitations with the design of McKenna and Sharma's (2004) study, Frings et al. (2010) used a different methodology that would be capable of detecting both fast and slow effects in the EST, while controlling for the effects of signalling. In this study, words were presented in a random order so the trials were uncorrelated. As a result, a particular trial was not capable of signalling neutrality or negativity. Therefore, if individuals responded to neutral words following a negative word slower than a neutral word following a neutral word, a slow effect would be present in its own right. Additionally, fast effects can be examined by looking only at trials that follow a neutral word (as opposed to neutral trials that follow a negative word).

Experiments 2 and 3 of the current research program used the same EST methodology as McKenna and Sharma (2004). Due to this, the conclusion was drawn that the prior experiments conducted could not effectively conclude whether or not fast and slow effects co-exist within the EST. As a result, the decision was made to investigate whether fast and slow effects were present in a completely randomised version of the task, whereby results could not be influenced by a contingency. This experiment (Experiment 5) is presented in Chapter 9.

7.4.8 Strengths and Limitations

A potential limitation of the current experiment related to the sample that was assessed. As in Experiment 2, participants were university students. While this is not necessarily problematic, the decision was to recruit individuals from both a population of university students and the general community for the final emotional Stroop experiment. This would enable the findings of the study to have greater generalisability.

Another potential limitation of the sample relates to the unequal representation of men and women, and the unequal distribution of participants within each of the anxiety groups (as was the case in Experiment 2). In addition, the size of the state anxious group was quite small. It was hoped that by expanding the participant pool for the last experiment, these issues might be rectified, or at least improved. Despite this (as in Experiment 2), based on the effect sizes and power levels, the lack of significant effects reported were not likely due to an unequal distribution of participants between the anxiety groups.

Despite these potential issues, this study (in conjunction with Experiment 2) was the first to investigate the presence of both fast and slow effects in low anxious, state anxious, trait anxious, and state-trait anxious individuals. In addition to this, it was also the first study to explicitly attempt to determine the duration of the slow effect by examining the contribution that time (as opposed to just trials) may play in influencing the bias.

7.5 Summary of Chapter

The current experiment aimed to investigate the nature of fast and slow effects in the EST for individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. Due to the unexpected results of Experiment 2, the decision was made to replicate the experiment using a new set of neutral stimuli in Position 1. Based on the findings of the current study, the target neutral stimuli used in Position 1 in Experiment 2, were not responsible for the lack of fast or slow effects.

The hypotheses proposed for the present study were not supported. However, the finding that participants respond fastest in the 1000 ms block, followed by the 2000 ms, and 32 ms block was maintained. Interestingly, these changes in RTs did not manifest as the result of a speed versus accuracy trade-off.

Several reasons why the current study did not detect the presence of fast and slow effects were presented. In particular, a potential possibility for not detecting the presence of both fast and slow effects could be attributed to the design of the task itself. As a result, the decision was made to conduct another experiment (Experiment 5) whereby words were presented in a contingency-free environment.

Chapter 8. Word Selection Study for Experiment 5 (Experiment 4)

8.1 Introduction

8.1.1 Overview of Chapter

The current chapter presents the word selection process for stimuli to be used in Experiment 5. Specifically, a rationale for the word selection study is outlined in addition to the criteria utilised for the inclusion of words. The methodology and results of the study are presented along with the final list of words selected for Experiment 5.

8.1.2 Rationale

Based on the results of Experiments 2 and 3, a decision was made to conduct an additional EST utilising a different methodology. The reasons for this were outlined in the discussion of Chapter 7. Although the final EST of this thesis (Experiment 5) was interested in examining the fast and slow components of biased attention in the EST, the decision was made to employ a random presentation of the task (as opposed to a pseudorandom style utilised in both Experiments 2 and 3). The design of this task required fewer categories of words; however more words per category were needed. Instead of 15 categories (3 target and 12 neutral) with 5 words in each, Experiment 5 needed 3 categories of words (i.e., positive emotion, negative emotion, and neutral), with 10 words in each category. Due to this, it was considered necessary to conduct an additional word selection study.

8.1.3 Aims and Conditions of Stimuli Selection

The current word selection study aimed to select 30 words for use in the EST for Experiment 5. Specifically, 10 words were needed for the categories of positive emotion, negative emotion, and neutral. As outlined in Chapter 5 (section 5.1.3), it is important to ensure the lexical equivalence of words for use in ESTs. Namely it is important to ensure that each category of words have their own semantic theme (e.g., Holle et al., 1997), are consistent in terms of length and frequency of occurrence in the English language (e.g., Larsen et al., 2006), and that categories of emotional words are matched in terms of their arousal levels (e.g., Dresler et al., 2009). In addition, it is also important to ensure that words are representative of their category in terms of valence; that is, a negative word is in fact negative.

As in Experiment 1, in order for categories of words to be considered for use in an emotional Stroop task, the following criteria must be satisfied. All categories of words need to be matched for length and frequency of occurrence in the English language. In addition, each category of words needs to differ in valence ratings, with the positive emotion words receiving the highest ratings, negative emotion words receiving the lowest ratings, and neutral words receiving middle-range ratings. The positive and negative categories must also receive higher arousal ratings than the neutral words, however, there must be no differences in the arousal levels of the positive and negative categories.

8.2 Method

8.2.1 Participants

Forty-two participants completed the word selection study (32 women, 10 men), with ages ranging 19-52 (M = 32.89, SD = 9.23). The sample primarily consisted of individuals in full-time employment (n = 26), who were not currently studying (n = 25). Participants were predominately recruited using the social networking site “Facebook” in conjunction with a snowball technique. Selection of participants employed the same criteria as the prior experiments.

8.2.2 Design

The current study was an independent groups design. The IV was word type with three levels: Positive emotion, negative emotion, and neutral. There were two DVs: Valence ratings and arousal ratings. In addition, analyses were conducted to ensure no differences were present in the length and frequency of occurrence in the English language between each category of words.

Initially, four categories of words were developed: Two emotion categories (i.e., positive and negative emotion) and two neutral categories (animals and solar system), each with their own distinct semantically related theme. These categories were developed in the same manner as in Experiment 1. Twenty words were selected for each category with the emotional words (i.e., positive and negative) taken from the ANEW (Bradley & Lang, 1999). The categories were then refined based on their average length and frequency of occurrence in the English language **(**Brysbaert & New, 2009) using the same method as Experiment 1 (see section 5.2.2 for a full description). Words that had approximately the same length and frequency of occurrence in the English language were retained to form a final list of 16 words per category.

8.2.3 Materials

The materials of the current study were identical to that of Experiment 1 with the exception of the words themselves (information letter to participants and demographics page can be found in Appendices E and F). A list of the words utilised in the present study, including their frequency of occurrence in the English language, length, valence and arousal ratings (from the current word selection study) are presented in Table 8.1 for the emotional words and Table 8.2 for the neutral words.

8.2.4 Procedure

In total, 64 words were selected with each participant required to rate the words on two separate dimensions (arousal and valence). The procedure was identical to that of the first word selection study (Experiment 1), with the exclusion of the words themselves. In addition, due to the reduced number of words, participants were required to rate all the words (as opposed to separating them into different lists as was done in the prior word selection experiment).

Table 8.1

Positive and Negative Words Utilised in the Word Selection Study Including Frequency, Length, Valence and Arousal Ratings

	Positive Emotion					Negative Emotion			
Word	Freq	Len	Val	Arou	Word	Freq	Len	Val	Arou
achieve	7.33	7	6.98	6.50	abortion	7.24	8	2.76	6.31
admired	3.67	7	7.00	6.10	agony	3.75	5	2.41	6.69
bliss	3.14	5	7.51	6.31	betrayal	4.24	8	1.93	7.07
ecstasy	3.18	7	7.54	6.90	bludgeon	0.24	8	2.37	6.00
elated	0.27	6	7.34	6.38	despise	4.51	7	2.54	6.83
hopeful	2.98	7	7.22	5.90	enraged	0.69	7	2.20	6.86
humble	9.8	6	6.63	4.79	execute	5.55	7	2.61	6.20
inspired	7.65	8	7.51	6.83	hatred	5.41	6	2.02	6.98
joyful	1.49	6	7.51	6.55	hostile	8.94	7	2.83	5.95
kindness	9.02	8	7.73	5.98	loathe	2.08	6	2.56	6.29
lively	4.06	6	6.83	5.55	massacre	3.96	8	1.95	6.86
luxury	6.02	6	6.85	5.69	molest	0.61	6	2.12	6.48
orgasm	4.18	6	7.73	6.90	mutilate	0.57	8	1.78	6.76
radiant	2.16	7	7.00	5.93	punish	9.67	6	2.56	6.26
thankful	5.37	8	7.27	5.98	rejected	6.61	8	2.49	6.24
thrill	8.41	6	7.29	6.60	torment	2.73	7	1.95	6.38
Mean	4.92	6.63	7.25	6.18	Average	4.18	7.00	2.32	6.51

Note: Freq- Frequency; Len- Length; Val- Valence; Arou- Arousal

Table 8.2

Neutral Words Utilised in the Word Selection Study Including Frequency, Length, Valence and Arousal Ratings

Solar System					Animals				
Word	Freq	Len	Val	Arou	Word	Freq	Len	Val	Arou
asteroid	1.69	8	4.73	3.57	alpaca	0.2	6	4.83	3.07
crater	2.59	6	4.78	2.86	beaver	4.82	6	4.66	3.21
density	1.43	7	5.00	3.98	bison	0.33	5	4.76	3.12
galaxy	6.65	6	5.07	3.38	camel	5.02	5	5.05	2.69
jupiter	4.04	7	4.90	2.98	cheetah	2.29	7	5.05	3.10
meteor	3.53	6	4.85	3.57	donkey	5.35	6	5.00	2.57
moons	2.35	5	5.07	3.36	echidna	0.76	7	5.02	3.21
neptune	2.67	7	4.88	2.95	falcon	3.31	6	5.00	3.38
orbit	5.65	5	4.90	3.24	finch	4.02	5	5.00	2.38
planets	4.29	7	5.05	3.17	gorilla	5.55	7	4.90	3.29
pluto	3.04	5	4.90	3.24	hamster	2.14	7	4.85	2.45
rotation	2.92	8	5.10	3.26	iguana	0.78	6	4.76	2.95
saturn	1.51	6	4.93	3.19	moose	5.53	5	4.88	2.93
seasons	4.12	7	5.51	4.14	rooster	3.86	7	4.78	3.02
solar	4.63	5	5.20	2.88	squirrel	5.47	7	5.02	2.86
uranus	0.69	6	4.85	3.88	walrus	1.12	6	4.80	2.45
Average	3.24	6.31	4.98	3.35	Average	3.16	6.13	4.90	2.92

Note: Freq- Frequency; Len- Length; Val- Valence; Arou- Arousal

8.3 Results

8.3.1 Descriptive Statistics

Mean valence and arousal ratings were computed for each word and classified as positive, negative, or neutral in the same manner as Experiment 1 (ratings were presented in Tables 8.1 and 8.2). All words classed as positive, negative, and neutral received valence ratings appropriate to that category (e.g., all negative words received ratings below three). Final word selection commenced with an examination of mean valence ratings. The positive emotion and negative emotion categories were selected first. The 10 lowest rated negative words and the 10 highest rated positive words were selected from the initial lists of 16. Once these words had been selected, the average length of each category was examined. Based on the length of words in both the positive and negative emotion lists, the decision was made to retain the neutral category of solar system (as opposed to animals), as this category had an average length that was more similar to the emotion categories.

8.3.2 Inferential Statistics

Analyses were conducted on the final lists of 10 words selected for Experiment 5 to ensure there were no significant differences between the lengths and frequencies of different categories of words. Additionally, analyses were conducted to ensure that differences in arousal (between the emotion and neutral words) and valence (between all categories of words) were significant and in the expected direction.

8.3.2.1 Length. A one-way between groups ANOVA was conducted to ensure no differences existed between lengths of words in each category (positive, negative, and neutral). Results revealed there were no significant differences between the lengths of words in each category, $F(2, 27) = 1.19$, $p = .318$, $\eta p^2 = .08$, observed power = .24.

8.3.2.2 Frequency. A one-way between groups ANOVA was conducted to ensure no differences existed between the frequencies of words in each category (positive, negative, and neutral). Results indicated there were no significant differences between the frequency of words in each category, $F(2, 27) = 0.80$, $p = .458$, $\eta p^2 = .06$, observed power = 17.

8.3.2.3 Valence. A one-way between groups ANOVA was conducted to examine differences between the valence ratings of words in each category (positive, negative, and neutral). Results from the analysis revealed significant differences between the valence ratings of words, $F(2, 27) = 1121.70$, $p < .001$, $\eta p^2 = .99$, observed power = .99. As expected, positive words received the highest valence ratings ($M = 7.31$, $SD = 0.26$), followed by neutral ($M = 4.96$, $SD = 0.12$) and negative ($M = 2.23$, $SD = 0.29$) words. The differences between each of these categories were significant ($p < .001$ for each comparison).

8.3.2.4 Arousal. A one-way between groups ANOVA was conducted to examine differences between the arousal ratings of words in each category (positive, negative, and neutral). Results from the analysis revealed significant differences between the arousal ratings of words, $F(2, 27) = 217.59$, $p < .001$, $\eta p^2 = .94$, observed power = .99. As expected, positive words ($M = 6.22$, $SD = 0.45$) and negative words ($M = 6.54$, $SD = 0.37$) received approximately the same arousal ratings ($p = .198$), whereas neutral words ($M = 3.32$, $SD = 0.31$) were rated significantly lower than both the emotional categories ($p < .001$ for each comparison).

8.4 Discussion

The current study selected 30 words for use in the subsequent EST (Experiment 5). Table 8.3 presents the final lists of words resulting from the current study. Specifically, three categories of semantically related words were developed, and these categories can be considered lexically equivalent in terms of their length and frequency of occurrence in the English language. Additionally, each category of words received appropriate valence ratings, with the positive emotion words receiving the highest ratings, negative emotion words receiving the lowest ratings and neutral words receiving middle-range ratings. As stipulated in the conditions for word selection in section 8.1.3, the positive and negative categories received higher arousal ratings than the neutral words. In addition, there was no difference in the arousal levels of the positive and negative categories of words.

Table 8.3

Final Words Selected for the EST in Experiment 4

Positive	Negative	Neutral
achieve	mutilate	moons
admired	betrayal	meteor
radiant	massacre	asteroid
hopeful	torment	neptune
thankful	enraged	jupiter
inspired	bludgeon	saturn
joyful	rejected	density
ecstasy	despise	planets
kindness	agony	galaxy
elated	execute	rotation

While the current study ensured the differing categories of words were matched on several important lexical features, differing only in terms of valence and arousal, there are limitations that should be noted. As in Experiment 1, the present study did not formally have the semantic relatedness of words in each category independently rated. Despite this, efforts were made to ensure the words in each category were representative of the categorical theme. Additionally, orthographic neighbourhood size was not controlled for between the categories of words, a feature that has been implicated in affecting processing of word stimuli (e.g., Larsen et al., 2006), however, word frequency and valence have been more readily identified as key features to control for in emotional Stroop experiments (e.g., Kahan & Hely, 2008), in addition to word arousal (e.g., Dresler et al., 2009). These three features, in conjunction with semantic relatedness within categories of words, were however taken into account when selecting words, thus the words selected for Experiment 5 are matched on the several important dimensions and can be consider lexically equivalent.

In conclusion, the current study offers a word list that consists of three categories of semantically related words. Each category of words has been matched on several important dimensions and were normed on an Australian sample. Furthermore, newer word frequencies were utilised, which better reflect the use of current language (Balota et al., 2004; Brysbaert & New, 2009; Larsen et al., 2006). Essentially, the criteria utilised for the word selection study ensures that differences emerging in RTs can be more readily attributed to the emotional content of the words, and not due to other lexical features such as frequency of occurrence in the English language.

8.5 Overview of Chapter

The current chapter presented a study whereby a list of words was developed for use in the final emotional Stroop experiment (Experiment 5). While Experiment 1 created a pool of 75 words for Experiments 2 and 3, Experiment 5 required fewer categories of words, with more words within each category. Initially, four categories of words were developed, each with their own semantically related theme (e.g., negative emotion, solar system). Each category was comprised of 16 words, creating a pool of 64 words that were matched in regards to average length and frequency of occurrence in the English language. These words were rated on the dimensions of arousal and valence.

In total, three categories of words were selected for use in Experiment 5. Each category was comprised of 10 semantically related words, which do not differ to the other categories in regards to word length and frequency of occurrence in the English language. The only differences between the categories of words are in relation to valence and arousal levels. The emotional words (both positive and negative) were more arousing than the neutral words. In addition, Experiment 5 ensured that each category of words received valence appropriate ratings. For example, positive words were rated positively, negative words were rated negatively, and neutral words were rating neutrally.

Due to the matching of words for length, frequency of occurrence in the English language, valence, and arousal, in addition to the creation of semantically related word categories, differences in RTs that emerge in the subsequent Stroop experiments can be more readily attributed to the content of the words themselves (e.g., emotionality) or other individual difference factors (e.g., anxiety type or level) as opposed to differences in lexical characteristics of words.

Chapter 9. Fast and Slow Effects in a Contingency Free Environment (Experiment 5)

9.1 Introduction

9.1.1 Chapter Overview

The current chapter aimed to address the nature of fast and slow effects in the EST for low anxious and anxious individuals. The results of both Experiment 2 and 3 were not consistent with predictions, as fast and slow effects did not emerge for the negative emotion or positive emotion sequences. Additionally, anxiety was not implicated within the task as a playing a role in biased attention. Several possible reasons for the unexpected findings have been explored in previous chapters; however one possible theory had not yet been tested. Chapter 7 highlighted the possibility that the lack of findings could be related to the design of the task, and as a result, the decision was made to employ a completely random methodology that was contingency-free. This design allows fast and slow effects to be computed independently of one another as each trial is uncorrelated with the last. A rationale, methodology, results, and discussion of the findings are presented.

9.1.2 Rationale

Experiments 2 and 3 did not find evidence of fast effects or consistently find evidence of slow effects occurring within the EST. Experiment 2 found that in general, participants responded slowest to neutral words, namely at Position 2 after a target neutral word was presented. Although a significant interaction emerged between sequence type, position, and ITI, results showed an unusual pattern of responding to the pure sequences of neutral words that did not replicate results of McKenna and Sharma (2004). Despite this, however, Experiment 2 did find that at the 32 ms ITI there was a gradual increase in the time it took participants to identify the ink-colour of neutral words that followed a target negative word. This increased steadily until Position 4, where the difference reached significance. This difference, however, was only significant in comparison to neutral words that followed target positive words (as opposed to neutral words that followed target neutral words). This finding is potentially indicative of a slow effect being present.

Due to the unexpected patterns of responding to neutral words in Experiment 2 (e.g., the increase in time to identify the colour of a neutral word following a target neutral word at Position 2 at both the 32 ms and 1000 ms ITI blocks), a decision was made to replicate the experiment using a different set of target neutral words. Although the present research program carefully selected words for use in all the ESTs (see Chapter 5 and Chapter 8), the target neutral category employed at Position 1 in Experiment 2 received slightly higher positivity ratings than the other categories of neutral words. It should be noted that the difference was not significant, and participants did not respond to this set of neutral words in a similar pattern to the positive emotion sequences, which may be expected if these words were deemed as positive by participants. Elevations in RTs, however, to the target neutral words at Position 1 and the subsequent neutral words in the pure neutral sequences could not be accounted for, and as a result the target neutral words were changed and Experiment 3 was conducted. In addition, an added benefit of conducting Experiment 3 was that the experiment attempted to control for the unusual findings of Experiment 2, and therefore provided another opportunity for the findings of McKenna and Sharma (2004) to be replicated. Furthermore, conducting Experiment 3 provided an additional opportunity to explore the role of fast and slow components of biased attention in the EST, and test whether the predications of Wyble et al. (2008) could be supported.

If the same patterns of responding occurred during Experiment 3, it could be concluded that a slow effect is best detected at the 32 ms time period, albeit at a later position than expected and only on neutral words that followed target words of directly opposing valences (i.e., positive and negative words). Experiment 3, however, did not replicate the results of Experiment 2 in regards to the presence of slow effects found for negative words at 32 ms ITI. Additionally, position and ITI were not implicated collectively in any interaction terms. This absence of a significant interaction did not replicate the potential slow effect initially reported in Experiment 2. Consistent with Experiment 2 was the absence of fast effects, and the finding that participants consistently responded faster to words presented at the 1000 ms block, followed by the 2000 ms and 32 ms blocks (a main effect of ITI). Experiment 3 did report a two-way interaction between anxiety group and position of word, however, follow-up analyses revealed that this interaction was due only to a significant difference in the group of individuals who were both state and trait anxious, as opposed to the low anxious, state anxious and trait anxious groups. Furthermore, the difference was only significant between the RTs of Positions 3 and 4 (regardless of sequence type), with RTs decreasing from Position 3 to Position 4. Due to the inconsistent results between Experiments 2 and 3, it became clear that another experiment was required. Additionally, a new methodology was employed, one that could independently assess the contributions of both fast and slow effects.

In the prior emotional Stroop tasks (Experiments 2 and 3) participants were presented with words in a pseudorandom order (in direct replication of the study of McKenna & Sharma, 2004). More recently, Frings et al. (2010) proposed an alternative methodology that allows for the detection of both fast and slow effects in a contingency-free environment. Frings and colleagues proposed that the use of a pseudorandom presentation format may inadvertently suppress fast effects from occurring, due to the contingency created by the probability that a neutral word would follow a negative word, and a negative word would follow a neutral word. An important characteristic of automatic processing, which is assumed to be the mechanism underlying the ESE or at least the fast component of the effect, is uncontrollability (Tzelgov, Henik, & Berger, 1992). If participants become familiar with a particular contingency, in this case the order that neutral and emotional words will be presented, RTs may be affected by the participant's expectations or their ability to exercise control over responding.

Frings and colleagues (2010) utilised a design whereby valence in the current trial (N+1) was uncorrelated with the valence in the previous trial (N), and as such fast and slow effects are able to be independently calculated. The findings of Frings et al. indicated that both fast and slow effects can be detected when using a balanced design. Although, it is not entirely clear whether fast and slow effects are entirely distinct phenomena. It is possible that (a) both effects are caused by a generic slowdown in colour-naming in response to emotional stimuli (e.g., Algom et al., 2004; Phaf & Kan, 2007), or (b) the effects are distinct phenomena that co-exist within the task (e.g., McKenna & Sharma, 2004). Frings et al. postulated that one way of determining whether these are in fact separate entities or reflections of the same process (or processes) is to examine the phenomena in anxious individuals, as "traditional" ESE effects have previously been documented within this population. It could be that one of or both of these effects are different within individuals with varying levels of anxiety. Divergent effects across different populations would support the idea that the slow and fast effects correspond to two distinct processes.

Frings and colleagues (2010) also suggested that when the ITI is longer, detection of slow effects may not be possible due to the extended period of time between the stimuli (i.e., detection of slow effects is likely optimal with short ITIs).Although, fast effects should still be present with longer ITIs, and potentially occur to a greater extent due to the extended period of time between trials (when the slow effect would have dissipated). Therefore, the present experiment will maintain the manipulation of ITI across three levels, as in the previous experiments. In addition to this, based upon the prior results of

Experiments 2 and 3 in regards to anxiety, it was decided that the current experiment (Experiment 5) would compare individuals who were low on anxiety versus those who were high anxious (as opposed to those who are state, trait, and state and trait anxious).

9.1.3 Aims and Hypotheses

The current chapter aimed to investigate the nature of both fast and slow effects in the EST for low anxious and anxious individuals. The hypotheses remain similar to that used in Experiments 2 and 3, however, due to the lack of effects found in regards to anxiety group, some hypotheses have been altered.

Specifically, it was predicted that fast effects would be present for the anxious group, as opposed to the low anxious group. Based on the model of Wyble et al. (2008), it was anticipated that anxious individuals would show biased attention, as characterised by a fast effect, due to the strengthened connections throughout their information processing system. Additionally, it was expected that if arousal rather than valence of words is responsible for emotional Stroop interference, then fast effects will be present for negative and positive words in comparison with neutral words.

It was also expected that the low anxious and anxious participants would show an attentional bias characterised by a slow effect. This was expected, as both groups of individuals would have greater activation of the affective component of the AAC unit, thus causing neutral material presented after an emotional stimulus to be responded to more slowly. Furthermore, if arousal rather than valence of words is responsible for emotional Stroop interference, then slow effects would be present for negative and positive words in comparison to neutral words. It was also expected that due to the increased activation of the AAC in state anxious individuals, the anxiety group would report a larger slow effect than low anxious individuals. Finally, it was expected that magnitude of fast and slow effects would be greatest when the ITI is short.

9.2 Method

9.2.1 Participants

The sample was comprised of 99 individuals. In total, 93 participants complied with the restrictions placed on the sample, which were the same as Experiments 2 and 3. Participants were recruited from undergraduate psychology classes at Australian Catholic University (*n* = 69; Melbourne *n* = 33, Brisbane *n* = 36) and the general community (*n* = 24) using a snowball technique. Students were eligible to receive 1% course credit for participating in the project. No incentives were offered to members of the general community. The age range of the sample was 18-51 years with a mean age of 25.92 years (*SD* = 8.62). Testing was done either individually (*n* = 26) or in small groups (*n* = 67). Testing of the university sample was conducted in a computer laboratory. Testing of members of the general community was done at a mutually convenient location. An experimenter was present at all testing sessions.

9.2.1.1 Anxiety group allocation. Participants were classified as low anxious or anxious based on their scores on the STAI (Spielberger et al., 1983). The same cut-offs were used as in Experiment 2 and 3. In the current study, however, regardless of anxiety type (state or trait), all individuals with anxiety levels above the cut-off were placed into the anxious group. Using these criteria, more than half of participants were classed as anxious (*n* = 54 ; women *n* = 42, men *n* = 12). For the anxious group, state anxiety scores ranged from 20-72 (*M* = 43.33, *SD* = 9.31) and trait anxiety scores ranged from 22-67 (*M* = 45.56, *SD* = 9.04). The low anxious group comprised of 38 of the total sample (*n* = 38; women *n* = 26, men *n* = 12). State anxiety scores ranged from 20-35 (*M* = 27.68, *SD* = 4.69) and trait anxiety scores ranged from 24 - 38 (*M* = 32.10, *SD* = 4.48). It should be noted that the anxiety group breakdowns reported (including *M*s and *SD*s) were based on the participants included in the final analyses.

9.2.2 Design

The design formed a 3 x 3 x 3 x 2 mixed factorial model. The first IV was valence in a particular trial (trial N): Positive, negative, or neutral. The second IV was valence in the subsequent trial (trial N+1): Positive, negative, or neutral. The third IV was duration of ITI with three levels: Short (32 ms), medium (1000 ms), and long (2000 ms). These IVs were within-subject factors. The fourth IV was anxiety group (low anxious and anxious) which was a between-subjects factor. The DV was mean correct RT (measured in ms).

9.2.3 Materials

Both the demographic questionnaire and STAI (Spielberger et al., 1983) previously used in Experiments 2 and 3 were administered in the current experiment. A different set of words was developed for the EST. Experiment 4 (Chapter 8) presents how words were developed, in addition to the final list of words utilised in the current Experiment.

9.2.3.1 Emotional Stroop task. The EST was presented electronically. Each word was presented one at a time, in the middle of the screen, in 38 point font, lower case, in one of four ink-colours: Purple, blue, green, or yellow. In total 30 words were used in the EST, 10 positive emotion, 10 negative emotion, and 10 neutral. The words used in the current experiment were selected in Experiment 4.

Words were presented in a random order and occurred in three blocks, each with a differing ITI (i.e., 32 ms, 1000 ms, and 2000 ms). Within each block, each word was presented twice. A short break of 30 seconds was given to participants after the completion of each block. Order of block presentation was counter-balanced across participants using the same method as in Experiments 2 and 3. In total participants completed 60 trials in each block, totalling 180 trials.

9.2.4 Procedure

The procedure was identical to Experiment 2 and 3 with the exception of the time taken to complete the task. The current experiment took approximately 10 minutes to complete.

9.3 Results

9.3.1 Data Screening

9.3.1.1 Questionnaire data. The internal consistency of both the S (Cronbach's alpha= .93) and T (Cronbach's alpha= .92) scales of the STAI were excellent. A missing values analysis was performed on the STAI (Spielberger et al., 1988) revealing fewer than 5% of missing values on all questionnaire items. Missing values were replaced using median replacement across six variables for five participants. One participant failed to complete all items on the T scale, and as a result their data was omitted from analyses.

The Shapiro-Wilk test for normality was significant for both the S (p = .015) and T (p = .044) scales, indicating potential problems with normality as both distributions were positively skewed. Standardised skew values however indicated that the breaches in normality were not problematic.

9.3.1.2 RT data. Averages were obtained for each possible pairing of words across trials N and N+1. The word pairings of most interest were negative words that followed a neutral word, positive words that followed a neutral word, and neutral words that followed a neutral word, as by examining the RTs between these variables, the presence of fast effects could be detected. To examine slow effects, the variables of interest were neutral words that followed a negative word, neutral words that followed a neutral word, and neutral words that followed a positive word. In addition, other combinations of variables were also scored, for example, negative words following a negative word, and positive words following a positive word. While these variables were not specifically related to any hypotheses per se, examining these RTs allows for additional information regarding the ESE to be investigated. As in the prior experiments (Experiments 2 and 3), only mean correct RTs were utilised. In addition, RTs over 2000 ms or under 200ms were excluded from analyses. One participant had their data removed from the 1000 ms block (and due to the design of the study their data was omitted from the analysis and any follow-up comparisons) as they responded under 200ms on 83% of trials and had identified the colour accurately on only 17% trials.

9.3.1.2.1 Low anxious. The Shapiro-Wilk test for normality indicated potential issues with normality across three variables. Standardised skew and kurtosis values indicated that skew and kurtosis were only problematic on the negative words that followed negative words in the 32 ms block. Removal of an outlier (z = 4.24) on this variable restored normality.

9.3.1.2.2 Anxious. The Shapiro-Wilk test for normality indicated potential issues across eight variables. Standardised skew and kurtosis values indicated that skew and kurtosis were only problematic on the negative words that followed negative words and positive words that followed neutral words, both in the 32 ms block. Removal of an outlier on each of these variables (z = 3.44 and z =4.04 respectively) restored normality.

9.3.2 Descriptive Statistics

Prior to commencement of the experiment, an a priori power analysis was conducted using G*Power (Faul et al., 2009) in order to determine sample size. The statistical test selected for the power analyses was a repeated measures ANOVA (within-between interaction). The analyses showed that in order to detect a small to moderate effect size (f =.18; Cohen, 1992) with a power of .95 and alpha set at .05, a total sample size of 82 was required.

Table 9.1 presents the mean RT and standard deviation for each word valence in trial N+1, as a function of valence in trial N, at each anxiety group and each ITI.

Table 9.1

Means and SDs in Trial N+1 as a Function of Valence in Trial N for the Low Anxious and Anxious Groups at the 32 ms, 1000 ms, and 2000 ms Blocks

ITI	Anxiety group	Trial N	Trial N+1					
			Neg		Pos		Neu	
			M	*SD*	*M*	*SD*	*M*	*SD*
32 ms	Low anxious	Neg	762.11	122.13	748.14	116.43	758.98	103.43
		Pos	738.80	129.98	720.27	114.21	743.68	117.64
		Neu	744.41	147.19	759.81	126.04	749.48	127.79
1000 ms		Neg	699.40	132.52	727.31	158.65	702.25	129.63
		Pos	716.99	145.37	696.24	125.28	715.33	126.93
		Neu	695.76	111.61	679.22	105.63	691.24	126.06
2000 ms		Neg	708.65	119.98	685.02	112.04	705.10	140.52
		Pos	694.30	128.71	694.46	113.82	723.50	144.88
		Neu	711.99	140.16	696.35	138.20	692.47	136.57
32 ms	Anxious	Neg	747.88	145.04	744.54	132.02	737.63	130.73
		Pos	743.33	147.13	736.14	138.57	723.15	118.69
		Neu	723.29	142.27	733.57	115.96	737.82	140.28
1000 ms		Neg	672.89	132.96	690.72	133.07	714.18	134.01
		Pos	694.55	127.86	695.06	120.35	689.12	155.19
		Neu	714.23	163.63	693.19	125.55	706.40	148.04
2000 ms		Neg	727.02	167.73	705.27	150.80	727.90	150.18
		Pos	700.97	132.52	743.67	164.95	699.50	134.82
		Neu	708.46	134.62	721.33	141.12	721.13	136.24

Note: Neg- Negative; Pos- Positive; Neu- Neutral

9.3.3 Inferential Statistics

A 3 (ITI) x 2 (anxiety group) mixed factorial ANOVA was conducted to examine error rates for the 32 ms, 1000 ms , and 2000 ms blocks for the low anxious and anxious individuals. No significant differences emerged either between or within the anxiety groups at the 32 ms, 1000 ms , and 2000 ms blocks, $F(1.31,116.84) = 0.40$, $p = .586$, $\eta_p^2 < .01$, observed power = .10. The mean percentages of errors for the low anxious group at each block were 2.71%, 3.16%, and 2.50% respectively. The mean percentages of errors for the anxious group at each block were 3.21%, 5.13%, and 3.60% respectively.

Fast and slow effects were examined using a 3 (ITI: 32 ms, 1000 ms, and 2000 ms) x 3 (word type at trial N) x 3 (word type at trial N+1) x 2 (anxiety group: Low anxious vs. anxious) mixed factorial ANOVA, with RT as the dependent variable. Of particular interest was whether a four-way interaction occurred between ITI x N x N+1 x anxiety group. Results of the main analyses are presented in Table 9.2.

As can be seen in Table 9.2, there was a main effect of ITI. The fastest RTs were noted in the 1000 ms block (M = 699.67, SE = 12.59), followed by the 2000 ms (M = 709.28, SE = 13.33), and 32 ms (M = 741.84, SE = 11.87) blocks. The differences between the 32 ms block and the 1000 ms ($p < .001$) and 2000 ms ($p = .001$) blocks were significant. The difference between the 1000 ms and 2000 ms blocks was non-significant ($p = .497$). There were no other significant main effects.

A significant interaction was found between ITI, N, and N+1. To follow-up this interaction, the decision was made to assess whether differences were occurring between N and N+1 at each ITI, as this would allow for the contribution of both fast and slow effects to be examined at each ITI. Follow-up comparisons on the variables of interest needed to be conducted in two different ways. First, to assess whether there were fast effects occurring, RTs of correctly colour-identified positive, negative and neutral (N+1) words that followed a neutral word (N) only were examined at each ITI. Second, to assess whether slow effects were occurring, the differences in RTs between neutral words (N+1) that followed from positive, negative, or neutral words (N) were examined at each ITI.

Table 9.2

Results of the 3 x 3 x 3 x 2 Mixed Factorial ANOVA for Experiment 2

	df	*F*	Sig.	ηp^2	Observed Power
ITI	1.93, 164.26	16.90	<.001*	.17	1.00
N	2, 170	1.39	.253	.02	.29
N1	2, 170	0.49	.614	.01	.13
Anxiety	1, 85	<0.01	.990	<.01	.05
ITI * N	4, 340	1.00	.407	.01	.32
ITI * N1	4, 340	0.14	.968	<0.01	.08
ITI * Anxiety	1.93, 164.26	1.77	.175	.02	.36
N * N1	4, 340	0.14	.968	<0.01	.08
N * Anxiety	2, 170	0.66	.517	.01	.16
N1 * Anxiety	2, 170	1.12	.327	.01	.25
ITI * N * N1	7.67, 587.01	2.37	.018*	.03	.88
ITI * N * Anxiety	4, 340	2.51	.042*	.03	.71
ITI * N1 * Anxiety	4, 340	1.04	.386	.01	.33
N * N1 * Anxiety	4, 340	2.81	.026*	.03	.77
ITI * N * N1 * Anxiety	7.67, 587.01	0.73	.660	.01	.33

Note: * *p* <.05; ***p* <.001

Results from the fast effects comparisons revealed that there was no evidence of fast effects occurring at the 32 ms, 1000 ms, or 2000 ms ITIs. For statistics see Table 9.3.

Table 9.3

Post-hoc Univariate Tests Comparing the RTs of Positive, Negative, and Neutral Words at Trial N+1 That Followed Neutral Words at Trial N, at Each ITI

ITI	*df*	*F*	Sig.	ηp^2	Observed Power
32 ms	2, 84	0.71	.496	.02	.17
1000 ms	2, 84	1.64	.200	.04	.34
2000 ms	2, 84	0.06	.945	>.01	.06

Results from the slow effects comparisons also revealed no evidence of slow effects occurring at the 32 ms, 1000 ms, or 2000 ms ITIs. For statistics see Table 9.4.

Table 9.4

Post-hoc Univariate Tests Comparing the RTs of Neutral Words at Trial N+1 That Followed Positive, Negative, and Neutral Words at Trial N, at Each ITI

ITI	*df*	*F*	Sig.	ηp^2	Observed Power
32 ms	2, 84	1.37	.259	.03	.29
1000 ms	2, 84	0.635	.635	.01	.12
2000 ms	2, 84	0.39	.680	.01	.11

A significant three way interaction emerged between ITI, N, and anxiety. This interaction was followed up with one-way ANOVAs, comparing effects for the three word types at N, for each anxiety group at the 32 ms, 1000 ms, and 2000 ms ITIs. It should be noted that only significant results are reported. Results indicated there were significant differences occurring at the 32 ms, $F(2, 84) = 3.29$, $p = .042$, $\eta_p^2 = .07$, observed power

=.61, and 1000 ms , $F(2, 84) = 3.21$, $p = .045$, $\eta_p^2 = .07$, observed power = .60, ITI for the low anxious group. At the 32 ms block, low anxious individuals responded significantly more slowly to words that followed a negative N (*M* = 756.41, *SE* = 18.31) than words that followed a positive N (*M* = 734.25, *SE* = 18.69; *p* = .041). Overall analyses were significant for low anxious individuals at the 1000 ms block, however, after applying the Bonferroni correction only a trend emerged (*p* = .084). The trend found that participants responded faster to words that followed a neutral word at N (*M* = 688.74, *SE* = 19.72) than words that followed a positive word at N (*M* = 709.52, *SE* = 19.72).

A significant-three way interaction was also found between N, N+1, and anxiety. This interaction was followed up by assessing whether differences were occurring between N and N+1 for each anxiety group. These follow-up comparisons on the variables of interest needed to be examined in two different ways. First, to assess whether there were fast effects occurring, positive, negative, and neutral (N+1) words that followed a neutral word (N) were examined for each anxiety group. Second, to assess whether slow effects were occurring, the differences between neutral words (N+1) that followed from a positive, negative, or neutral word (N) were examined for each anxiety group.

Results from the fast effects comparisons revealed that there was no evidence of fast effects occurring for either anxiety group on the variables of interest (i.e., positive, negative, and neutral words that followed a neutral word). Statistics for these analyses are presented in Table 9.5.

Table 9.5

Post-hoc Univariate Tests Comparing the RTs of Positive, Negative, and Neutral Words at Trial N+1 that Followed Neutral Words at Trial N, for each Anxiety Group

Anxiety group	*df*	*F*	Sig.	ηp^2	Observed Power
Low	2, 84	0.2	.812	.01	.08
Anxious	2, 84	0.3	.761	.01	.09

Analyses did however reveal that low anxious individuals were significantly slower, $F(2, 84) = 3.13$, $p = .046$, $\eta_p^2 = .07$, observed power = .59, to respond to neutral words that followed a positive word (*M* = 727.51, *SE* = 19.58), versus a positive word that followed a positive word (*M*= 707.66, *SE*= 18.42; *p*=.042). This finding was reversed in the anxious group with participants responding significantly faster, $F(2, 84) = 3.32$, $p = .041$, $\eta p^2 = .07$, observed power = .61, to neutral words that followed a positive word (*M* = 703.92, *SE* = 16.84), as opposed to a positive word that followed a positive word (*M* = 724.96, *SE* = 15.84; *p* = .036). Results from the slow effects analyses revealed that slow effects were present in the anxious group, $F(2, 84) = 4.78$, $p = .011$, $\eta_p^2 = .10$, observed power = .78. Pairwise comparisons revealed that anxious individuals were significantly slower to respond to neutral words that followed a negative word (*M* = 726.57, *SE* = 16.46) than neutral words that followed a positive word (*M* = 703.92, *SE* = 16.84; *p* =.009). There was no evidence of slow effects in the low anxious group, $F(2, 84) = 1.27$, $p = .285$, $\eta_p^2 = .03$, observed power = .27.There were no other significant interactions from the main analyses.

A 3 (ITI) x 3 (WT) x 2 (anxiety group) mixed factorial ANOVA was conducted to examine RTs to negative words that followed a negative word, positive words that followed a positive word, and neutral words that followed a neutral word, for both the anxiety groups at the 32 ms, 1000 ms and 2000 ms blocks. This specific comparison could not be achieved from the main analyses (or in the previous follow-up tests to examine interactions). Interest in conducting this analysis was to determine whether there would be a slowdown in RTs on positive, negative, and neutral words at N+1 when they had followed a word of the same valence at N. The interaction between ITI x WT x anxiety group was the interaction of interest, and results indicated that this interaction was non-significant, $F(4, 344) = .55$, $p = .703$, $\eta_p^2 = .01$, observed power = .18 (for *M*s and *SD*s see Table 9.1).

9.4 Discussion

9.4.1 Overview of Aims and Hypotheses

The current chapter aimed to investigate the nature of both fast and slow effects in the EST for low anxious compared to anxious individuals. The specific hypotheses are restated below, in addition to the interaction term of interest for each hypothesis or set of hypotheses.

It was expected that fast effects would be present for the anxious group as opposed to the low anxious group. It was also predicted that fast effects would be present for negative and positive words (if arousal rather than valence of words could account for emotional Stroop interference) in comparison to neutral words. These hypotheses were not supported.

For a fast effect to be present, RTs to words at N+1 were examined only if they were preceded by a neutral word at N. Therefore, the variables of N and N+1 needed to be implicated in a significant interaction term. Additionally, to examine fast effects between anxious and low anxious participants, the interaction of specific interest was N, N+1, and anxiety group. This interaction was significant; however follow-up analyses revealed the differences were not significant between the three word types at N+1 (when trial N was neutral) for either of the anxiety groups, showing no evidence of fast effects.

It was also predicted that low anxious and anxious participants would demonstrate an attentional bias characterised by a slow effect. Additionally, it was proposed that slow effects would be present on neutral words that followed negative and positive words, in comparison to neutral words that followed neutral words. Furthermore, due to the increased activation of the AAC in state anxious individuals it was suspected that the anxiety group would report a larger slow effect than low anxious individuals. These hypotheses were partially supported.

In order for a slow effect to be present, only trials in which a neutral word occurred at N+1 were examined; specifically, neutral trials at N+1 that were preceded by positive, negative, and neutral words (which were presented at trial N). Therefore, the variables of N and N+1 needed to be implicated in a significant interaction term. Additionally, to examine slow effects between anxious and low anxious participants, the interaction of specific interest was N, N+1, and anxiety group. This interaction was significant, with follow-up analyses revealing the differences were significant between the neutral words at trial N+1 which followed positive and negative words at trial N. This was only present for the anxious group.

It addition, it was also predicted that the magnitude of fast and slow effects would be greatest when the ITI is short. This hypothesis was not supported.

In order for both fast and slow effects to be present the variables of N and N+1 had to be implicated in a significant interaction term. Furthermore, to examine the contribution of both fast and slow effects across the three different ITIs, the interaction of specific interest was N, N+1, and ITI. This interaction was significant, however, follow-up analyses revealed there was no evidence of significant fast or slow effects at each of the ITIs.

9.4.2 Fast Effects

The current study did not find any evidence of fast effects occurring. There were no increases of RTs to positive or negative words that appeared after a neutral word, compared with the RTs to a neutral word appearing after a neutral word. Although it was not necessarily expected that a fast effect would be present for the low anxious individuals, it was expected that a fast effect would be present on negative emotion words for individuals who were anxious.

There are several possibilities for why the presence of fast effects did not occur in the current study. Although these theories have been discussed in Chapters 6 and 7, in order to explain the results from the present study, it was necessary to highlight several of these theories again. Although some potential considerations may appear speculative in nature, it was deemed important to address the possible explanations for the lack of findings in regards to fast effects, as doing so allows for a more definitive conclusion to be drawn in Chapter 10.

The predictions regarding fast effects were made based on previous studies which have robustly reported that anxious individuals tend to respond more slowly to emotionally laden words in comparison to neutral words (e.g., Becker, Rinck, Margraf, & Roth, 2001; Williams et al., 1996). While these studies have not examined the fast and slow components of the ESE, the model of Wyble et al. (2008) predicted that fast effects would be present in anxious (particularly trait anxious) individuals. Essentially, this occurs due to the strengthened connections throughout their information processing system, which allows negative material to disrupt performance on the immediate trial.

In their meta-analysis, however, Phaf and Kan (2007) found that the largest ESEs were reported in blocked formats of the task, particularly when utilising clinically anxious patients or high anxious individuals. Phaf and Kan (2007) interpreted their results as evidence for a slow form of bias within the task, rather than a fast and automatic bias, and concluded that in random (or pseudorandom) formats of the task, the ESE may not necessarily detect a fast component.

The design of the current experiment was based on the study by Frings et al. (2010). Frings and colleagues utilised a contingency-free methodology to explore the nature of fast and slow effects in a sample of non-specified individuals (i.e., levels of potential psychopathology were not measured). Frings and colleagues reported evidence of both fast and slow effects occurring (slow effects are discussed in the next section of this Chapter, section 8.4.3). Frings et al. found that participants were, on average, 14 ms slower to identify the colour of a negative word that followed a neutral word (as opposed to a neutral word that followed a neutral word). Additionally, the fast effect detected in their study was smaller than the slow effect. Results of the current study do not corroborate the results reported by Frings et al., as the current study did not find any elevations in RTs on negative words that were preceded by a neutral word (i.e., a fast effect). As noted in previous chapters (Chapters 6 and 7), there were two key differences between the current research program and that of Frings and et al. It was previously suggested (Chapter 6), that the differing results between Frings et al. and the current research program related to the sample utilised. The current study investigated the nature of both fast and slow effects in individuals who predominately had elevated levels of state, trait, or state-trait anxiety, whereas Frings and colleagues did not report levels of anxiety. Given that the sample in Frings et al. was drawn from a similar population as the sample utilised in the current research program (i.e., undergraduate university students), it is a possibility that anxiety levels would be similarly disturbed throughout the two samples (e.g., Ozen et al., 2010). Although, as anxiety was not measured in the study of Frings et al., this is purely speculation as the theory cannot be comprehensively explored.

The second key difference between the study of Frings et al. (2010) and the current research program was the inclusion of personally salient words. As a result, it could be concluded that due to the personally relevant stimuli utilised by Frings et al., fast and slow effects occurred. This is because of the ability of personally salient information to cause greater interference in the colour-naming pathway (Williams et al., 1996). Additionally, in the model of Wyble and collegues (2008), this increased personal salience may be represented in a similar manner to the threat monitoring unit which is present for state anxious individuals. That is, as the material is of greater relevance, there is a lower threshold required to cause activation.

Another explanation explored for the absence of fast effects in the current study may be an effect of anxiety level. Prior research has demonstrated that both trait and state anxiety can lead to the avoidance of negative material within the EST (e.g., Egloff & Hock, 2001; MacLeod & Hagan, 1992). For example, MacLeod and Hagan (1992) found that trait anxious individuals were capable of suppressing the automatic bias towards negative material. In addition, it is possible that state anxious individuals may have unconsciously ignored the negative material as a protective factor to avoid experiencing a further aversive state (e.g., Egloff & Hock, 2001). If this was the case, however, it might be expected that RTs on emotional, predominately negative material would be significantly faster than RTs of neutral material, and this was not found in the current experiment. Additionally, Egloff and Hock found that individuals who were both highly trait and state anxious showed greater interference when colour-naming compared with individuals with lower levels of state anxiety. Although the current study examined only one anxiety group, the bulk of individuals within this group were both highly state and trait anxious, and as such it would be expected that a fast effect would occur. While, Egloff and Hock utilised a blocked presentation format of the task (thus the fast and slow components of biased attention cannot be independently assessed), given the absence of fast effects, in conjunction with the findings in relation to slow effects, it is not believed that the lack of fast effects in the present study were caused by anxious individuals avoiding negative material.

The connectionist model proposed by Wyble and colleagues (2008) could explain the absence of fast effects in the present experiment in terms of the high proportion of individuals in the anxious group who were highly state anxious. The model suggests that trait anxious individuals would demonstrate a fast effect on the immediate negative trial, but due to the increased activation of the AAC in state anxious individuals, the response to negative emotion words would be delayed to the trial immediately following the negative material (i.e., a neutral word). The results of the current study do partially support this notion (in respect to the results regarding slow effects discussed in section 10.4.3). As the bulk of the anxious group, however, were highly trait and state anxious, it would be expected that delays in RTs would be noted on the immediate trial (in addition to the subsequent trial) due to the strength of connections for processing negative material throughout the information processing system (which would be more typical for a trait anxious individual). Although, due to the fact that the anxious sample was not comprised of individuals with clinical levels of anxiety, it is possible that these connections were not strengthened to the point that negative material had the ability to disrupt colour-identification performance on the immediate negative trial. As the current experiment did not differentiate between state and trait anxiety groups, it is not possible to conclusively determine why there was an absence of fast effects in this group. A potential consideration is that there may not be a fast effect to be detected, and this proposal is explored in greater detail in Chapter 10.

It was also predicted that the current study would uncover fast effects for positive emotion words, in addition to negative emotion words. Generally within the attention and EST literature, fast effects (or biases of attention) are more consistently reported on negative or threatening information. Recent research, however, has suggested arousal, irrespective of valence, can account for this fast effect (e.g., Dresler et al., 2008). The present study utilised positive words that were matched to the negative words in terms of arousal level, as it was thought that if arousal, in addition to or instead of valence, accounts for disruptions in colour-identification, then individuals might demonstrate a fast effect for positive material in conjunction with negative material. Results of the current study did not support this prediction, as no elevation in RTs was noted on either the positive or negative emotion words following a neutral word. Despite the absence of fast effects occurring in the present study, some interesting findings did emerge in regards to slow effects.

9.4.3 Slow Effects

Although the current study did not report evidence of fast effects, evidence of slow effects did emerge. These slow effects were observed in a slightly different manner than expected. It was predicted that slow effects would be present for both the low anxious and anxious groups on neutral words that were preceded by a negative emotion word. However, the current study also suggested that if arousal, as opposed to just valence, could account for emotional Stroop interference, then a slow effect might also be present on neutral words that were preceded by a positive word. In order for a slow effect to be present, participants should have responded slowest to neutral words that followed negative (or possibly positive) words, in comparison to neutral words that followed neutral words, and results of the current experiment did not support this.

Overall, all words that followed a negative word in trial N were responded to more slowly than words that appeared after a positive word in trial N. Specifically, there was a generic increase in RTs to any word that followed a negative word (regardless of whether it was positive, negative, or neutral at trial N+1). This effect, however, was only present when the ITI was short (32 ms), and only for individuals who were low anxious. This finding was not the main interest of the present study as for a genuine slow effect (as it is currently known in the literature) to occur, the words in trial N+1 must be neutral as opposed to either negative or positive. Despite this, the finding does seem to suggest that presentation of a negative word at trial N may lead to a general slowdown in colour-identification of stimuli presented in trial N+1, regardless of the valence of those stimuli, at least in low anxious individuals. In addition, this result must be interpreted with caution, as the effect was only significant in comparison to the words at N+1 that followed a positive word at trial N, and words that followed neutral words at trial N were not implicated. It is also possible that the significant result is indicative of RTs being affected by the nature of the words appearing at trial N+1, as opposed to being only affected by the function of N. Although, the interaction between ITI, N, and anxiety group does seem to suggest that at least for the low anxious individuals, when the ITI is short, presentation of negative stimuli in trial N does impact upon the RTs of successive words, at least in comparison to words that follow a positive word. The interaction of ITI, N, and anxiety group does not allow for an adequate exploration of slow effects, as the interaction itself did not include N+1 comparisons. The interaction between N, N+1, and anxiety does allow for a thorough investigation of the nature of slow effect to be explored.

Of particular interest in the present experiment was whether participants would respond more slowly to neutral words that followed a negative word (or a positive word) than a neutral word that followed a neutral word. If an elevation in RTs was found on any neutral words at N+1, this would be indicative that RT was affected due to the valence (or arousal) of material presented at trial N. To understand the interaction between N, N+1, and anxiety group, the RTs to neutral words (in trial N+1) that were preceded by either a positive, negative, or neutral word (in trial N) were compared for the low anxious and the anxious group separately. Results from these analyses revealed that there were no differences in RTs for the low anxious group on neutral words that followed a positive, negative, or neutral word. Specifically, slow effects were not present in the low anxious group. In the anxious group, individuals responded significantly more slowly to neutral words that followed a negative word, in comparison to neutral words that followed a positive word. The difference between these neutral words was approximately 23ms. At a surface level, this result does seem to support the presence of slow effects in the EST, at least for anxious individuals. The finding, however, may not necessarily reflect an increase in RTs to neutral words that follow negative words, but rather, a decrease in RTs to neutral words that follow positive words. Support for this notion is found in the examination of the RTs to neutral words that followed neutral words. Although the RTs to neutral words that followed neutral words did not significantly differ from neutral words that followed either positive or negative words, participants in the anxious group responded to neutral words that followed neutral words in a similar manner to how they responded to neutral words that followed negative words. The difference in RTs between both of these neutral words was approximately 5 ms. However, the difference between RTs to neutral words that followed neutral words and neutral words that followed positive words was 18 ms. Essentially, while the RTs to neutral words that followed neutral words fell between neutral words that followed negative words and neutral words that followed positive words, the RTs were closer to the RTs of neutral words that followed negative words. Despite this, most importantly, the findings of the present study do indicate that colour-identification ability of neutral words can be affected by the presentation of positive and negative words in preceding trials.

No evidence of slow effects emerged for the low anxious group in regards to delayed colour-identification of neutral words that were preceded by emotion words (either negative of positive). There was, however, a significant difference noted for this group (at trials N+1) between stimuli that followed from a positive word at trial N. While this result is not necessarily indicative of the occurrence of slow effects, it is an interesting finding in its own right. Results indicated that participants within this group were significantly slower to respond to a neutral word that followed a positive word, in comparison with a positive word that followed a positive word. The difference was approximately 20 ms. Previous research investigating the slow effect has found that participants can be particularly slow in colour-naming sequences of two negative (or addiction relevant) words in a row (e.g., Frings et al., 2010; Waters et al., 2005). Similarly, ESTs employing a blocked format have been thought to show elevated levels of RTs on the emotion block, due to the gradual build-up of colour-naming latencies as participants are presented with a series of negative stimuli (McKenna & Sharma, 2004). Based on these findings, it may be expected that when participants are presented with two words in a row from the same emotive category, speed of colour-naming would be impaired on the second trial. Previous research has demonstrated that when participants are presented with a semantically related prime, colour-naming on the subsequent trial increases (Warren, 1972). This slowing of RTs is suggested to be a product of the prime making the stimuli of the subsequent colour-naming trial more accessible, and as a result interfering with the participant's ability to colour-name the trial. If participants were able to ignore the prime (i.e., not required to recall the material for a later memory task), however, then RTs to the trial following the prime decreased (Rothermund & Wentura, as cited in Frings et al., 2010). This finding has been referred to as a kind of “spreading inhibition” whereby a semantically related prime makes the subsequent trial less accessible, thus essentially speeding RTs on the trial after its presentation (Frings et al., 2010). Frings and colleagues (2010) found support for this theory as participants were not slower to identify the colour of a negative word that followed a negative word, in comparison to a neutral word that followed a neutral word. This theory would also support results of the current study where the low anxious group were faster to identify the colour of a positive word that followed a positive word in comparison with a neutral word that followed a positive word (i.e., the second positive word was responded to faster due to the reduced accessibility of the stimuli). Although, this interpretation becomes somewhat complicated when examining the findings in the anxious group.

RTs for participants in the anxious group in trials N+1 were also affected by the presentation of a positive word at N. Interestingly, this finding was reversed from what occurred within the low anxious group. Participants in the anxious group were significantly faster in identify the colour of a neutral word that followed a positive word, in comparison to a positive word that followed a positive word. The difference between these words was approximately 21 ms. For the anxious group, at least, this appears to support the notion that RTs to consecutive trials of emotive stimuli are affected by a gradual build-up of rumination effects (e.g., Algom, Chajut, & Lev, 2004; McKenna & Sharma, 2004). Alternatively, it may be that for individuals who are anxious, it is impossible to suppress meanings of words, thus a priming-like process leads to a longer RT on the second semantically related trial. This may occur as the word is more accessible and thus interferes to a greater extent with colour-identification.

Another interesting finding to emerge from the present study is that the patterns noted above (i.e., low anxious individuals were faster to respond to a positive word following a positive word than a neutral word following a positive word, with the finding reversed for the anxious group) did not occur for the negative words. It would seem more likely that participants would be slower to identify the colour of a negative word that followed a negative word (unless inhibition played a role), or a neutral word that followed a negative word. In order to explore the possible theory of either rumination effects or an inability to suppress word meanings, the analysis that was conducted between pairs of semantically homogeneous words was considered. That is, differences between the RTs of negative words that followed negative words versus positive words that followed positive words versus neutral words that followed neutral words were examined. There was no difference between these three categories of words for either anxiety group at any of the ITI blocks. This finding was consistent with Frings et al. (2010), who reported no significant difference between the RTs of neutral words that followed neutral words and negative words that followed negative words. Furthermore, this finding suggests that there was not a gradual build up of rumination effects. Although, that is not to say that rumination effects cannot exist in blocked formats of the EST where multiple negative trials are presented in one set (as opposed to two trials in the current experiment). What these results do potentially suggest, however, is that, at least for the low anxious group, "spreading inhibition" may have occurred, at least with the positive words.

A potential conclusion from the present study is that arousal alone cannot account for emotional Stroop interference. If arousal alone could account for emotional Stroop interference, then the effects found for positive stimuli would have also occurred for negative stimuli. A potential limitation, however, is that the present study only matched emotional words for arousal rather than employing categories of high and low arousing emotional words, and it may have been more desirable to split the positive and negative emotion categories into two subcategories: One that included high arousing words and one that included low arousing words. It is possible that arousal could play an interactive role with word valence. For example, Larsen et al. (2008) found that participants responded more slowly on a lexical-decision task to negative words that were low to moderately arousing than negative words that were high arousing. Although this possibly warrants further investigation in regards to EST performance, it was beyond the scope of the current research program.

In regards to slow effects, what did emerge from the current study was the ability of emotional information to affect performance on the subsequent neutral trial. It is, however, unclear as to whether this finding reflected a slowing in RTs to neutral words that followed negative words, or a speeding in RTs to neutral words that followed positive words. Additionally, the current experiment also highlights the difference between the low anxious and anxious groups in terms of responding to positive sequences of words.

The nature of slow effects in the present study is somewhat consistent with the model of Wyble and colleagues (2008). This model suggests that slow effects should be present in anxious, namely state anxious, individuals due to the increased activation of the AAC, which in turn suppresses the cognitive component essentially causing a slowdown in colour-naming on the following neutral trial (this also occurs for low anxious and also trait anxious individuals, albeit to a lesser extent). The current study found that anxious participants did respond more slowly to neutral words that followed negative emotion words, however, this was only in relation to neutral words that followed positive emotion words. Furthermore, due to the time it took participants to respond to the neutral words that followed neutral words, whether this was a slowdown in colour-identification on the neutral words preceded by negative words in not entirely clear. An alternate explanation would be that participants responded faster to neutral words that followed positive words, however, the current experiment has shown that emotional stimuli in trial N has the ability to disrupt performance on subsequent trials in N+1.

9.4.4 Biased Attention and Time Pressure

An interesting finding that emerged from the present experiment related to how time pressure (i.e., ITI duration) within the task impacted upon RTs. Participants were faster to respond to words at the 1000 ms block, followed by the 2000 ms and the 32 ms blocks. This result has been consistently found across all the emotional Stroop experiments thus far (Experiments 2, 3, and the present experiment). It should be noted that while the differences between colour-identification speed were significant between the 32 ms and 1000 ms block, and between the 32 ms and 2000 ms block in the current experiment, the difference between the 1000 ms and 2000 ms blocks was non-significant.

Another finding of the present study consistent with that of Experiments 2 and 3 is that the faster speed of colour-identification at the 1000 ms, and 2000 ms ITIs, relative to 32 ms ITI, did not compromise the accuracy of colour-identification. There were no significant differences in the error rates between the 32 ms, 1000 ms, or 2000 ms blocks. Additionally, there were no significant differences between the anxiety groups in terms of error rates. Therefore, results suggest that the increase of speed in the 1000 ms block, followed by the 2000 ms and 32 ms block, is not caused by a function of a speed versus accuracy trade off.

As documented in the previous chapters (Chapter 6 and 7), large differences in average RTs emerged between the current emotional Stroop experiments and the study of Sharma and McKenna (2001). In Experiments 2 (737 ms), 3 (790 ms), and the current experiment (741 ms), participants on average responded 167 ms faster to stimuli (averaged across word type) at the 32 ms block than what was reported by Sharma and McKenna (924 ms; 2001). Given that in Sharma and McKenna’s study, interference on negative emotion words decreased as average RTs became faster in the 1000 ms block, it is possible that the general increase in the speed of responding observed in the emotional Stroop experiments of the current research program could have affected the detection of both fast and slow effects.

As proposed in Chapter 7, a potential explanation for the speeded RTs in Experiments 2, 3, and the current experiment, may relate to the high number of participants within the samples with elevated levels of anxiety, as research has shown that anxiety levels can influence RTs (e.g., Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Verschuere, Van Damme, & Wiersems, 2006). Additionally, interactive effects of state and trait anxiety can lead to differing outcomes for colour-naming speed (e.g., Egloff & Hock, 2001; Dresler et al., 2009). In the current experiment (and in Experiment 2 and 3) a generic speeding in the colour-identification of all words could have occurred. Although, if speed of RTs were attributable to anxiety level, results should have shown a main effect of anxiety, and this was not found. Additionally, if speed increased as a function of anxiety, then it is likely that there would be a speed versus accuracy trade-off. Results from the current study found no differences between the anxiety groups in terms of error rates at each block, which supports the proposal that anxiety did not cause a generic increase in RTs.

9.4.5 Implications of Results

Results of the current study found no evidence of fast effects occurring within the EST for low anxious or anxious individuals. The current experiment utilised a contingency-free methodology in which the presence of fast and slow effects could be calculated independently from another. The use of this methodology was in direct replication of the study by Frings and colleagues (2010). Based on the study of Frings et al., in conjunction with the model proposed by Wyble and colleagues (2008), it was predicted that fast effects would occur, for anxious individuals, on either the negative or positive words that followed neutral words. The differing results between the current study and that of Frings et al. was attributed to the personally relevant stimuli used in their experiment. It is likely that these stimuli interfered with colour-identification as they were personally relevant, which in non-clinical samples can be sufficient to interfere with emotional Stroop performance (Williams et al., 1996). The finding of the current study does not support the model of Wyble et al., at least with regards to fast effects.

The current study found some evidence to support the presence of slow effects within the EST, although not necessarily in the manner that was initially predicted. For a slow effect to be present, participants would have responded more slowly to neutral stimuli presented in trial N+1 following a negative (or positive word) as opposed to a neutral word, and this effect was not found in the present study. In general, the low anxious participants did respond, on average, more slowly to words in trial N+1 that were preceded by a negative word in trial N at the 32 ms block. This was not the case for words that were preceded by a either neutral or a positive word at trial N. These findings suggest that presentation of a negative word can disrupt colour-identification performance beyond that of its presentation. This result, however, should be interpreted with caution as the effect was found for words of different valences at trial N+1.Thus, while this generic slowdown was noted (and should not be dismissed), it is technically not a true reflection of the slow effect, as not all the stimuli in trials N+1 were neutral.

Further evidence for the slow effect emerged from the interaction between N, N+1, and anxiety group. This interaction found that anxious participants responded more slowly to neutral words that followed a negative word compared with neutral words that followed positive words. Given that the difference between neutral words that followed neutral words was not implicated in this interaction, it is difficult to determine precisely why the result occurred. This finding may have emerged because of a slowdown in ability to identity the ink colour of neutral stimuli presented after a negative word, or because of a speeded colour-identification response to neutral stimuli that followed positive words. Despite this, the result does suggest that stimuli presented in trial N have the ability to impact the RTs of stimuli presented in trial N+1, at least for anxious individuals.

Another interesting finding to emerge from the present study relates to the difference between the low anxious and anxious individuals in regards to the effect that positive stimuli had on RTs. Although this finding was not of key interest in the present study, consideration should be given as to why low anxious individuals took longer to respond to a neutral word that followed a positive word, as opposed to a positive word that followed a positive word. Additionally, this finding was reversed in the anxious group. These results may indicate that, for the low anxious individuals, a kind of “spreading inhibition” caused an increase in RTs to the second positive word in the sequence, whereas for the anxious individuals, a generic slowdown was caused due to an inability to disengage from the emotive material. Although it could be argued that this effect might seem more likely to occur for negative stimuli, the positive stimuli employed in the current study had comparable arousal ratings to the negative stimuli. Therefore, this effect could be a function of the valence of the positive words themselves, which has received less attention within the literature. Additional analyses indicated that there were no differences between the RTs of negative words that followed negative words, in comparison with positive words that followed positive words, or neutral words that followed neutral words. This was examined for both anxiety groups at each ITI. This finding lends support to the idea of a kind of “spreading inhibition” in operation, at least for the low anxious group, however, in conjunction with the result reported earlier for the anxious group; it seems likely that there are different factors at play for each anxiety group.

9.4.6 Strengths and Limitations

A potential limitation of the current study may relate to the anxiety groups used. Based on Experiments 2 and 3, the decision was made to only examine the differences between individuals who were low anxious versus individuals who were anxious. Experiments 2 and 3 examined four anxiety groups, specifically comparing the RTs of individuals who were low anxious, state anxious, trait anxious, and both state-trait anxious. The classification of individuals into four separate groups allowed for a comparison between not only levels of anxiety, but also for type of anxiety, however, due to a lack of significant findings in Experiment 2 and 3 regarding anxiety, the decision was made to only examine the difference between low anxious and anxious individuals. Although it may have been beneficial to examine whether the contingency-free methodology would yield different results (or even the same results) in the present experiment, unfortunately there were not enough individuals who were solely state anxious. The bulk of individuals in the anxious group in the present experiment had elevated levels of both state-trait anxiety. Out of interest, participants who identified as state anxious or as trait anxious were removed from the analyses to see if this impacted upon results, however, results remained the same. Therefore, in the current experiment at least, it appears that regardless of type of anxiety, participants who were anxious generally responded in the same way (i.e., the addition of these individuals to the anxious group of high state-trait did not affect results).

A strength of the current study relates to the sample, which incorporated a mixed representation of university students and members of the general community. The prior EST experiments (2 and 3) solely utilised university samples whereas this experiment employed members of the general community, hence increasing the generalisability of results. As in the prior experiments, women were still over represented within the sample., however, the percentage of men who participated in the current experiment was the highest thus far.

Despite these potential limitations, this study (in conjunction with Experiment 2 and 3) was the first to investigate the presence of both fast and slow effects in low anxious and anxious individuals. In addition to this, this study utilised a contingency-free methodology whereby fast and slow effects could be measured independently of one another.

9.5 Summary of Chapter

The current chapter aimed to investigate the nature of fast and slow effects in the EST for individuals who were low anxious and anxious. Due to the unexpected results of Experiment 2 and 3, the decision was made to conduct the experiment using a methodology whereby the contribution of both fast and slow effects could be measured independently of one another.

The current experiment did not find evidence of fast effects occurring. There was evidence to suggest the presence of slow effects, or at least, evidence suggesting that presentation of emotional material at trial N can impact RTs at trials N+1. As in Experiment 2, the slow effect was only noted between neutral stimuli that followed a positive word, in comparison to neutral stimuli that followed a negative word, however, the effect was interpreted as a potential speeding of neutral stimuli that followed positive words, versus a slowing of neutral stimuli that followed negative words. Furthermore, the effect was only present for anxious individuals.

Chapter 10 Critical Integration of Fast and Slow Effects

10.1 Overview of Chapter

The purpose of this Chapter is to critically examine the results of Experiments 2, 3, and 5, collectively. An overview of the findings from each experiment are briefly presented, and discussed in the context of models designed to account for interference in the EST in addition to literature investigating biased attention and anxiety. Specifically, this chapter is broken up into two main sections, the first examining the contribution of fast effects, and the second examining the role of slow effects within the task.

10.2 Fast Effects

Until relatively recently, the ESE was thought to reflect a single component of biased attention (McKenna & Sharma, 2004), and this assumption was predominately based on the finding that individuals respond more slowly to emotional words than neutral words (e.g., Williams et al., 1997). Additionally, the use of blocked presentation methods has not allowed for the assessment of whether emotional material would disrupt colour-identification performance for more than one trial (Frings et al., 2010; McKenna & Sharma, 2004).

As documented in previous Chapters (e.g., 1, 2, 6, 7, 9), the ESE is most robustly reported in individuals with clinical levels of a disorder when disorder specific words are used (e.g., Becker et al., 2001; Phaf & Kan, 2007; Thorpe & Salkovskis, 1997; Williams et al., 1997). ESEs, however, have also been reported in individuals with sub-clinical or elevated levels of a particular disorder (e.g., Egloff & Hock, 2001; Kambouropoulous & Knowles, 2005), and in samples drawn from the normal population (e.g., Ashley & Swick, 2010; Wingenfeld et al., 2006). This thesis was particularly interested in examining both the nature of fast effects and slow effects in individuals with varying types, and levels, of anxiety. Anxiety was selected as a key variable of interest in the present study because the

ESE has been extensively documented within this population (at least in blocked presentations of the EST; e.g., Phaf & Kan, 2007; Wiliams et al., 1996), however, the roles of both fast and slow effects has not previously been explored. Additionally, less attention has been paid to the nature of biased attention in the EST between individuals who are state anxious in comparison with individuals who are trait anxious. Given that studies that have investigated the role of state and trait anxiety and emotional Stroop interference often report inconsistent findings (e.g., Dresler et al., 2009; Egloff & Hock, 2001), the current research program aimed to provide a greater understanding to the mechanisms underlying the ESE in these individuals. Ultimately, by including individuals with varying levels and types of anxiety, this allowed for the predictions of the Wyble et al. (2008) model to be tested.

10.2.1 Fast Effects in Experiments 2, 3, and 5

The current research program predicted that fast effects would be present for anxious individuals. Specifically, in Experiments 2 and 3 it was predicted that trait anxious, state anxious, and individuals who were high in both state and trait anxiety, would respond more slowly to emotional words (i.e., negative and positive) as opposed to neutral words. For a fast effect to be present, longer colour-identification latencies to the emotion words at Position 1, as opposed to the neutral words at Position 1, must be observed. ESEs tend to occur more robustly for negative or threatening material, however, as arousal was controlled for between the target positive and negation emotion categories, it was predicted that fast effects may have occurred for both these word types. Experiment 5 also made similar predictions in regards to fast effects, however, for individuals who were anxious in general (i.e., as opposed to differentiating between state or trait anxious). The decision was made to examine these effects in anxious versus low anxious individuals due to the lack of findings in the prior two emotional Stroop experiments with regards to the four groups of anxiety. For a fast effect to be present in Experiment 5, RTs were only considered when the target word (trial N+1) followed a neutral word (trial N), that is, fast effects were investigated by comparing the RTs of positive, negative, and neutral words that were preceded by a neutral word.

No evidence of fast effects emerged in Experiments 2, 3, or 5. The possible explanations presented for the absence of fast effects centred around the following premises. First, the stimuli utilised in the task were not threatening (or emotional) enough to interfere with the processing of information. Second, participants in the anxiety groups were not anxious enough for the stimuli to capture attention and cause a slowdown in colour-identification. Third, the slow effect is the dominant form of attentional bias occurring within the EST and therefore a fast effect would not be reported. Last, in the case of Experiments 2 and 3 the EST design created a contingency whereby neutrality signalled negativity and negativity signalled neutrality, thus suppressing the occurrence of fast effects. For this reason, Experiment 5 employed a contingency-free methodology where words were presented in a random order. Each one of these theories will be discussed in turn.

10.2.2 Stimuli Utilised in the ESTs

The current research program conducted two word selection studies where words were rated for arousal and valence. This, in addition to matching for length, frequency of occurrence in the English language (using Brysbaret & New, 2009), and semantic relatedness within categories of words ensured that the words selected for the ESTs were lexically equivalent. As a result, differences occurring between the emotional and neutral categories would be more attributable to other factors, such as anxiety level and valence of the material, rather than differences in the category’s lexical characteristics. Due to the stringent criteria placed on words selected for use in the experiments, it is unlikely that fast effects were not detected in Experiment 2, 3, and 5 due to the words selected for use. Another possible explanation may relate to the particular sample used.

10.2.3 Anxiety Levels of Participants

Research has documented that clinically anxious patients demonstrate biased attention towards emotionally salient stimuli, however, this finding has been less documented in participants with elevated levels of anxiety (as oppose to clinically anxious patients). A recent meta-analysis (Phaf & Kan, 2007) investigating the automaticity of the EST examined the findings of 70 published studies that investigated biased attention within the EST for anxious individuals. Phaf and Kan (2007) reported that the ESE was most reliably found in clinically anxious patients and also individuals with elevated levels of anxiety, and these effects were strongest when a blocked presentation of the task was utilised in samples of clinically anxious patients. A potential explanation for the lack of fast effects emerging in the current research program may be a result of the participants' anxiety levels in conjunction with the presentation format of the task (i.e., pseudorandom and random).

As the role of both fast and slow effects had not been explored in a population of individuals who were low anxious, state anxious, trait anxious, and state-trait anxious, the hypotheses of the current program were developed based on previous literature (e.g., Phaf & Kan, 2007) in addition to the model of Wyble et al. (2008). Wyble and colleagues speculated that fast effects would not be present in low anxious individuals, and that anxious (namely trait anxious) individuals would demonstrate a fast effect on threatening material. According to this model, when a trait anxious individual is exposed to a threatening word this information causes greater activation in the categorical layer due to strengthened connections within their information processing systems. These strengthened connections are a result of increased practice or familiarity with anxiety related material.

This is synonymous with the word reading pathway in Cohen et al’s. (1990) model of classic Stroop interference, and the cause of emotional interference in Williams et al’s. (1996) model of the ESE. Wyble et al. suggested that the strength of the connections throughout the information processing system is dependent on levels of trait anxiety. Essentially, when a trait anxious individual is exposed to a threatening trial, the negative input unit is activated and projected to the categorical layer, whereby interference is caused laterally due to the increased activity between the colour and word-form nodes. Activity builds until it crosses threshold and a response is executed. A delay is evident on the current negative trial, due to the increased interference at the categorical layer.

Based on this model, it was expected that the current research program would have found a fast effect, at least for the trait anxious and state-trait individuals on the negative emotion words; however this was not the case. It is possible that the trait anxious individuals in Experiment 2, 3, and 5, did not have trait anxiety levels that were elevated enough to have caused a permanent restructuring of their information processing systems. The mean scores for the trait anxious groups, listed in order of emotional Stroop experiments were 47.00, 47.34, and 45.56 (mean trait score in the anxious group in Experiment 5), respectively. Additionally, the mean trait anxiety score in the state-trait anxiety groups, listed in order of emotional Stroop experiments were 51.98 and 51.17, respectively. Research investigating the role of anxiety and attentional bias in the EST and other paradigms (e.g., lexical-decision naming, the dot-probe task) have utilised anxious groups with higher levels of trait anxiety (using the STAI) than what was employed in the current experiments. Despite this, significant differences have still been noted in studies that have utilised similar or lower averages of both trait (e.g., *M* = 46.4; MacLeod & Rutherford, 1992) and state anxiety (*M* = 38.7; Mogg, Bradley, De Bono, & Painter, 1997). Phaf and Kan (2007) reported in their meta-analysis that the ESE is most reliably detected when using clinically anxious patients in conjunction with a blocked design, however, the authors also found the effects to be present for individuals with elevated levels of anxiety. Given that Phaf and Kan defined elevated levels of anxiety as average scores above 40 on the trait scale of the STAI, the current research program utilised a sample of anxious individuals that should not be considered dissimilar to that of other research. Therefore, the argument that participants were not anxious enough for an effect to be present does not appear particularly plausible. The lack of effects could relate more to the fact that fast effects are not the dominant form of attentional bias within the EST.

10.2.4 Fast Versus Slow Components of the ESE

Phaf and Kan (2007) theorised that because the ESE is most reliably found in clinical patients or individuals with elevated levels of anxiety when a blocked presentation is used, and that ESEs are not reliably detected in sub-optimal presentations of the task, the ESE does not reflect a fast automatic bias. Instead, Phaf and Kan proposed that the ESE likely reflects a slower disengagement process. As a result, it could be concluded that the current research program did not detect fast effects, because fast effects are not the principal form of attentional bias occurring within the task (at least not within non-clinical samples). Although Experiments 2 and 3 did not consistently find evidence of slow effects, there was a consistent finding of no evidence of fast effects. Based on this, an argument could be made that fast effects do not exist in participants with varying levels and types of non-clinical anxiety, and that the findings of previous studies which have found ESEs in anxious individuals are actually reflections of slow components of biased attention. Before this conclusion could be drawn, however, it was necessary to ensure that there were no other factors that could be influencing the results. One such factor identified was contingency effects that may have occurred as a result of the pseudorandom design. In addition to participants potentially being aware of the pattern in which words were presented.

10.2.5 Contingency Effects

Based on the findings of McKenna and Sharma (2004), Frings and colleagues (2010) were interested in whether fast effects would be present in addition to slow effects. The study of McKenna and Sharma found evidence only of slow effects (although there was a trend towards significance for a fast effect on negative emotion words) occurring on neutral words at Position 2 which were preceded by target negative emotion words at Position 1. Frings and colleagues, however, argued that fast effects may have been inadvertently suppressed in the study of McKenna and Sharma, due to the particular methodology employed. McKenna and Sharma presented words in sets of seven; the first word in each set was either a target positive, negative, or neutral word. The words that appeared in Positions 2-7 were all neutral words. This particular style of presentation increased the conditional probability that slow effects would occur (Frings et al., 2010; McKenna & Sharma, 2004). Frings and colleagues argued that this, in addition to signalling effects (i.e., participants associating a negative word with neutrality, and a neutral word with negativity), may have caused a suppression of fast effects. To control for these possible contingency effects, Frings et al. employed a completely random (i.e., a contingency- free) methodology to investigate whether both fast and slow effects would co-occur.

Frings et al. (2010) found evidence of both fast and slow effects. This is a significant finding given that the results of McKenna and Sharma (2004) questioned the interpretation of ESEs as relatively fast. Although, whether fast and slow ESEs are caused by a single or by multiple mechanisms remains unclear. For example, the effects might reflect two separate cognitive processes: One that relates to a fast, automatic capture of attention (e.g., Chajut, Lev, & Algom, 2005; Williams et al., 1996), and another that could be related to a generic slowdown in the presence of threat (e.g., Algom et al., 2004). Alternatively Frings et al. suggested that the effects could be caused by the same cognitive process, such as disengagement, which start on one trial and persist onto following trials. Frings et al. (2010) proposed that one way to investigate the mechanisms underlying these effects would be to examine fast and slow components of attentional bias in a sample of individuals who differ in anxiety levels. The authors proposed that this would offer insight into the possible causes of the effects (or at least one of the effects), as the ESE has previously been robustly documented in certain anxious populations (e.g., clinically anxious patients, individuals with high trait anxiety). Assessing the role of fast and slow effects in individuals with differing types, and levels, of anxiety was one of the primary aims of the current research program. Additionally, the contributions of both fast and slow effect were assessed using a random design in Experiment 5. Experiment 5 did not find evidence of fast effects. As it is unlikely that no fast effects were found due to the words selected for the ESTs, the sample utilised, or even the methodology employed, it is possible that fast effects do not comprise a significant component of the ESE (at least within non-clinical samples of anxious individuals).Although, given the inconsistent results with regards to slow effects, this interpretation becomes somewhat more complex. Additionally, it is difficult to speculate as to the mechanisms underlying the effects, however, these are explored in greater detail in section 10.3.

10.3 Slow Effects

The EST has been utilised since the 1970s to investigate biased attention in emotional disorders. More recent research that has examined the ESEs in various non-clinical populations (e.g., Cane et al., 2008; Franken et al., 2000; Frings et al., 2010; McKenna & Sharma, 2004; Sayette et al., 2001; Wilson & Wallis, 2013; Wertz & Sayette, 2001; Waters & Feyerabend; 2000; Waters et al., 2005) utilising random or pseudorandom presentations of the task has uncovered a slower form of biased attention. Generally speaking, a fast effect is noted on the emotional word (Position 1 or trial N) in comparison with the neutral word (with the exception of McKenna & Sharma, 2004). Additionally, slow effects are noted on the first neutral word that follows the emotional word (Position 2 or trial N+1), with the exception of Cane et al. (2008) and Ashley and Swick (2010) who found evidence of slow effects persisting across multiple positions. The current research program was interested in whether these slow effects would occur in low anxious and anxious individuals. Additionally, as the duration of slow effects had not previously been investigated over differing ITIs, and given that ITI duration has been shown to impact upon ESEs (Sharma & McKenna, 2001), the current study manipulated the duration of the ITI to gain a better understanding of biased attention over trials and time.

The methodological design of Experiment 2 and 3 (replicating McKenna & Sharma, 2004) allowed RTs to be monitored over a series of five positions. Additionally, the task was presented in three separate bocks; each with a different ITI (i.e., 32 ms, 1000 ms, and 2000 ms). It was expected that an interaction would occur between position of word and ITI, so that slow effects may be found with some (but not all) ITI manipulations. For example, the slow effect may extend for several trials after an emotional word has been presented when the ITI was short (32 ms). When a longer ITI is employed, however, slow effects may not occur, or would be isolated to the trial immediately following the emotional stimulus. McKenna and Sharma (2004) found that with a short ITI (32m) and using a sample drawn from the normal population, slow effects were present on neutral words that were preceded by negative emotion words. This effect lasted for only one position (i.e., Position 2). Cane et al. (2008), however, found that in a sample of marijuana users, a slow effect occurred in Position 2 and extended to Position 4. Although the ITI was not specified in Cane and collagues study, words were presented immediately after a response had been made (and due to the refresh rates of computer monitors there is generally a very brief delay), thus it is likely that the ITI was short. Additionally, several other studies investigating the role of fast and slow effects in addiction-related populations (e.g., Waters & Feyerabend, 2000; Waters et al., 2005; Wertz & Sayette, 2001) and social drinkers (Sayette et al., 2001) have utilised longer ITIs that have ranged from 500ms-1500ms, which have also detected the presence of slow effects. In each of these studies, the slow effect was evident on Position 2. Additionally, Ashley and Swick (2009) found slow effects persisting across several positions (i.e., Positions 2, 4, 5, 6, and 7) after the presentation of a target negative word in Position 1. This occurred in a group of young adults with an ISI of 1500ms. Prior to this research program, the relationship between ITI and duration of the slow effects had not been explored. Experiments 2, 3, and 5, manipulated the duration of the ITI and were thus able to examine the impact that time between trials had on emotional Stroop inference. More specifically, Experiments 2 and 3 examined the relationship between ITI and interference occurring over several trials. For example, it was predicted that when the ITI was short (32 ms), the slow effect may extend across more positions than when the ITI was longer (i.e., 1000 ms, and 2000 ms).

10.3.1 Slow Effects in Experiments 2, 3, and 5

Experiments 2 and 3 predicted that slow effects would be present for individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. It was expected that slow effects would occur on neutral words that were preceded by target emotional (i.e., positive and negative) words, versus neutral words that were preceded by target neutral words. Additionally, it was expected that slow effects would be largest in the state and state-trait anxious groups. Experiment 5 had similar predictions, however, only two anxiety groups (low anxious and anxious) were assessed. Specifically, Experiment 5 predicted that low anxious and anxious individuals would demonstrate a slow effect, with the effect being strongest in the group of anxious individuals. In addition, it was also expected that the duration of slow effects would vary across position, depending on the ITI.

Although there was no evidence of slow effects in Experiment 3, mixed evidence of slow effects emerged in Experiment 2 and 5. A brief overview of the results of each experiment is presented, followed by a collective discussion of these results.

The results from Experiments 2 and 3 found mixed support for the presence of slow effects. Experiment 2 did not find any significant differences in RTs based on anxiety groups. At a mean level there were differences that emerged between the groups, the most interesting of which occurred at the 32 ms block. Participants who were state anxious and trait anxious, showed increases in colour-identification latencies on the neutral words in Position 4 in the negative emotion sequence. Additionally, the group of state-trait anxious individuals showed elevations in colour-identification on neutral words at Positions 2 and 3 in the negative emotion sequences. These differences were not found in the low anxious group. Despite the lack of significant findings in regards to anxiety, the most interesting finding of Experiment 2 was the three-way interaction that emerged between ITI, sequence type, and position. The interaction was followed up at each ITI by examining the RTs of individuals, regardless of anxiety type, to each sequence type of words across Positions 1-5. The analyses found no significant differences at the 2000 ms block, however, significant findings emerged at the 32 ms and 1000 ms blocks. The strongest evidence in support of a slow effect occurred at the 32 ms block.

Although there was an unusual pattern of responding in this block to the pure sequences of neutral words (due to a spike in RTs on Position 2, which also occurred at the 1000 ms block), colour-identification latencies gradually increased in the negative emotion sequence, reaching significance at Position 4. This difference was only significant in comparison to neutral words in the positive emotion sequences. Regardless of this, on average, participants were slower to identify the colour of neutral words at Position 4 in the negative emotion sequences in comparison with neutral words at the same position in the positive emotion sequences (the difference was approximately 33 ms). This difference occurred at a position later than the position reported by McKenna and Sharma (2004), and to a lesser magnitude (the slow effect reported in their study was approximately 70 ms between the neutral words in the negative and positive sequence, and 105 ms between neutral words in the positive and negative sequence). Despite these differences, Experiment 2 did detect disruptions in colour-identification latencies on neutral words presented after a target negative emotion word. Perhaps one of the most interesting components of this finding was the gradual increase in colour-identification latencies. RTs on neutral words that followed a target negative emotion word steadily increased over Positions 2 and 3 before reaching significance at Position 4. This finding is somewhat consistent with the results of Cane and colleagues (2008), who found a slow effect that extended across four positions in marijuana smokers using marijuana related words. Cane et al. also reported fast effects, however, in conjunction with a large slow effect, which emerged at Position 2, and steadily decreased until Position 4. Furthermore, the slow effect noted at Position 2 in the study of Cane et al. was somewhat larger than what was found in Experiment 2 of the current study (approximately 90 ms difference between neutral words that followed target marijuana words versus neutral words that followed target neutral words).

Ashley and Swick (2010) also found a slow effect extending across multiple positions in younger adults using negative emotion words. Although, rather than a large increase in RTs noted at any one position following the target negative word, participants generally responded to all words within a negative emotion sequence comparatively slower to all words in the pure neutral sequence. That is, there were small differences between the RTs to the target negative words and the matched neutral words within its sequence (all were within approximately 10 ms of each other). There were also small differences in the RTs of the target neutral word and matched neutral words within its sequence (again, approximately10 ms difference). Despite this, when comparing the two sequences against one another, there are larger differences between the neutral words at each position (excluding Position 3) of each sequence (the difference was around 30 ms). Based on the findings of both Cane et al. (2008) and Ashley and Swick (2010), the slow effects documented in Experiment 2 should not necessarily be discounted based on the fact that it emerged in a somewhat different manner to what was expected. Given the limited number of studies that have examined both fast and slow effects in the EST, a finding (or lack thereof) should not be dismissed, even if the results do not fit the existing data in the way that was anticipated.

At the 1000 ms block, the only significant difference in RTs in Experiment 2 emerged between the neutral words at Position 2 that followed either target neutral or target negative words at Position 1. At this position, participants were significantly slower to identify the colour of the neutral words in the pure neutral sequence. The current study predicted that a significant difference would be noted on this position, however, results showed that this effect was in the opposite direction to expectations. A similar pattern also emerged with the pure sequences of neutral words at the 32 ms block. Participants at both the 32 ms and 1000 ms blocks showed an increase in the time taken to identify the colour of neutral words that followed target neutral words, versus neutral words that followed either target positive or negative emotion words. Additionally, this difference was significant at Position 2 for both the 32 ms and 1000 ms blocks.

This pattern of responding had not previously been reported in the literature, and a possible explanation for the results regarded the target neutral words used for Position 1. Even though words were carefully selected for each of the emotional Stroop experiments, it was possible that there was something unique about the words selected for the target neutral category at this position. A possible explanation was based on the average valence ratings of this category. These words received slightly higher valence ratings (indicating they were more positive) than the other categories of neutral words. Despite this, the pattern of responding to sequences of pure neutral words was not similar to the pattern of responding to sequences of positive words, which may be expected if the above explanation was accurate.

A recent study investigating the role of both fast and slow components using the EST in a sample of restrained and non-restrained eaters also found an increase in colour-identification to neutral words that were presented after a target neutral word in Position 1 (Wilson & Wallis, 2013). This study employed a design similar to McKenna and Sharma (2004), whereby words were presented in a pseudorandom order over five positions. Wilson and Wallis (2013) speculated that this unusual pattern of responding to the pure sequences of neutral words may have emerged due to a categorical effect in relation to the target neutral words selected for Position 1. Words were matched for length, frequency of occurrence (using Leech, 2001), initial phoneme, and semantic relatedness within each category (at least for the words presented at Position 1); however the target neutral words in Position 1 were not rated for valence. Wilson and Wallis (2013) utilised an animal category for their target neutral words at Position 1, and in order to account for their unexpected findings, they suggested that some of the words within this category may have been fear inducing. For example, the word *tiger* may have induced fear in some participants (similar to that of a food or ego threat word) which could have accounted for the increase in RTs on neutral words at Position 2. This is an interesting finding in the context of Experiments 2 and 3 (which used a design similar to McKenna & Sharma, 2004), given that these experiments also found unexpected patterns of responding to the pure sequences of neutral words. Unlike Wilson and Wallis, however, the current research program did ensure that the target neutral words used in the ESTs were rated as neutral (which was done in Experiments 1 and 3). Irrespective of this, there was still an unexpected pattern of RTs in the pure neutral sequences of words (particularly in Experiment 2). The study of Wilson and Wallis, however, provides support for the argument that the target neutral words utilised at Position 1 did not affect RTs on latter positions. Despite this, at the time the current research program was conducted, the Wilson and Wallis study had not been published.

Ashley and Swick (2009) also reported an unusual pattern of responding to pure sequences of neutral words; specifically, at Position 2, neutral words following a target neutral word were responded to more slowly than the target neutral words presented in Position 1. This occurred for both sample groups of older and younger adults, although only in the pure neutral sequences. Interestingly, in their study, the target neutral words presented in Position 1 were responded to consistently faster than the neutral words that followed in Positions 2-7. Ashley and Swick did not specify what neutral words were used, and whether factors such as semantic relatedness within categories were controlled for. The authors did, however, report that all words were matched for length and frequency of occurrence in the English language (using Kucera & Francis, 1982). Given these findings, in addition to that of Wilson and Wallis, the pattern of results to the pure sequences of neutral words in Experiment 2 do not seem quite as unusual. Although there is still some uncertainty regarding why pure sequences of neutral words should be responded to in this way, the current study was not the first to report these results.

As only one published study, however, had reported the unusual pattern of responding to pure sequences of neutral words, and this finding was in opposition to that of McKenna and Sharma (2004) and other studies that had investigated slow effects (e.g., Cane et al., 2008), the decision was made to replace the target category of neutral words. Doing this not only enabled Experiment 3 to remove a possible confound, but also allowed for another opportunity to test the model of Wyble et al. (2008). Furthermore, Experiment 3 provided another opportunity to partially replicate the results of McKenna and Sharma. Additionally, it also provided the current research program with an opportunity to replicate the results of Experiment 2, that is, Experiment 3 further explored whether slow effects occurred within the EST.

Results from Experiment 3 did not replicate those of Experiment 2 with respect to the slow effect; however the unusual patterns of responding to neutral words did not occur, at least not at a significant level. Although a significant interaction emerged between anxiety group and position, follow-up analyses revealed that the only significant difference occurred for the state-trait anxious individuals between Positions 3 and 4. RTs at Position 4 were significantly faster than RTs at Position 3, regardless of sequence type. This interaction was not interpreted as overly meaningful, as no other significant differences occurred.

Although not statistically significant, another finding that emerged from Experiment 3 that warrants discussion, were the patterns of RTs that emerged for each anxiety group. As can be seen in Figure 7.5 in Chapter 7, regardless of sequence type and ITI, the state anxious and low anxious participants had similar patterns of responding across the five positions. Additionally, the trait anxious and state-trait anxious individuals also had similar patterns of responding across each of the positions. Although these were non-significant, it appeared that the RT pattern of the highly anxious individuals (i.e., state-trait anxious) mirrored that of the low anxious individuals. Moreover, the pattern of responding by the state anxious group appeared to mirror that of the trait anxious individuals. In addition, the fastest RTs were noted in the trait and state-trait anxious groups. The finding that the state anxious and low anxious participants exhibited similar patterns of responding is interesting in the context of Egloff and Hock's (2001) research. Egloff and Hock found that emotional Stroop interference decreased in state anxious individuals who had low levels of trait anxiety, and suggested that this may occur in an effort to avoid experiencing a further negative state.

The findings from Experiments 2 and 3 were somewhat difficult to reconcile, as results were not consistent between the two experiments. If both studies had not found evidence of any slow effects occurring, it could be potentially argued that slow effects do not exist within the EST for individuals with varying levels and types of anxiety. Experiment 2, however, did find partial support for the presence of a slow effect, although on a position later than expected. Additionally, pure sequence of neutral words were not implicated, rather the difference emerged between the neutral words in the positive and negative emotion sequences (with participants responding to neutral words in the negative emotion sequence more slowly). Several possible reasons for why fast and slow effects did not consistently occur between Experiments 2 and 3 were explored (e.g., stimuli used, anxiety levels of participants in the samples). These possible explanations were, however, largely discounted after exploration. One possible explanation believed to warrant further testing related to that of the design of the task itself. As outlined in section 9.2.5, the methodology of Frings et al. (2010) was employed for the final emotional Stroop experiment. The three types of words (i.e., positive, negative, and neutral) were presented at random and sequences of specific words were then used to investigate the presence of fast and slow effects. For example, slow effects were examined by comparing the RTs of neutral words at trial N+1, which were preceded by either a positive, negative, or neutral word at trial N. Experiment 5 found some evidence to support the presence of a slow ESE.

Experiment 5 found that regardless of valence in trial N+1, all words that followed a negative word were responded to more slowly than all words that followed a positive word. This only occurred at the 32 ms block and for individuals who were low anxious. This result, however, is not necessarily indicative of a slow effect. Words at trial N+1 were comprised of all three word types, and as such elevations may have been present due to the words that appeared in trial N+1 themselves, rather than the valence of the word in trial N. Additionally, the difference was only significant between the positive and negative words at trial N, and not the neutral words. Furthermore, RTs of words that followed a neutral word at trial N were more similar to RTs of words that followed a negative word at trial N. Thus, it may not necessarily reflect a slowdown in colour-identification of stimuli that follows a negative word, but a speed up in colour-identification on stimuli that follows a positive word. Despite this, however, it is interesting to note that differences emerged between word types of opposing valences (as in Experiment 2).

Further evidence of a slow effect emerged for the anxious group. In this group, individuals responded significantly more slowly (23ms) to neutral words that followed a negative word, in comparison with neutral words that followed a positive word. When comparing this difference to the RTs of neutral words that followed neutral words, however, the finding becomes slightly more complex. Although RTs to neutral words that followed neutral words did not significantly differ from neutral words that followed either positive or negative words, participants in the anxious group responded to neutral words that followed neutral words in a similar manner to how they responded to neutral words that followed negative words. The difference in RTs between these categories was approximately 5 ms, as opposed to approximately 18 ms between neutral words that followed neutral words and neutral words that followed positive words. Thus, this finding may reflect speeded responses to neutral words that follow a positive word, rather than a slowdown in colour-identification on neutral words preceded by negative words. The findings of Experiment 5 do, however, indicate that ability to identify the colour of neutral words can be affected by the presentation of emotional material in preceding trials.

10.3.2 Theoretical Explanations for the Results

Based on the model proposed by Wyble and colleagues (2008), it was predicted that low anxious, state anxious, trait anxious, and state-trait anxious individuals (or the low anxious and anxious group in Experiment 5) would likely show slow effects on neutral words presented after emotion words. The model postulates that this effect would occur on the neutral trial immediately following the negative stimulus. As Experiment 2, 3, and 5 controlled for arousal between emotion categories, it was also anticipated that slow effects may occur on neutral trials that were preceded by a positive word.

Specifically, the Wyble et al. (2008) model predicts that when a negative emotion word is presented, the affective portion of the AAC is activated, thereby suppressing the cognitive component. In the interim, a colour-naming response has already been executed on the immediate trial. However, the momentary suppression of the cognitive component of the AAC unit decreases the importance of colour-naming, freeing resources for the system to scan for potential threat in the environment. As a result, when a neutral word is presented on the next trial, RTs are slowed. The momentary suppression of the cognitive component of the AAC manifests as a slow effect on the immediate neutral trial following a negative word. Based on the model of Wyble et al., slow effects should be most pronounced in state anxious individuals. This is due to the increased excitation of the negative word form node, which projects to the AAC, strongly activating the emotional component, thereby suppressing the cognitive component. While this also occurs in low anxious, and potentially trait anxious individuals, it is strongest in state anxious individuals, due to the increased excitation of the negative word from node.

Based on the findings of Experiment 2, 3, and 5, this model is not able to account for the patterns of responding. When examining the results of Experiment 2 only, it is possible to theorise that the cognitive component of the AAC remains suppressed for more than one trial. This could potentially account for the gradual delay that emerged regardless of anxiety group, on the third neutral word in the negative emotion sequence. Although, as previously stated, the difference was not significant between the pure neutral sequences, but rather between the neutral words in the positive emotion sequence. Experiment 5 also found potential evidence of a slow effect, with elevated RTs noted on neutral words that followed a negative word relative to neutral words that followed a positive word. Despite this, the interpretation in the context of this model is somewhat difficult, as neutral words that followed a neutral word were responded to in a similar manner as the neutral words that followed negative words. Thus it appears that rather than the negative words causing a slowdown in colour-identification on subsequent trials, RTs on neutral words that followed a positive word were speeded. This finding is incompatible with the proposal that negative words activate the AAC unit causing a suppression of cognitive control. What is clear from the current results is that it does not appear that positive information can activate the AAC unit. Despite this, it does appear that positive information can affect performance on subsequent trials.

Research has shown that anxiety and word arousal can have interactive effects on colour-naming performance. For example, Dresler et al. (2009) reported that state anxious individuals showed delayed colour-naming responses to positive emotion words that had been matched in arousal level with negative emotion words. This effect, however, was uncorrelated to trait anxiety levels. Furthermore, Larsen et al. (2008) reported that automatic vigilance tends to decrease on negative words that have a high arousal value. That is, high arousing negative words may not disrupt colour-naming to the extent of lower-arousing negative words. Additionally, as this is restricted to negative words, higher arousing positive words may have the ability to interfere with colour-naming performance (Dresler et al., 2009). It would be expected, however, that this may lead to an increase in RTs for positive words instead of a decrease in RTs, which was what emerged in Experiment 5 (at least on the subsequent neutral trial).

Prior studies have also documented the interactive effects between state and trait levels of anxiety and the ESE. MacLeod and Hagan (1992) found that trait anxious individuals who displayed an ESE in a sub-optimal presentation of the task no longer showed these interference effects when an optimal presentation was employed. The authors suggested that when stimuli are presented optimally, individuals may be able to suppress the automatic processing bias towards negative information. Furthermore, research has shown that individuals will try harder to avoid and escape the experience of bad moods (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001).This notion supports the findings of Egloff and Hock (2001) who found evidence that low-trait anxious individuals will avoid threatening information when state anxiety is high. They postulated that this is an effort to protect the self from experiencing further elevated levels of anxiety.

These theories might be able to account for, at least part, of the results of the current research program (i.e., the lack of differences in RTs between negative and neutral material).Despite this, it remains more difficult to account for the speeded RTs on neutral words following positive words. The consensus in the literature tends to suggest that negative material is more able to interfere with colour-naming ability, which is generally reflected by a slowdown in colour-naming responses (Algom, Chajut, & Lev, 2004; Baumeister et al., 2001; Estes & Verges, 2008; Estes & Adelman, 2008).

Several other interesting findings emerged from Experiment 5 that may assist in developing a greater understanding of the results. Regardless of ITI block, the low anxious group were significantly slower (20 ms) to respond to a neutral word that followed a positive word, in comparison to a positive word that followed a positive word. Waters et al. (2005) found that participants were particularly slow in colour-naming sequences of two negative (or addiction relevant) words in a row. Additionally, blocked ESTs have been thought to show increased RTs on the emotion block relative to the neutral block due to the gradual build-up of colour-naming latencies for emotional words over a series of trials (McKenna & Sharma, 2004). Thus, it may be expected that when participants are presented with two words in a row from the same emotive category, that speed of colour-naming would be slowed on the second trial. This suggestion was further supported by the research of Warren (1972), who found that participants who were presented with a semantically related prime demonstrated increased colour-naming latencies on the subsequent trial. Warren suggested that this slowing of RTs is due to the prime making the stimuli of the subsequent colour-naming trial more accessible causing greater interference with colour-naming ability. If participants were able to ignore the prime, however, then RTs on the subsequent trial would decrease (Rothermund & Wentura, as cited in Frings et al., 2010). This finding has been referred to as a kind of “spreading inhibition” whereby a semantically related prime makes the subsequent trial less accessible (Frings et al., 2010). This causes a speeding of RTs on the next trial (N+1). Frings and colleagues (2010) found support for this theory as participants were not slower to identify the colour of a negative word that followed a negative word in comparison with a neutral word that followed a neutral word. This finding was replicated in Experiment 5, as no significant differences emerged between the RTs of neutral words that followed a neutral word, positive words that followed a positive word, or negative words that followed a negative word. It is possible that this finding indicates no effect, however, given that the low anxious participants in Experiment 5 were faster to identify the colour of a positive word that followed a positive word in comparison with a neutral word that followed a positive word, this could also be considered as a kind of "spreading inhibition". That is, the second positive word was responded to faster due to the reduced accessibility of the stimuli. Although, a potential confound of this explanation is that this finding is reversed in the anxious group.

Anxious individuals RTs in trials N+1 were also affected by the presentation of a positive word at N; however this finding was reversed from what occurred within the low anxious group. Anxious individuals were significantly faster in identify the colour of a neutral word (21ms) that followed a positive word, in comparison with a positive word that followed a positive word. For the anxious group at least, the results appear to support the theory that consecutive trials of emotive stimuli are affected by a gradual build-up of rumination effects (e.g., Algom, Chajut, & Lev, 2004; McKenna & Sharma, 2004). Alternatively, these results may indicate that anxious individuals are unable to suppress the meanings of words, thus a priming type process leads to a longer RT on the second semantically related trial. This occurs as the word is more accessible and thus interferes to a greater extent with colour-identification. This finding, however, did not occur for the negative words.

Collectively, the results from Experiment 2, 3, and 5 are somewhat difficult to interpret as consistent findings in regards to fast and slow effects did not emerge. For example, Experiment 2 demonstrated a slowdown in colour-identification on neutral words in Position 4 following a negative emotion word in Position 1; however this effect was not replicated in Experiment 3. Additionally, as in Experiment 5, the difference was only significant in comparison with neutral words that followed positive emotion words. In

Experiment 2, while the difference that emerged was non-significant between the anxiety groups, it is interesting to note that this experiment included a sample that was significantly higher in state anxiety (see Appendix H for analyses, and section 10.3.3). Overall analyses for Experiment 2 did not implicate anxiety group in a significant interaction term. Despite this, the elevated levels of state anxiety in this sample of individuals may have accounted for the pattern of responding to the negative emotion sequences at the 32 ms block. This is explored in greater detail in section 10.3.3.

10.3.3 Anxiety Levels in Experiments 2, 3, and 5

Other than the neutral words utilised in Position 1, there were no methodological differences between Experiments 2 and 3 to account for the divergent results. Although, as a new sample was utilised for Experiment 2, it was possible the different pattern of results emerged due to sample characteristics. As a result, the anxiety levels of participants across the three emotional Stroop experiments was compared to determine any significant sample differences. These results are presented in Appendix H. Analyses were also conducted to ensure that anxiety groups in each experiment differed on the appropriate dimensions of the STAI. These results are presented in Appendix I.

The analyses indicated that regardless of anxiety group, mean levels of trait anxiety were significantly higher across the experiments than levels of state anxiety. Participants also reported the highest levels of anxiety in Experiment 2, followed by Experiment 3, and Experiment 5. Additionally, there was a significant two-way interaction between anxiety level and experiment that was followed up by comparing the state and trait anxiety levels between Experiments 2, 3, and 5. There were no significant differences between the trait anxiety scores of the experiments, however, significant differences did emerge between the levels of state anxiety. Pairwise comparisons revealed that individuals in Experiment 2 were significantly more state anxious than individuals in both Experiments 3 and 5. There was no difference between the state anxiety levels of Experiments 2 and 5.

Based on these findings, it is possible that due to the elevated levels of state anxiety of participants in Experiment 2 the disruption in colour-identification noted on Position 4 in the negative emotion sequences was caused by a greater activation of the affective component of the AAC module. This in turn suppressed the cognitive component, making the system less effective at identify the colour of successive emotional words. Although, when looking at the mean RT data of each anxiety group at the 32 ms block, it can be seen that the trait anxious individuals (who had lower levels of state anxiety) also demonstrated increased RTs on the neutral words at Position 4 in the negative emotion sequence. As a result, this interpretation does not appear particularly likely, unless the AAC unit is also strongly activated in trait anxious individuals, and according to the model of Wyble et al. (2008), this should not be the case. Ultimately, the differences in anxiety levels cannot assist with the interpretation of the results for Experiment 5, but may explain the lack of findings in Experiment 3. As stated previously, however, the lack of significant effects reported in the current research program are not a product of sample variability.

10.4 ITI Manipulation and Biased Attention

One of the key interests for the current research program was whether the magnitude or duration (in the case of slow effects) of ESEs would be affected by the amount of time between stimulus presentations. As no evidence of fast effects emerged, it is not possible to speculate about the role that ITI duration may play in regards to the size of this effect. However, significant differences in regards to slow effects did emerge at the 32 ms and 1000 ms ITIs, although generally not on the sequence types or position that was expected. The key effect of interest here is that no significant differences in regards to slow effects emerged at the 2000 ms block. In Experiment 2, a disruption in colour-identification was noted on three trials after the target (in this case negative) word had been presented, and therefore results may infer that shorter ITIs are optimal for detecting the presence of slow effects. Consistent with this, Frings et al. (2010) suggested that it may be more appropriate to utilise longer ITIs, if fast components of biased attention are the main effects of interest. Although, Sharma and McKenna (2001) reported a reduced ESE when utilising a longer ITI (1000 ms) in comparison with a brief ITI (32 ms).

A consistent finding throughout the emotional Stroop experiments was the main effect of ITI. In Experiment 2, 3, and 5, participants consistently responded fastest at the 1000 ms block, followed by the 2000 ms and 32 ms block. It was suggested that perhaps the 1000 ms block may be the optimal block for eliciting short RTs. Although, given that differences occurred across several positions in Experiment 2 at the 32 ms block, it might be optimal to detect the presence of slow effects using very brief ITIs. Based on the findings from the current research program, it is premature to speculate on this issue, as fast and slow effects were not reliably detected across the three emotional Stroop experiments. This would, however, be an interesting area for future research, particularly as the model of Wyble et al. (2008) does not account for ITI duration. The model is based on the premise that ITIs will be short (e.g., 32 ms); however given the non-linear relationship between ITI and RT, this may be an area of research that warrants further investigation. Essentially, the main effects of ITI were the only consistent finding to emerge from the current research program. Although the relationship between ITI and RTs that occurred is not entirely understood, the results do confirm that ITI duration has a significant effect on RTs.

10.5 Chapter Summary

The current chapter presented a discussion of the results from Experiment 2, 3, and 5. Results of each experiment had previously been outlined in each of the Experimental chapters; however this chapter presented the collective discussion of results from all three emotional Stroop experiments. The chapter was essentially broken into two main sections: A discussion of fast effects, and a discussion of slow effects. Due to the divergent findings between the three emotional Stroop experiments, it was somewhat difficult to provide an explanation for the findings; however several potential accounts for the results of the research project were presented. A valuable contribution of the current research program, however, is the confirmation that emotional material can disrupt performance on subsequent neutral trials. The next chapter presents the strengths, limitations, suggestions for future directions, and concluding remarks.

Chapter 11. Concluding Remarks

11.1 Overview of Chapter

The purpose of this concluding chapter is to present a brief summary of the key findings that emerged from the research program. Additionally, limitations, future directions, and strengths are discussed. The chapter concludes with the contributions of the research program.

11.2 Summary of the Research Program and Key Findings

The purpose of this thesis was to investigate attentional bias in the EST for individuals who were low anxious and anxious. Specifically, the project investigated fast and slow components of biased attention, in individuals who were low anxious, state anxious, trait anxious, and state-trait anxious. Based on the model of Wyble et al. (2008), the research program was interested in whether different types of non-clinical anxiety contributed to biased attention within the task. By including individuals with varying levels and types of anxiety, the predictions of the Wyble et al. model could be tested.

Furthermore, the project investigated whether positive, in addition to negative stimuli, would cause disruptions in colour-identification abilities. Finally, the research program examined how these effects would be impacted by the manipulation of time elapsed between trials (i.e., the ITI).

In total, five experiments were conducted. Two of these studies were word selection studies (Experiment 1 and 3), which developed a large word pool of positive, negative, and neutral words to be used in the subsequent emotional Stroop experiments (Experiments 2, 3, and 5). These lists were created so that words were matched between categories for length and frequency of occurrence in the English language (Brysbaert & New, 2009). Conducting the word selection studies also ensured words received appropriate valence ratings (e.g., the negative emotion words all received negative valence ratings). Furthermore, performing the word selection studies also enabled words to be matched for arousal levels between the target neutral and neutral categories of words and the target emotional categories of words. In addition, each category of words, regardless of whether it was an emotional or neutral category, had their own semantic theme. By matching the words utilised in the ESTs in the aforementioned ways, differences that emerged in RTs could then be more likely attributed to the emotional content of the words themselves, rather than differences in their lexical characteristics. Essentially, these carefully controlled word lists ensured the relative contributions of fast and slow components of the ESE could be measured without being compromised by lexical differences between categories or sequences. In addition, these studies have contributed two word lists that have been matched on several important lexical characteristics and also ensured the interval validity of the emotional Stroop experiments.

Results from the three emotional Stroop experiments did not detect the presence of fast effects on either positive or negative emotion words. Additionally, there were no differences in anxiety groups with regards to fast effects. Mixed evidence emerged for the presence of slow effects. In Experiment 2, a significant difference was found between neutral words in the negative emotion sequence and neutral words in the positive emotion sequence. Results reported that RTs to neutral words in the negative emotion sequence steadily increased over the course of Positions 2 and 3, however, the difference only became significant at Position 4. In Experiment 3, however, no evidence of slow effects was found. As a result of the contradictory results of Experiment 2 and 3, Experiment 5 employed a methodology different to the two prior emotional Stroop experiments, and found differences in the RTs of neutral words that followed a negative word, and neutral words that followed a positive word. This finding was only present for the anxious individuals, and furthermore was interpreted as an increase in RTs to neutral words that followed positive words, rather than a slowing of RTs to neutral words that followed negative words.

Taken collectively, the results of the current research program did not find a fast component of attentional bias in the EST. Additionally, mixed support was noted for the presence of a slow component of attentional bias. Furthermore, results did not find support for the model proposed by Wyble and colleagues (2008). Despite this, the results do seem to suggest that emotional stimuli have the ability to disrupt colour-identification performance on subsequent neutral trials.

Despite the lack of significant effects reported, the methodology of the research program was particularly strong. Before commencement of the ESTs, words were carefully selected and normed on an Australian population. Additionally, newer word frequencies were utilised, that better reflect the use of current language. The ESTs were carefully designed not just in terms of whether words should be presented in a pseudorandom or random format, but careful consideration was also given to factors such as whether a sub-optimal versus optimal format should be used, and whether it was more appropriate to utilise vocal or button-press responses. Ultimately, what makes the current methodology particularly strong was the use of two separate presentation formats of the EST. Experiment 2 and 3 utilised a pseudorandom design almost identical to that of McKenna and Sharma (2004). Additionally, given that an adequate explanation of the results could not be achieved based on the results of these experiments, an additional EST was conducted that employed a random design. This allowed for further exploration of the roles of fast and slow components in the ESE. Finally, the samples of the emotional Stroop experiments comprised of individuals with varying levels (i.e., low and high) and types (i.e., state and trait) of anxiety, a sample in which the effects had not previously been explored in.

11.3 Limitations, Strengths and Future Directions

There were several potential limitations noted in the research program. The first relates to the sample sizes of the emotional Stroop experiments. Namely, while the overall numbers of each experiment were reasonably sized, there was an unequal distribution of participants between the anxiety groups. In Experiments 2 and 3, the state and trait anxiety groups were considerably smaller than the low anxious and state-trait anxiety groups. If a large effect size was present for the non-significant results, then a potential limitation may be that these unequal group sizes were contributing to a Type II Error. Based on the small effect sizes, however, and observed power reported in the results, these results are not considered particularly meaningful.

Another potential limitation is that the bulk of the samples were comprised of undergraduate university students. Although not necessarily problematic, as previous studies have used similar samples (e.g., Algom et al., 2008; Frings et al., 2010; McKenna & Sharma, 2010), increasing the number of participants from the wider community would increase the representativeness of the sample, and in turn the generalisability of results. Therefore, in order to rectify this potential limitation and to expand the participant pool, Experiment 5 assessed individuals from undergraduate university courses in addition to the general community.

It may have been beneficial for the current research program to include positive and negative words that were split into categories of high and low arousing. Words used in the current study were carefully selected for inclusion in the emotional Stroop experiments. Despite this, having both high and low arousing emotional words may have assisted in the interpretation of some of the unexpected findings. For example, Larsen et al. (2006) reported that negative words with high arousal values cause less interference than moderately arousing words. At the outset of this project, however, arousal was not necessarily a key variable of interest but rather a factor that needed to be considered when using emotional words. Despite this, refined word lists were developed that were matched on several important lexical dimensions for use in the emotional Stroop experiments.

Regardless of the limitations noted, there were several strengths of the research program. For example, the ESTs were designed from a strong theoretical base, which allowed for both fast and slow components of the ESE to be examined. Additionally, these effects were explored across both time (via the manipulation of the ITI) and also trials (in Experiments 2 and 3). Furthermore, the effects were examined in groups with varying levels and types of anxiety, which previously had not been investigated. The inclusion of this sample also allowed for the model of Wyble and colleagues (2008) to be tested.

Based on the findings of the research program, there are several areas regarding attentional bias in the EST that could be explored in the future. For example, it would be interesting to examine the role of fast and slow effects in clinically anxious patients. The current program did not find evidence of fast effects and found inconsistent findings in regards to slow effects. This may be due to the anxiety levels of the individuals who participated in the current set of experiments. It is possible that participants' anxiety levels were not elevated enough to either cause an increased activation on the negative emotion word form node, or to have led to the permanent restructuring of the information processing system, thus the presence of fast and slow effects for negative information were not detected. By including a sample of clinically anxious patients, a greater understanding of the role of both fast and slow effects could be gained.

Future research would also benefit from thoroughly examining the role that word arousal has on biased attention, specifically when contributing to either fast or slow effects. This may be particularly interesting, as research has documented interactive effects based on word valence and arousal levels. Given the results of the current research program, in regards to both target positive words and neutral words within the positive emotion sequences (or at trial N+1), the role of positively valenced stimuli warrants further investigation.

Future research exploring attentional bias in the EST should also consider comparing sub-optimal and optimal presentations of the task. In sub-optimal presentations, stimuli are presented for very short periods below that of conscious awareness. By examining the difference between sub-optimal and optimal presentations of the task, inferences could be made regarding the mechanisms mediating the fast and slow components of biased attention. For example, if the effects were both caused by a fast, automatic capture of attention, then differences should not be present between their occurrences in the different formats of the task.

Finally, the current research program did not find support for the model proposed by Wyble and colleagues (2008). Future research could further test this model by employing the use of congruent and incongruent stimuli. An interesting way to investigate the role of the AAC is by activating the cognitive component (as opposed to the emotional component). Wyble and colleagues speculated that the presentation of an incongruent trial would activate the cognitive component of the AAC, suppressing the affective component, thereby strongly biasing the information processing system towards colour-naming. Thus an emotion trial that follows an incongruent trial should essentially be ignored. Interestingly, it might be expected that an emotional trial that follows a congruent trial would be responded to more slowly as the colour-naming system is not as strongly geared towards naming colours, thus the presence of threatening information (in this case a negative emotion word) would be able to disrupt performance.

11.4 Contributions of this Research Program to the Literature

Despite the limitations noted, this research program was the first to investigate the role of both fast and slow components of attentional bias in the EST for individuals with varying levels and types of anxiety. Additionally, it was also the first to explicitly explore the duration of the slow effect by examining RTs over a series of trials in conjunction with utilising differing ITIs. Furthermore, this study has produced a refined pool of words matched on several important lexical characteristics, including semantic relatedness within categories.

Although no evidence of fast effects were found, there was evidence to suggest that emotional material can disrupt colour-identification performance beyond its presentation, and this finding has several important implications. A particularly important implication of this result is that future researchers investigating biased attention should account for the occurrence of slow effects to different words when utilising the EST to investigate biases of attention, that is, RTs of neutral words should not just be compared to RTs of emotional words in order to determine an effect. Given that emotional words can affect how subsequent words are responded to, it is important to examine these words in their own right.

What is clear from the current research program is that the mechanisms mediating the ESE, whether fast or slow components, are still not entirely understood, at least in non-clinical populations. Additionally, the findings also suggest that further research into the role that positive valence has in contributing to biases of attention is necessary. As limited research has explored fast and slow effects in EST, future studies may uncover results that will expand on the findings from the current research program. Despite the majority of hypotheses not being supported, null effects should still be considered important findings in their own right, and given the strong methodology of the current design, a potential conclusion of the research program is that fast effects are not present in low anxious or anxious individuals.

References

Algom, D., Chajut, E., & Lev, S. (2004). A rational look at the emotional Stroop phenomenon: A generic slowdown, not a Stroop effect. *Journal of Experimental Psychology, 133*(3), 323-338. doi: 10.1037/0096-3445.133.3.323

Algom, D., Zakay, D., Monar, O., & Chajut, E. (2009). Wheel chairs and arm chairs: A novel experimental design for the emotional Stroop effect. *Cognition and Emotion, 23*(8), 1552-1564. doi: 10.1080/02699930802490243

Amir, N., McNally, R., Riemann, B., Burns, J., Lorenz, M., & Mullen, J. (1996). Suppression of the emotional Stroop effect by increased anxiety in patients with social phobias. *Behaviour Research and Therapy, 34*(11-12), 945-948. doi: 10.1016/S0005-7967(96)00054-X

Anderson, A. K. (2005). Affective influences on the attentional dynamics supporting awareness. *Journal of Experimental Psychology: General, 134*(2), 258-281. doi: 10.1037/0096-3445.134.2.258

Aquino, J. M., & Arnell, K. M. (2007). Attention and the processing of emotional words: Dissociating effects of arousal. *Psychonomic Bulletin & Review, 14*(3), 430-435. doi: 10.3758/BF03194084

Ashley, V., & Swick, D. (2009). Consequences of emotional stimuli: Age differences on pure and mixed blocks of the emotional Stroop. *Behavioral and Brain Functions, 5*(14), 1-11. doi: 10.1186/1744-9081-4-14

Balota, D.A., Cortese, M.J., Sergent-Marchall, S.D., Spieler, D.H., & Yap, M.J. (2004). Visual word recognition of single-syllable words. *Journal of Experimental Psychology: General, 133*(2), 283-316. doi: 10.1037/0096-3445.133.2.283

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van Ijzendoorn, M. H. (2007). Threat-related attention bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*(1), 1-24. doi: 10.1037/0033-2909.133.1.1

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology, 5*(4), 323-370. doi: 10.1037//1089-2680.5.4.323

Beck, A. T. (1976). *Cogntive therapy and the emotional disorders.* New York: Harper & Row.

Beck, A. T. (1991). Cognitive therapy: A 30-year retrospective. *American Psychologist, 46*(4), 368-375. doi: 10.1037/0003-066X.46.4.368

Beck, A. T., & Clark, D. A. (1988). Anxiety and depression: An information processing perspective. *Anxiety Research: An International Journal, 1*(1), 23-36. doi: 10.1080/10615808808248218

Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: Automatic and strategic processes. *Behaviour Research and Therapy, 35*(1), 49-58. doi: 10.1016/S0005-7967(96)00069-1

Becker, E. S., Rinck, M., Margraf, J., & Roth, W. (2001). The emotional Stroop effect in anxiety disorders: General emotionality or disorder specificity? *Anxiety Disorders, 15*(3), 147-159. doi: 10.1016/S0887-6185(01)00055-X

Bertels, J., Kolinsky, R., Pietrons, E., & Morais, J. (2011). Long-lasting attentional influence of negative and taboo words in an auditory variant of the emotional Stroop task. *Emotion, 11*(1), 29-37. doi: 10.1037/a0022017

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108* (3), 624-652. doi: 10.1037/0033-295X.108.3.624

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36*(2), 129-148. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7224324

Bower, G. H. (1987). Commentary on mood and memory. *Behaviour Research and Therapy, 25*(6), 443-455. doi: 10.1016/0005-7967(87)90052-0

Bugg, J. M., Jacoby, L. L., & Toth, J. P. (2008). Multiple levels of control in the Stroop task. *Memory & Cognition, 36*(8), 1484-1494. doi: 10.3758/MC.36.8.1484

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The Self-Assessment Manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry, 25*(1), 49-59. doi: 10.1016/0005-7916%2894%2990063-9

Bradley, M. M., & Lang., P.J. (1999). *Affective Norms for English Words (ANEW): Instruction manual and affective ratings.* Technical Report C-1, The Center for Research in Psychophysiology, University of Florida.

Brysbaert, M., & New, B. (2009). Moving Beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods*, *41*(4), 977-990. doi: 10.3758/BRM.41.4.977

Cane, J.E., Sharma, D., & Albery, I.P. (2008). The addiction Stroop task: Examining the fast and slow effects of smoking and marijuana-related cues. *Journal of Psychopharmacology, 23*(5), 510 - 519. doi: 10.1177/0269881108091253

Cassin, S. E., & von Ranson, K. M. (2005). Word lists for testing cognitive biases in eating disorders. *European Eating Disorders Review*, *13*(3), 216-220. doi: 10.1002/erv.607

Chajut, E., Lev, S., & Algom, D. (2005). Vicissitudes of a misnomer: Reply to Dalgleish (2005). *Journal of Experimental Psychology: General, 134*(4), 593-595. doi: 10.1037/0096-3445.134.4.593

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-159. doi: 10.1037/0033-2909.112.1.155

Cohen, J. D., Dunbar, K., & McClelland, J. L. (1990). On the control of automatic processes: A parallel distributed processing account of the Stroop effect. *Psychological Review, 97*(3), 332-362. doi: 10.1037/0033-295X.97.3.332

Cooper, M., & Fairburn, C. G. (1994). Changes in selective information processing with three psychological treatments for bulimia nervosa. *British Journal of Clinical Psychology*, *33*, 353-356. doi: 10.1111/j.2044-8260.1994.tb01131.x

Dalgleish, T. (2005). Putting some feeling into it – the conceptual and empirical relationships between the classic and emotional Stroop tasks: Comment on Algom, Chajut, and Lev (2004). *Journal of Experimental Psychology: General, 134*(4), 585-591. doi: 10.1037/0096-3445.134.4.585

Der, G., & Deary, I. J. (2006). Age and sex differences in RT in adulthood: Results from the United Kingdom Health and Lifestyle Survey. *Psychology and Aging, 21*(1), 62-73. doi: 10.1037/0882-7974.21.1.62

Dresler, T., Mériau, K., Heekeren, H.R., & van der Meer, E. (2009). Emotional Stroop task: Effect of word arousal and subject anxiety on emotional interference. *Psychological Research, 73*(3), 364-371. doi: 10.1007/s00426-008-0154-6

Edwards, M. S., Burt, J. S., & Lipp, O. V. (2006). Selective processing of masked and unmasked verbal threat material in anxiety: Influence of an immediate acute stressor. *Cognition and Emotion*, *20*(6), 812-835. doi: 10.1080/02699930500375761

Edwards, M.S., Burt, J.S., & Lipp, O.V. (2009). Selective attention for masked and unmasked emotionally toned stimuli: Effects of trait anxiety, sate anxiety, and test order. *British Journal of Psychology, 101*(2), 325-343. doi: 10.1348/000712609X466559

Edwards, M. S., Burt, J. S., & Lipp, O. V. (2010). Selective attention for masked and unmasked threatening words in anxiety: Effects of trait anxiety, state anxiety and awareness. *Behaviour Research and Therapy, 48*(3), 210-218. doi: 10.1016/j.brat.2009.11.003.

Egloff, B., & Hock, M. (2001). Interactive effects of state anxiety and trait anxiety on emotional Stroop interference. *Personality and Individual Differences, 31*(6), 875-882. doi: 10.1016/S0191-8869(00)00188-4

Eilola, T. M., Havelka, J., & Sharma, D. (2007). Emotional activiation in the first and second language. *Cognition and Emotion, 21*(5), 1064-1076. doi: 10.1080/02699930601054109

Estes, Z., & Adelman, J. (2008). Automatic vigilance for negative words in lexical decision and naming: Comment on Larsen, Mercer, and Balota (2006). *Emotion, 8*(4), 441-444. doi: 10.1037/1528.3542.8.4.441

Estes, Z., & Adelman, J. (2008). Automatic vigilance for negative words is categorical and general. *Emotion, 8*(4), 453-457. doi: 10.1037/a0012887

Estes, Z., & Verges, M. (2008). Freeze or flee? Negative stimuli elicit selective responding. *Cognition, 108*(2), 557-565. doi: 10.1016/j.cognition.2008.03.003

Eysenck, M., Derakshan, N., Santos, R., & Calvo, M. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7*(2), 336-353. doi: 10.1037/1528-3542.7.2.336

Faul, F., Erdfelder, E., Buchner, A., & Lang, A-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149-1160. doi: 10.3758/BRM.41.4.1149

Field, A. (2005). *Discovering statistics using SPSS* (2nd ed.). London, UK: Sage Publications Ltd.

Field, M., Munafò, M. R., & Franken, I. H. (2009). A meta-analytic investigation of the relationship between attentional bias and subjective craving in substance abuse. *Psychological Bulletin, 135*(4), 589-607. doi: 10.1037/a0015843

Flykt, A. (2005). Visual search with biological threat stimuli: Accuracy, RTs, and heart rate changes. *Emotion*, *5*(3), 349-353. doi: 10.1037/1528-3542.5.3.349

Foa, E. B., Feske, U., Murdock, T. B., Kozak, M. J., & McCarthy, P. R. (1991). Processing of threat-related information in rape victims. *Journal of Abnormal Psychology, 100*(2), 156-162. doi: 10.1037/0021-843X.100.2.156

Foa, E. B., Ilai, D., McCarthy, P. R., Shoyer, B., & Murdock, T. (1993). Information processing in obsessive-compulsive disorder. *Cognitive Therapy and Research, 17*(2), 173-189. doi: 10.1007/BF01172964

Foa, E. B., & McNally, R. J. (1986). Sensitivity to feared stimuli in obsessive-compulsives: A dichotic listening analysis. *Cognitive Therapy and Research, 10*(4), 477-485. doi: 10.1007/BF01173299

Fox, E. (1993). Attentional bias in anxiety: Selective or not? *Behaviour Research and Therapy*, *31*(5), 487-493. doi: 10.1016/0005-7967(93)90129-I

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General*, *130*(4), 681-700. doi: 0.1037/0096-3445.130.4.681

Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for delayed disengagement from emotional faces. *Cognition and Emotion, 16*(3), 355-379. doi: 10.1080/02699930143000527

Franken, I. H., Kroon, L. Y., Wiers, R.W., & Jansen, A. (2000). Selective cognitive processing of drug cues in heroin dependence. *Journal of Psychopharmacology, 14*(4), 395-400. doi: 10.1177/026988110001400408

Frings, C., Englert, J., Wentura, D., & Bermeitinger, C. (2010). Decomposing the emotional Stroop effect. *The Quarterly Journal of Experimental Psychology, 63*(1), 42-29. doi: 10.1080/17470210903156594

Frings, C., Wentura, D., & Holtz, M. (2007). Dysphorics cannot ignore unpleasant information. *Cognition and Emotion, 21*(7), 1525-1534. doi: 10.1080/02699930601054042

Gootjes, L., Coppens, L. C., Zwaan, R. A., Franken, I. H., & Van Strien, J. W. (2011). Effects of recent word exposure on emotion-word Stroop interference: An ERP study. *International Journal of Psychophysiology, 79*(3), 356-363. doi: 10.1016/j.ijpsycho.2010.12.003

Green, M., & McKenna, F. P. (1993). Developmental onset of eating related color-naming interference. *International Journal of Eating Disorders, 13*(4), 391-397. doi: 10.1002/1098-108X%28199305%2913:4%3C391::AID-EAT2260130407%3E3.0.CO;2-U

Harris, C. L., Ayçiçeği, A., & Gleason, J. B. (2003). Taboo words and reprimands elicit greater autonomic reactivity in a first language than in a second language. *Applied Psycholinguistics, 24*(4), 561-579. doi: 10.1017/S0142716403000286

Holle, C., Neely, J. H., & Heimberg, R. G. (1997). The effects of blocked versus random presentation and semantic relatedness of stimulus words on response to a modified Stroop Task among social phobias. *Cognitive Therapy and Research, 21*(6), 681-697. doi: 10.1023/A:1021860324879

Isenberg, N., Silbersweig, D., Engelien, A., Emmerich, S., Malavade, K., Beattie, B., Leon, A., & Stern, E. (1999). Linguistic threat activates the human amygdala. *Neurobiology, 96*, 10456-10459. Retrieved from http://www.pnas.org/

Johansson, L., Ghaderi, A., & Andersson, G. (2005). Stroop interference for food- and body- related words: a meta- analysis. *Eating Behaviours, 6*(3), 271-281. doi: 10.1016/j.eatbeh.2004.11.001

Kahan, T. A., & Hely, C. D. (2008) The role of valenceand frequency in the emotional Stroop task. *Psychonomic Bulletin & Review, 15*(5), 956-960. doi: 10.3758/PBR.15.5.956

Kambouropoulos, N., & Knowles, S. (2005). Psychological distress and responses to blocked and random presentation of emotional Stroop stimuli: An online experiment. *E-Journal of Applied Psychology: Clinical and Social Issues, 1*(2), 3-8, Retrived from *ojs.lib.swin.edu.au/index.php/ejap/article/download/20/44*

Kampman, M., Keijsers, G., Verbraak, M., Näring, G., & Hoogduin, C. (2002). The emotional Stroop: A comparison of panic disorder patients, obsessive-compulsive patients, and normal controls, in two experiments. *Anxiety Disorders, 16*(4), 425-441. doi: 10.1016/S0887-6185(02)00127-5

Keppel, G., & Wickens, T. (2004). *Design and analysis: A researcher's handbook* (4th ed.). London, UK: Prentice Hall.

Kindt, M., Bierman, D., & Brosschot, J. F. (1996). Stroop versus Stroop: Comparison of a card format and a single-trial format of the standard color-word Stroop task and the emotional Stroop task. *Personality and Individual Differences, 21*(5), 653-661. doi: 10.1016/0191-8869(96)00133-X

Klein, A. A. (2007). Suppression-induced hyperaccessibility of thoughts in abstinent alcoholics: A preliminary investigation. *Behaviour Research and Therapy, 45*(1), 169-177. doi: 10.1016/j.brat.2005.12.012

Koster, E., Crombez, G., Verschuere, B., Van Damme, S., & Wiersema, J. (2006). Components of attentional bias to threat in high trait anxiety: Facilitated engagement, impaired disengagement, and attentional avoidance. *Behaviour Research and Therapy*, *44*(12), 1757-1771. doi: 10.1016/j.brat.2005.12.011

Koster, E., Fox, E., & MacLeod, C. (2009). Introduction to the special section on cognitive bias modification in emotional disorders. *Journal of Abnormal Psychology, 118*(1), 1-4. doi: 10.1037/a0014379

Kucera, H., & Francis, W. N. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University Press.

Larsen, R. J., Mercer, K. A., & Balota, D. A. (2006). Lexical characteristics of words used in emotional Stroop experiements. *Emotion*, *6*(1), 62-72. doi: 10.1037/1528-3542.6.1.62

Larsen, R. J., Mercer, K. A., Balota, D. A., & Strube, M. J. (2008). Not all negative words slow down lexical decision and naming speed: Importance of word arousal. *Emotion, 8*(4), 445-452. doi: 10.1037/1528-3542.8.4.445

Lavy, E., Van den Hout, M., & Arntz, A. (1993). Attentional bias and facilitated escape: A pictorial test. *Advances in Behaviour Therapy and Research, 15*(4), 279-289. doi: 10.1016/0146-6402%2893%2990013-R

Lee, L. O., & Knight, B. G. (2009). Attentional bias for threat in older adults: Moderation of the positivity bias by trait anxiety and stimulus modality. *Psychology and Aging, 24*(3), 741-747. doi: 10.1037/a0016409

Lee, M., & Shafran, R. (2004). Information processing biases in eating disorders. *Clinical Psychology Review*, *24*(2), 215-238. doi: 10.1016/j.cpr.2003.10.004

Leech, G., Rayson, P., & Wilson, A. (2001). *Word frequencies in written and spoken English: Based on the British National Corpus*. London, UK: Longman.

Li Wen, K., Paller, K., Zinbarg, R. (2008). Conscious intrusion of threat information via unconscious priming in anxiety. *Cognition and Emotion, 22*(1), 44-62. doi: 10.1080/02699930701273823

Lim, S., & Kim. J. (2004). Cognitive processing of emotional information in depression, panic and somatoform disorder. *Journal of Abnormal Psychology*, *114*(1), 50-61

MacKay, D. G., Shafto, M., Taylor, J. K., Marian, D. E., Abrams, L., & Dyer, J. R. (2004). Relations between emotion, memory, and attention: Evidence from taboo Stroop, lexical decision, and immediate memory tasks. *Memory & Cognition, 32*(3), 474-488. doi: 10.3758/BF03195840

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, *109*(2), 163-203. doi: 10.1037/0033-2909.109.2.163

MacLeod, C. M., & Hagan, R. (1992). Individual differences in the selective processing of threatening information, and emotional responses to a stressful life event. *Behaviour Research and Therapy, 30*(2), 151-161. doi: 10.1016/0005-7967(92)90138-7

MacLeod, C. M., & Rutherford, E. M. (1992). Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables, and personal relevance of stimulus materials. *Behaviour Research and Therapy, 30*(5), 479-491. doi: 10.1016/0005-7967(92)90032-C

Mathews, A., & Mackintosh, B. (1998). A cognitive model of selective processing in anxiety. *Cognitive Therapy and Research, 22*(6), 539-560. Retrieved from http://homepage.psy.utexas.edu/homepage/

Mathews, A., & MacLeod, C. (2002). Induced processing biases have causal effects on anxiety. *Cognition and Emotion, 16*(3), 331-354. doi: 10.1080/026999930143000518

Mathews, A., & MacLeod, C. (1985). Selective processing of threat cues in anxiety states. *Behaviour Research and Therapy, 23*, 563-569. 10.1016/0005-7967(85)90104-4

Mathews, A., May, J., Mogg, J., & Eysenck, M. (1990). Attentional bias in anxiety: Selective search or defective filtering? *Journal of Abnormal Psychology, 99*(2), 166-173. doi: 10.1037/0021-843X.99.2.166

Mathews, A., Mogg, K., Kentish, J., & Eysenck, M. (1995). Effect of psychological treatment on cognitive bias in generalized anxiety disorder. *Behaviour Research and Therapy, 33*(3), 293-303. doi: 10.1016/0005-7967%2894%29E0022-B

Matthews, G., & Harley, T. (2009). Connectionist models of emotional distress and attentional bias. *Cognition & Emotion, 10*(6), 561-600. doi: 10.1080/026999396380060

McKenna, F. P., & Sharma, D. (1995). Intrusive cognitions: An investigation of the emotional Stroop task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*(6), 1595-1607. doi: 10.1037/0278-7393.21.6.1595

McKenna, F. P., & Sharma, D. (2004). Reversing the emotional Stroop effect reveals that it is not what it seems: The role of fast and slow components. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*(2), 382-392. doi: 10.1037/0278-7393.30.2.382

McNally, R. J., Amir, N., Louro, C. E., Lukach, B. M., Riemann, B. C., & Calamari, J. E. (1994). Cognitive processing of idiographic emotional information in panic disorder. *Behaviour Research and Therapy, 32*(1), 119-122. doi: 10.1016/0005-7967%2894%2990092-2

Mogg, K., Bradley, B.P., De Bono, J., & Painter, M. (1997). Time course of attentional bias for threat information in non-clinical anxiety. *Behaviour Research and Therapy, 35*(4), 297-303. doi: 10.1016/S0005-7967(96)00109-X

Mogg, K., Bradley, B. P., Williams, R., & Mathews, A. (1993). Subliminal processing of emotional information in anxiety and depression. *Journal of Abnormal Psychology, 103*(2), 304-311. doi: 10.1037/0021

Mogg, K., Kentish, J., & Bradley, B. P. (1993). Effects of anxiety and awareness on colour-identification latencies for emotional words. *Behaviour Research and Therapy, 31*(6), 559-567. doi: 10.1016/0005-7967(93)90107-6

Moritz, S., Fischer, B., Hottenrott, B., Kellner, M., Fricke, S., Randjbar, S., & Jelenek, L. (2008). Words may not be enough! No increased emotional Stroop effect in obsessive-compulsive disorder. *Behaviour Research and Therapy, 46*(9), 1101-1104. doi: 10.1016/j.brat.2008.05.005

Ozen, N.S., Ercan, I., Irgil, E., & Sigirli, D. (2010). Anxiety prevalence and affecting factors among university students. *Asia Pacific Journal of Public Health, 22*(1), 127-133. doi: 10.1177/1010539509352803

Pardo, J. V., Pardo, P. J., Janer, K. W., & Raichle, M. E. (1990). The anterior cingulate cortex mediates processing selection in the Stroop attentional conflict paradigm. *Proceedings of the National Academy of Sciences of the United States of America, 87*(1), 256-259. Retrieved from http://www.ncbi.nlm.nih.gov/

Peressotti, F., Cubelli, R., & Job, R. (2003). On recognizing proper names: the orthographic cue hypothesis. *Cognitive Psychology, 47*(1), 87-116. doi: 10.1016/S0010-0285(03)00004-5

Phaf, R. H., & Kan, K. (2007). The automaticity of emotional Stroop: A meta-analysis. *Journal of Behaviour Therapy and Experimental Psychiatry, 38*(2), 184-199. doi: 10.1016/j.jbtep.2006.10.008

Reinholdt-Dunne, M. L., & Mogg, K., & Bradley, B. P. (2009). Effects of anxiety and attention control on processing pictorial and linguistic information. *Behaviour Research and Therapy*, *47*(5), 410-417. doi: 10.1016/j.brat.2009.01.012

Rothermund, K., & Wentura, D. (1998). An unbiased test of a spreading activation account of affective priming: Analysis of affective congruency effects in the Stroop task. *Zeitschrift fur Experimentelle Psychologie*, *45*(2), 120-135. doi: 10.1037/t06065-000

Russo, R., Whittuck, D., Roberson, D., Dutton, K., Georgiou, G., & Fox, E. (2006). Mood-congruent free recall bias in anxious individuals is not a consequence of response bias. *Memory*, *14*(4), 393-399. doi: 10.1080/09658210500343166

Rutherford, E. M., MacLeod, C., & Campbell, L. W. (2004). Negative selectivity effects and emotional selectivity effects in anxiety: Differential attentional correlates of state and trait variables. *Cognition and Emotion*, *18*(5), 711-720. doi: 10.1080/02699930341000121

Saunders, J. B., Aasland, O. G., Babor, T. F., de la Feunte, J. R., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption-II. *Addiction*, *88*(6), 791-804. doi: 10.1111/j.1360-0443.1993.tb02093.x

Sayette, M. A., Martin, C. S., Perriot, M. A., Wertz, J. M., & Hufford, M. R. (2001). A test of the appraisal-disruption model of alcohol and stress. *Journal of Studies on Alcohol*, *62*(2), 247-256. Retrieved from www.jsad.com

Sharma, D., Albery, I. P., & Cook, C. (2001). Selective attentional bias to alcohol related stimuli in problem drinkers and non-problem drinkers. *Addiction*, *96*, 285-295. doi: 10.1080/09652140020021026

Sharma, D., & McKenna, F. P. (2001). The role of time pressure on the emotional Stroop task. *British Journal of Psychology*, *92*(3), 471-481. doi: 10.1348/000712601162293

Sichel, J. L., & Chandler, K. A. (1969). The color-world interference test: The effects of varied color-word combinations upon verbal response latency. *Journal of Psychology: Interdisciplinary and Applied, 72*(2), 219-231. Retrieved from www.tandfonline.com

Speilberger, C.D., Goursuch, R.L., Lushene, R., Vagg, P.R., & Jacobs, G.A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Speilberger, C.D., & Sydeman, S. J. (1994). State-Trait Anxiety Inventory and State-Trait Anger Expression Inventory. In M. E. Maruish (Ed.)., *The use of psychological testing for treatment planning and outcome assessment,* (pp. 292-321). Hillsdale, N. J.: L. Eelbaum Associates.

Strauss, G. P., Allen, D. N., Jorgensen, M. L., & Cramer, S. L. (2005). Test-retest reliability of standard and emotional Stroop tasks: An investigation of color-word and picture-word versions. *Assessment, 12*(3), 330-337. doi: 10.1177/1073191105276375

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*(6), 643-662. Retrieved from http://psychclassics.yorku.ca/Stroop/.

Storbeck, J., & Clore, G. L. (2007). On the interdependence of cognition and emotion. *Cognition and Emotion, 21*(6), 1212-1237. doi: 10.1080/02699930701438020

Taake, I., Jaspers-Fayer, F., & Liotti, M. (2009). Early frontal responses elicited by physical threat words in an emotional Stroop task: Modulation by anxiety sensitivity. *Biological Psychology, 81*(1), 48-57. doi: 10.1016/j.biopsycho.2009.01.006

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Allyn & Bacon.

Thorpe, S. J., & Salkovskis, P. M. (1997). Information processing in spider phobics: The Stroop colour-naming task may indicate strategic but not automatic attentional bias. *Behaviour Research and Therapy, 35*(2), 131-144. doi: 10.1016/S0005-7967(96)00093-9

Tzelgov, J., Henik, A., & Berger, J. (1992). Controlling Stroop effects by manipulating expectations for color words. *Memory & Cognition, 20*(6), 727-735. doi: 10.3758/BF03202722

Waters, A.J., & Feyerabend, C. (2000). Determinants and effects of attentional bias in smokers. *Psychology of Addictive Behaviours, 14*(2), 111-120. doi: 10.1037/0893-164X.14.2.111

Waters, A.J., Sayette, M.A., Franken, I.H., & Schwartz, J.E. (2005). Generalizability of carry-over effects in the emotional Stroop task. *Behaviour Research and Therapy, 43*(6), 715-732. doi: 10.1016/j.brat.2004.06.003

Waters, A.J., Sayette, M.A., & Wertz, J.M. (2003). Carry-over effects can modulate emotional Stroop effects. *Cognition and Emotion, 17*(3), 501-509. doi: 10.1080/02699930143000716

Watson, D., & Clark, L. A. (1984). Negative affectivity: The disposition to experience aversive emotional states. *Psychological Bulletin, 96*(3), 465-490. Retrieved from http://www.apa.org/pubs/journals/bul/index.aspx

Wertz, J. M., & Sayette, M.A. (2001). Effects of smoking opportunity on attentional bias in smokers. *Psychology of Addictive Behaviours*, *15*(3), 268-271. doi: 10.1037/0893-164X.15.3.268

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin, 120*(1), 3-24. doi: 10.1037/0033-2909.120.1.3

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and emotional disorders* (2nd ed.). Chichester, UK: Wiley.

Wilson, C., & Wallis, D. J. (2013). Attentional bias and slowed disengagement from food and threat stimuli in restrained eaters using a modified Stroop task. *Cognitive Therapy and Research*, *37*(1), 127-138. doi: 10.1007/s10608-012-9451-x

Wingenfeld, K., Bullig, R., Mensebach, C., Hartje, W., Driessen, M., & Belbo, T. (2006). Attention bias towards personally relevant stimuli: The individual emotional Stroop task. *Psychological Reports*, *99*(3), 781-793. doi: 10.2466/Pr0.99.3.781-793

Witthöft, M., Rist, F., & Bailer, J. (2008). Enhanced early emotional intrusion effects and proportional habituation of threat response for symptom and illness words in college students with elevated health anxiety. *Cognitive Therapy and Research*, *32*(6), 818-842. doi: 10.1007/s10608-007-9159-5

Wurm, L. H., Labouvie-Vief, G., Aycock, J., Rebucal, K. A., & Koch, H. E. (2004). Performance in auditory and visual emotional Stroop tasks: a comparison of older and younger adults. *Psychology and aging*, *19*(3), 523-535. doi: 10.1037/0882-7974.19.3.523

Wyble, B., Sharma, D., & Bowman, H. (2005). Modelling the slow emotional Stroop effect: Suppression of cognitive control. In A. Cangelosi, B. Guido & Borisyuk. R (Eds.), *Modeling language, cognition and action: Proceedings of the Ninth Neural Computation and Psychology Workshop* (pp. 291-300). River Edge, N.J.: World Scientific Publishing Co.

Wyble, B., Sharma, D., & Bowman, H. (2008). Strategic regulation of cognitive control by emotional salience: A neural network model. *Cogntion and Emotion*, *22*(6), 1019-1051. doi: 10.1080/02699930701597627

Yiend, J. (2010). The effects of emtoion on attention: A review of attentional processing of emotional information. *Cognition and Emotion, 24*(1), 3-47. doi: 10.1080/02699930903205698

Appendix A: Human Research Ethics Approval Form

Human Research Ethics Committee

Committee Approval Form

Principal Investigator/Supervisor: Associate Professor Anne Tolan Brisbane Campus

Co-Investigators: Dr Xochitl De la Piedad Garcia, Dr Kate Mulgrew (USC)

Student Researcher: Ms Jess Marrington Brisbane Campus

Ethics approval has been granted for the following project:

Differential factors related to the cause and duration of attentional bias in the Emotional Stroop Task. (Health status and RT to coloured words.)

for the period: 23 April 2010 to 30 May 2012

Human Research Ethics Committee (HREC) Register Number: Q2010 27

The following standard conditions as stipulated in the *National Statement on Ethical Conduct in Research Involving Humans* (2007) apply:

(i) that Principal Investigators / Supervisors provide, on the form supplied by the Human Research Ethics Committee, annual reports on matters such as:

- security of records
- compliance with approved consent procedures and documentation
- compliance with special conditions, and

(ii) that researchers report to the HREC immediately any matter that might affect the ethical acceptability of the protocol, such as:

- proposed changes to the protocol
- unforeseen circumstances or events
- adverse effects on participantThe HREC will conduct an audit each year of all projects deemed to be of more than low risk. There will also be

random audits of a sample of projects considered to be of negligible risk and low risk on all campuses each year.

Within one month of the conclusion of the project, researchers are required to complete a *Final Report Form* and submit it to the local Research Services Officer.

If the project continues for more than one year, researchers are required to complete an *Annual Progress Report Form* and submit it to the local Research Services Officer within one month of the anniversary date of the ethics approval.

Signed: K. Pashley. ..... Date: 23 April 2010

(Research Services Officer, McAuley Campus)

Ethics Register Number : Q2010 27
Project Title : Differential factors related to the cause and duration of attentional bias in the Emotional Stroop Task. (Health status and reaction time to coloured words.)
Data Collection Date Extended : 31/03/2014

Appendix B: Information Letter and Consent Instructions used in Experiments 1 and 3

Word Rating Survey

INFORMATION LETTER TO PARTICIPANTS

TITLE OF PROJECT: Differential Factors Related to the Cause and Duration of Attentional Bias in the Emotional Stroop Task.
SUPERVISOR: Associate Professor Anne Tolan

STUDENT RESEARCHER: Jessica Marrington

PROGRAMME IN WHICH ENROLLED: Doctor of Philosophy

Dear Participant,

You are invited to participate in the initial stage of a PhD research project investigating factors that contribute to biases of attention in the Emotional Stroop task. Specifically, this study aims to get both arousal and valence(or emotion) ratings for the words to be used in the Emotional Stroop task. Participation in this project requires completion of a brief demographic questionnaire along with a survey whereby you are required to rate a list of words.

It is not expected that there will be any adverse risks experienced as a result of participation in this study. Participation in this study may take up to approximately 20 minutes of your time.

If you choose to participate in this study, you will be asked a few brief demographic questions. You will then be presented with a list of words. Firstly, you will be asked on a scale of 1 (low) to 9 (high) how arousing you think the words are. Secondly, you will be asked on a scale of 1 (negative) to 9 (positive) what valence you think the words are. You do not need to spend a lot of time on each word rating, just indicate what rating initially comes to mind.

Those participants who are enrolled in psychology at Australian Catholic University may be eligible for course credit for participating in this project. Individuals from the wider community will not receive any incentives to participate in this study. While no direct benefits for participation will be offered, it is highly likely that results from this study will be published in psychological journals and significantly contribute to the literature, enhancing the understanding of factors which contribute to biases of attention.

Participation in this research project is voluntary. You can withdraw from the study at any stage without giving a reason. Any withdrawal from the research will not prejudice academic progress or your future interactions with the university.

Anonymity will be maintained during the study and in any report of the data. Individual participants will not be able to be identified in any publications arising from the research, with only aggregated data reported.

Any questions regarding this project should be directed to Associate Professor Anne Tolan and Jessica Marrington:

Associate Professor Anne Tolan/ Jessica Marrington
(07) 3623 7256
School of Psychology
1100 Nudgee Road
Banyo QLD 4014

If you wish to discuss the project, or have any questions or comments relating to the project, you can contact either the Supervisor or Student Researcher. Additionally, if you wish to receive feedback on the results of the project you can contact either the Supervisor or Student Researcher however, individual results cannot be determined as all responses will be anonymous.

This study has been approved by the Human Research Ethics Committee at Australian Catholic University. In the event that you have any complaint or concern, or if you have any query that the Supervisor and Student Researcher have not been able to satisfy, you may write to the Chair of the Human Research Ethics Committee care of the nearest branch of the Research Services Office.

Chair, HREC
C/- Research Services
Australian Catholic University
Brisbane Campus
PO Box 456
Virginia QLD 4014
Tel: (07) 3623 7429
Fax: (07) 3623 7328

Any complaint or concern will be treated in confidence and fully investigated. The participant will be informed of the outcome.

If you agree to participate in this project the completion and submission of the questionnaire will constitute your consent to participate. Your participation in this research project will be most appreciated.

Appendix C: Demographic Questionnaire used in Experiments 1 and 3

***1)**
What is your current age?

--Select--

***2)**
Are you male or female?

--Select--

***3)**
What was your first learnt language?

--Select--

***4)**
Which of the following best describes your current employment status?

--Select--

***5)**
Which of the following best describes your current study load?

--Select--

0			1	1259867	136425
1	0	32000	5	83305	Word Rating Surv
False	True	1778235	preview	0	0
1	0	1			

Continue ONLY when finished. You will be unable to return or change your answers.

powered by www.psychdata.com

Appendix D: List of Words Used in Experiment 1

Table D1

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
POSITIVE									ANIMALS								
elated	0.27	6	74	5.18	2.39	72	7.42	1.86	gerbil	0.75	6	37	2.27	1.90	37	4.16	1.50
agility	0.45	7	77	4.08	2.13	73	6.34	1.47	echidna	0.76	7	36	2.89	1.83	35	5.49	1.34
soothe	1.29	6	73	4.36	2.15	72	7.38	1.58	walrus	1.12	6	39	3.38	2.39	36	5.75	1.70
joyful	1.49	6	75	6.01	2.33	71	8.01	1.33	badger	1.75	6	37	2.62	1.88	37	4.41	1.61
radiant	2.16	7	75	5.99	1.94	71	7.61	1.37	cheetah	2.29	7	36	4.75	2.09	35	5.49	1.65
hopeful	2.98	7	75	5.77	2.14	71	7.70	1.41	dolphin	2.76	7	36	3.75	2.50	35	6.17	1.42
bliss	3.14	5	75	5.52	2.41	74	8.07	1.25	camel	5.02	5	38	2.32	1.76	37	4.95	1.22
lively	4.06	6	73	4.95	2.23	72	7.01	1.45	beaver	4.82	6	38	3.21	2.27	37	4.76	1.44
triumph	4.65	7	74	5.41	2.23	72	7.44	1.57	leopard	5.41	7	39	5.03	2.11	36	6.31	1.70
inspired	7.65	8	73	6.03	2.04	72	7.69	1.25	squirrel	5.47	8	36	3.19	1.92	35	5.37	1.90
Averages	2.81	6.50	74.40	5.33	2.20	72.00	7.47	1.45		3.02	6.50	37.20	3.34	2.06	36.00	5.28	1.55

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
NEGATIVE									SPACE								
shamed	0.86	6	75	4.52	2.34	74	2.16	1.17	uranus	0.69	6	37	3.27	2.46	37	4.97	1.44
enraged	0.69	7	72	6.51	2.08	71	1.94	1.49	density	1.43	7	36	2.89	2.50	35	4.86	1.75
deceit	1.86	6	75	5.16	2.52	74	2.00	1.28	crater	2.59	6	38	2.89	1.69	37	3.84	1.26
sinful	1.71	6	73	5.18	2.35	72	2.78	1.72	saturn	1.51	6	36	3.06	2.16	35	5.17	1.58
neglect	1.69	7	74	5.59	2.41	73	1.95	1.40	neptune	2.67	7	37	2.73	1.91	37	5.35	1.74
fearful	2.16	7	74	5.32	2.09	72	2.07	1.14	eclipse	2.82	7	39	5.31	2.45	36	7.00	1.79
Agony	3.75	5	76	5.96	2.47	73	1.62	.99	pluto	3.04	5	36	2.11	1.49	36	4.78	1.29
hatred	5.41	6	75	6.65	2.18	71	1.41	.98	meteor	3.53	6	39	4.87	2.38	36	4.81	2.24
despise	4.51	7	75	5.99	2.32	71	1.82	1.31	jupiter	4.04	7	36	2.78	1.76	35	5.40	1.19
rejected	6.61	8	75	5.81	2.51	74	1.58	1.02	asteroid	1.69	8	38	3.45	2.46	37	4.14	1.51
Averages	2.93	6.50	74.40	5.67	2.33	72.50	1.93	1.25		2.40	6.50	37.20	3.34	2.13	36.10	5.03	1.58

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
COUNTRIES									INSTUMENTS								
monaco	0.75	6	38	3.26	2.30	37	5.43	1.57	chimes	1.71	6	36	3.47	1.96	35	5.71	1.02
ireland	0.43	7	36	4.06	2.40	35	5.97	1.58	maracas	0.14	7	39	3.92	2.46	36	5.97	1.99
norway	1.73	6	36	3.22	2.63	35	5.83	1.77	fiddle	3.63	6	37	2.57	1.94	37	4.86	1.51
cyprus	1.88	6	37	2.51	1.80	37	5.03	1.28	rattle	3.37	6	36	4.06	1.85	35	4.34	1.16
bahamas	2.14	7	39	5.56	2.59	36	7.33	1.62	bagpipe	0.29	7	37	3.03	2.52	37	4.65	1.69
austria	2.86	7	38	3.00	2.25	37	5.30	1.61	piccolo	1.27	7	38	2.63	2.05	37	5.05	1.27
kenya	2.37	5	36	2.83	2.10	35	4.77	1.29	flute	2.12	5	36	2.56	1.89	35	5.43	1.70
greece	4.41	6	37	2.76	2.10	37	5.41	1.71	violin	4.75	6	36	2.92	1.86	35	5.63	1.85
jamaica	3.71	7	36	4.08	2.42	35	6.03	1.72	trumpet	4.12	7	38	3.32	2.31	38	4.89	1.69
colombia	1.96	8	39	2.90	2.07	39	4.67	1.66	clarinet	1.57	8	39	2.79	2.12	36	5.42	1.75
Averages	2.22	6.50	37.20	3.42	2.27	36.30	5.58	1.58		2.30	6.50	37.20	3.13	2.10	36.10	5.20	1.56

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
				FLOWERS									ACCOMODATION				
wattle	0.92	6	36	2.44	1.80	35	5.26	1.72	villas	0.24	6	38	2.92	2.14	37	5.73	1.59
stamens	0.02	7	36	2.11	1.37	35	5.03	.89	caravan	1.45	7	36	2.61	1.73	35	4.77	1.57
tulips	1.14	6	37	3.89	2.44	37	7.00	1.41	hostel	0.57	6	36	2.75	1.75	35	4.09	1.82
orchid	2.16	6	36	3.56	2.01	35	6.37	1.68	camper	1.43	6	37	2.51	1.77	37	5.00	1.55
daisies	1.53	7	38	3.24	2.15	37	6.68	1.56	chattel	0.29	7	39	2.13	1.73	36	4.50	1.06
petunia	2.08	7	36	2.67	1.49	35	5.57	1.40	cottage	5.29	7	39	3.23	1.95	36	6.11	1.35
poppy	3.96	5	39	3.38	2.22	36	6.06	1.69	shack	5.65	5	38	2.84	2.01	38	4.55	1.46
lilies	1.9	6	38	3.26	2.38	37	6.54	1.45	resort	6.9	6	36	4.44	2.14	36	7.31	1.33
blossom	3.61	7	37	3.70	2.04	37	6.68	1.47	mansion	6.45	7	37	4.68	2.48	37	6.43	1.80
daffodil	0.2	8	39	3.72	2.11	36	6.86	1.55	barracks	4.43	8	36	3.14	1.91	35	4.40	1.38
Aver.	1.75	6.50	37.20	3.20	2.00	36.00	6.20	1.48		3.27	6.50	37.20	3.13	1.96	36.20	5.29	1.49

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
WEATHER									FASHION								
breezy	0.78	6	38	3.82	2.09	37	6.11	1.41	thongs	0.47	6	36	3.00	2.06	35	5.14	1.38
snowing	2.98	7	36	3.33	1.94	36	6.06	1.94	mittens	1.02	7	36	3.28	2.28	35	5.94	1.33
Aurora	2.45	6	36	4.25	2.20	35	6.34	1.47	blazer	1.22	6	37	2.08	1.48	37	4.59	1.40
stormy	1.45	6	39	6.03	2.05	36	4.86	2.59	tights	2.65	6	36	2.83	2.01	35	5.00	1.66
cloudy	2.16	6	39	3.87	2.02	36	4.44	1.78	sandals	1.73	7	38	2.16	1.70	37	5.03	1.28
climate	3.53	7	37	3.35	1.93	37	5.14	1.55	earring	2.71	7	39	2.82	1.85	36	5.56	1.59
humid	0.88	5	36	4.08	2.18	36	3.36	1.25	scarf	4.69	5	36	2.69	1.82	35	5.43	1.50
autumn	3.78	6	37	3.84	2.52	37	6.24	1.57	blouse	5.33	6	39	2.56	1.85	36	5.28	1.30
rainbow	7.98	7	38	4.00	2.45	37	7.00	1.39	watches	7.96	7	37	2.16	1.52	37	4.92	1.16
sunlight	4.63	8	36	5.56	2.34	35	7.69	1.64	umbrella	7.49	8	38	2.16	1.35	37	4.51	1.12
Aver.	3.06	6.40	37.20	4.21	2.17	36.20	5.72	1.66		3.53	6.50	37.20	2.57	1.79	36.00	5.14	1.37

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
TRANSPORT									FURNITURE								
glider	0.69	6	37	3.03	2.32	37	5.16	1.62	stools	0.67	6	36	2.75	1.86	35	4.20	1.55
ferries	0.12	7	38	2.18	1.64	38	4.63	1.42	ottoman	0.31	7	36	2.61	1.68	36	5.33	1.66
trains	8.16	6	39	2.79	1.87	36	4.92	1.34	tuffet	0.14	6	38	1.92	1.50	37	4.43	1.30
vessel	9.35	6	38	2.55	1.66	37	4.78	.89	lounge	7.86	6	38	2.89	2.08	37	5.68	1.47
coaches	1.75	7	36	2.67	1.91	36	4.83	1.54	couches	0.43	7	37	2.76	2.22	37	5.73	1.61
chariot	2.02	7	39	4.10	2.10	36	5.31	1.51	dresser	3.57	7	39	2.10	1.37	36	5.03	1.13
taxis	1.02	5	36	2.83	1.76	35	3.91	1.25	bench	9.67	5	37	1.81	1.35	37	4.54	1.39
trucks	9.86	6	36	2.69	1.56	35	4.06	1.45	chairs	9.88	6	36	1.81	1.17	35	5.06	.91
bicycle	6.61	7	37	2.97	2.06	37	5.68	1.58	cabinet	8.33	7	36	1.86	1.22	35	4.37	1.48
vehicles	6	8	36	2.39	1.82	35	4.51	1.38	wardrobe	6.47	8	39	3.13	2.39	36	5.47	1.34
Aver.	4.56	6.50	37.20	2.82	1.87	36.20	4.78	1.40		4.73	6.50	37.20	2.36	1.68	36.10	4.98	1.38

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
				TERRAIN									TOOLS				
swamps	0.88	6	36	2.44	1.68	35	3.54	1.84	sander	0.53	6	38	2.03	1.57	37	4.14	1.25
jungles	0.71	7	36	3.50	1.84	35	5.26	1.50	ratchet	0.75	7	37	2.24	1.40	37	3.92	1.52
arctic	1.96	6	38	3.16	1.94	37	4.05	1.63	plough	1.06	6	39	2.49	1.57	36	4.11	1.47
plains	2.06	6	36	2.25	1.66	35	5.11	1.28	pliers	1.16	6	39	2.21	1.69	36	4.19	1.35
streams	1.57	7	38	3.58	2.24	37	6.68	1.68	grinder	1.27	7	36	2.83	1.96	35	3.54	1.50
forests	1.59	7	37	4.03	1.99	37	6.57	1.74	spanner	0.18	7	37	1.92	1.12	37	4.38	1.38
urban	4.65	5	39	3.05	1.86	36	5.22	1.55	spade	2.31	5	36	2.08	1.34	35	4.17	1.18
cities	8.78	6	39	3.41	2.20	36	5.53	1.34	wrench	3.96	6	36	3.42	2.17	35	3.74	1.27
beaches	4.1	7	37	5.73	2.36	37	7.19	1.35	compass	4.06	7	36	2.22	1.42	35	4.91	1.07
glaciers	0.16	8	36	3.61	1.98	35	5.46	1.65	chainsaw	1.08	8	38	3.84	2.26	37	3.38	1.71
Aver.	2.65	6.50	37.20	3.48	1.98	36.00	5.46	1.56		1.64	6.50	37.20	2.53	1.65	36.00	4.05	1.37

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
			CONSTRUCTION									ELECTRICAL					
thatch	0.75	6	36	1.81	1.19	35	4.29	1.41	juicer	0.39	6	39	2.95	1.89	36	5.47	1.42
plywood	0.45	7	39	1.64	1.06	36	4.31	1.33	blender	1.67	7	36	2.50	1.72	35	4.63	1.59
gravel	1.43	6	38	2.18	1.43	37	4.03	1.26	scales	2.02	6	37	2.05	1.51	37	4.49	1.30
lumber	2.47	6	37	2.05	1.51	37	4.51	1.17	kettle	2.8	6	39	2.08	1.31	36	5.00	1.60
fencing	1.37	7	36	2.14	1.38	35	4.40	1.17	printer	2.1	7	38	2.05	1.66	37	4.38	1.21
granite	1.59	7	36	3.00	2.16	35	4.94	1.41	scanner	2.94	7	37	2.00	1.75	37	4.35	1.27
fibre	0.65	5	39	2.36	1.69	36	4.86	1.51	dryer	4.53	5	36	2.64	1.50	35	5.00	.97
cement	4.59	6	37	2.05	1.73	37	4.38	1.42	vacuum	5.76	6	36	2.75	2.05	35	4.06	1.61
plaster	2.63	7	36	2.28	1.65	35	4.63	.91	freezer	5.16	7	36	2.81	1.67	35	4.37	1.35
concrete	7.43	8	38	1.74	1.08	37	4.38	1.36	keyboard	1.8	8	38	2.71	2.01	37	4.78	1.44
Aver.	2.34	6.50	37.20	2.13	1.49	36.00	4.47	1.29		2.92	6.50	37.20	2.45	1.71	36.00	4.65	1.38

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Fre	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
SPORTS									OCCUPATIONS								
discus	0.24	6	38	2.50	1.75	37	4.57	1.44	typist	0.82	6	38	1.95	1.41	37	4.32	1.23
archery	0.78	7	37	2.24	1.69	37	4.92	1.23	builder	0.94	7	36	2.42	1.66	35	5.09	.98
rowing	1.27	6	36	2.78	1.93	35	4.51	1.70	tailor	4.18	6	37	1.97	1.30	37	4.78	1.34
sprint	0.71	6	36	4.58	2.32	35	5.03	1.48	pastor	4.29	6	36	3.06	1.94	35	4.57	1.85
croquet	0.86	7	38	1.71	1.01	37	4.54	1.14	mailman	2.88	7	39	1.85	1.18	39	4.87	1.58
cricket	2.82	7	39	2.74	2.23	36	4.61	1.79	courier	3.29	7	36	2.25	1.42	35	4.43	1.38
rugby	0.86	5	39	3.46	2.09	39	4.97	2.02	valet	5.16	5	37	1.84	1.42	37	4.92	1.46
squash	4.37	6	36	2.42	1.32	35	4.31	1.37	banker	4.76	6	38	2.47	1.81	37	4.03	1.48
surfing	4.51	7	37	3.92	2.59	37	6.27	1.77	referee	3.59	7	39	2.72	1.72	36	4.50	1.44
climbing	7.88	8	36	3.69	2.23	35	5.14	1.29	mechanic	5.06	8	36	2.86	1.93	35	4.74	1.48
Aver.	2.43	6.50	37.20	3.01	1.92	36.30	4.89	1.53		3.50	6.50	37.20	2.34	1.58	36.30	4.63	1.42

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

Table D1 (continued)

Words Included in the Word Selection Study with Length, Frequency of Occurrence in the English Language, Arousal, and ValenceRatings

Word	Freq	Len	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*	Word	Freq	Leng	n(Ar)	Ar*M*	Ar*SD*	n(Val)	Val*M*	Val*SD*
STATIONARY									ELEMENTS								
rulers	0.53	6	36	1.78	1.20	35	3.94	1.26	alkali	0.35	6	37	1.81	1.33	37	4.16	1.28
notepad	0.16	7	36	2.14	1.73	35	4.94	.91	sulphur	0.84	7	38	3.21	2.33	37	2.65	1.40
eraser	1	6	36	1.81	1.14	36	4.11	1.30	iodine	1.25	6	39	2.05	1.43	36	3.75	1.44
folder	1.63	6	39	1.79	1.22	36	4.56	1.58	helium	1.43	6	38	2.50	1.59	37	5.05	1.22
markers	2.35	7	37	2.16	1.89	37	4.76	1.71	lithium	1.18	7	39	3.95	2.44	36	3.89	1.86
pencils	2.84	7	38	2.16	1.57	37	4.59	1.40	silicon	1.71	7	36	3.39	2.51	35	4.77	1.24
clips	2.18	5	36	2.03	1.25	35	4.69	1.16	alloy	1.02	5	37	1.97	1.42	37	4.41	1.28
staple	1.12	6	39	1.51	.85	36	3.89	1.41	carbon	5.24	6	36	2.78	2.04	35	4.80	1.64
journal	8.88	7	37	2.78	2.21	37	5.16	1.69	calcium	1.76	7	36	2.58	1.89	35	4.97	.79
scissors	6.69	8	38	2.71	1.84	37	4.11	1.29	hydrogen	2.67	8	36	3.22	2.36	35	4.86	1.77
Aver.	2.74	6.50	37.20	2.09	1.49	36.10	4.47	1.37		1.75	6.50	37.20	2.75	1.93	36.00	4.33	1.39

Note. Freq = Frequency of occurrence in the English language; Len = Length; Ar = arousal; Val = valence; Aver. = Averages

AUSTRALIAN CATHOLIC UNIVERSITY

Appendix E: Information Letter and Consent Form for Experiment 2, 3, and 5

INFORMATION LETTER TO PARTICIPANTS

TITLE OF PROJECT: Health Status and RT

SUPERVISOR: Associate Professor Anne Tolan

STUDENT RESEARCHER: Jessica Marrington

PROGRAMME IN WHICH ENROLLED: Doctor of Philosophy

Dear Participant,

You are invited to participate in a PhD research project investigating health status and RT to coloured words. Specifically, this study aims to examine cognitive processes involved in the processing of certain information. Participation in this project requires completion of a modified Stroop task, a brief demographic questionnaire and a self-report inventory.

It is not expected that there will be any adverse risks experienced as a result of participation in this study. Participation in this study may take up to approximately 30 minutes of your time.

If you chose to participate in this study, you will firstly be asked to complete a modified Stroop task on a computer. This task requires you to respond as quickly and as accurately as possible to the colour of ink in which a word appears. This will take approximately ten minutes to complete. You will then be asked to complete the respective questionnaires which should take no longer than 10 minutes. Testing will be arranged for a mutually convenient time, on campus at Australian Catholic University.

Those participants who are enrolled in psychology at Australian Catholic University may be eligible for course credit for participating in this project. Individuals from the wider community will not receive any incentives to participate in this study. While no direct benefits for participation will be offered, it is highly likely that results from this study will be published in psychological journals and significantly contribute to the literature, enhancing the understanding of heath status and information processing.

Participation in this research project is voluntary. You can withdraw from the study at any stage without giving a reason. Any withdrawal from the research will not prejudice academic progress or your future interactions with the university.

Confidentiality will be maintained during the study and in any report of the data. All participants will be given codes and names will not be retained with the data. Individual participants will not be able to be identified in any publications arising from the research, as only aggregated data will be reported.

Any questions regarding this project should be directed to Associate Professor Anne Tolan and Jessica Marrington:

Associate Professor Anne Tolan/ Jessica Marrington
(07) 3623 7256
School of Psychology
1100 Nudgee Road
Banyo QLD 4014

If you wish to receive feedback on the results of the project you will be able to contact either the Supervisor or Student Researcher however, individual results cannot be determined as these will be coded to protect confidentiality. You will also have the opportunity to discuss your participation and the project in general after completion of the experiment.

This study has been approved by the Human Research Ethics Committee at Australian Catholic University. In the event that you have any complaint or concern, or if you have any query that the Supervisor and Student Researcher have not been able to satisfy, you may write to the Chair of the Human Research Ethics Committee care of the nearest branch of the Research Services Office.

Chair, HREC
C/- Research Services
Australian Catholic University
Brisbane Campus PO Box 456
Virginia QLD 4014
Tel: (07) 3623 7429
Fax: (07) 3623 7328

Any complaint or concern will be treated in confidence and fully investigated. The participant will be informed of the outcome.

If you agree to participate in this project, you should sign both copies of the Consent Form, retain one copy for your records and return the other copy to the Student Researcher. Your participation in this research project will be most appreciated.

……………………………………….. ……………………………………….
Associate Professor Anne Tolan Student Researcher Jessica Marrington

CONSENT FORM
Copy for Participant to Keep

TITLE OF PROJECT: Health Status and RT

SUPERVISOR: Associate Professor Anne Tolan

STUDENT RESEARCHER: Jessica Marrington

I .... *(the participant)* have read (*or, where appropriate, have had read to me)* and understood the information provided in the Letter to Participants. Any questions I have asked have been answered to my satisfaction. I agree to participate in this project, which involves completing a modified Stroop task, a brief demographic questionnaire, and a self-report inventory. I am aware that the activity may take up 30 minutes to complete. I realise that I can withdraw my consent at any time without penalty. I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify me in any way.

NAME OF PARTICIPANT: ....

SIGNATURE: .... DATE ....

SIGNATURE OF SUPERVISOR:..

DATE:…………………...

SIGNATURE OF STUDENT RESEARCHER:...

DATE:..........................…...

CONSENT FORM
Copy for Researcher to Keep

TITLE OF PROJECT: Health Status and RT

SUPERVISOR: Associate Professor Anne Tolan

STUDENT RESEARCHER: Jessica Marrington

I .... *(the participant)* have read (*or, where appropriate, have had read to me)* and understood the information provided in the Letter to Participants. Any questions I have asked have been answered to my satisfaction. I agree to participate in this project, which involves completing a modified Stroop task, a brief demographic questionnaire, and a self-report health inventory. I am aware that the activity may take up 30 minutes to complete. I realise that I can withdraw my consent at any time without penalty. I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify me in any way.

NAME OF PARTICIPANT: ....

SIGNATURE: .... DATE ....

SIGNATURE OF SUPERVISOR:..

DATE:…………………………

SIGNATURE OF STUDENT RESEARCHER:...

DATE:...........................……

Appendix F: Demographic Questionnaire utilised in Experiments 2, 3 and 5

Demographic questionnaire

Participant number:

What is your current age?

Are you male of female (please circle): Male Female

What was your first learnt language?

Appendix G: Normality Investigation for Experiment 2

This is a detailed account of the normality investigation which was done prior to the analyses for Experiment 2a. Normality for each anxiety group is presented below.

Low anxious

The Shapiro-Wilk test for normality indicated potential issues with normality on Position 5 in the positive emotion sequence at 2000 ms (p =.047). Standardised values of skew and kurtosis values indicated normality was not problematic.

State anxious

The Shapiro-Wilk test for normality indicated potential problems with normality on Position 3 in the positive emotion sequence at 1000 ms (p =.018), and on Position 2 in the positive emotion sequence at 2000 ms (p =.044). Standardised values of skew and kurtosis values for each of these variables indicated normality was not problematic.

Trait anxious

The Shapiro-Wilk test for normality indicated potential problems with normality on Position 3 for the negative (p =.020) word sequence at 32 ms, Position 2 (p =.043), three (p =.050), and four (p =.039) for the positive emotion sequence at 32 ms; position 1 (p =.012) and 3 (p =.029) for the neutral word sequence at 32 ms; Position 5 for the positive emotion sequence at 1000 ms (p =.017), and Position 3 for the positive emotion sequence at 2000 ms (p =.010). Standardised values of skew and kurtosis values for each of these variables indicated normality was not problematic.

State-trait anxious

The Shapiro-Wilk test for normality indicated potential problems with normality on Position 2 (p =.044), 3 (p =0.39), and 5 (p =.042) for the negative emotion sequence at 32 ms; Position 3 for the neutral sequence at 32 ms (p =.018); Position 3 (p =.029) and 5 (p =.002) for the negative emotion sequence at 1000 ms ; Position 1 (p =.003), 3 (p =.010), 4 (p =.002), and 5 (p =.070) for the neutral sequence at 1000 ms ; Position 1 (*p* =.011), 2 (*p* =.021), and 4 (*p* =.001) for the negative emotion sequence at 2000 ms ; position 4 (*p* =.030) and 5 (*p* =.005) for the positive emotion sequence at 2000 ms . Standardised skew and kurtosis values revealed normality was still problematic on Position 5 for the negative emotion sequence at 1000 ms with normality effected by positive skew (z_{skew}= 3.52); Position 1 for the neutral word sequence at 1000 ms with the distribution positively skewed (z_{skew}= 4.55) and leptokurtotic ($z_{kurtosis}$= 4.63); Position 3 for the neural word sequence at 1000 ms with the distribution leptokurtotic ($z_{kurtosis}$= 4.71); Position 4 for the negative emotion sequence at 2000 ms with the distribution positively skewed ($z_{kurtosis}$= 3.61). An examination of outliers revealed there were extreme scores across each of these variables, excluding Position 4 for the negative emotion sequence at 2000 ms . These extreme scores came from participants 28 (Position 5 for the negative emotion sequence at 1000 ms) and 104 (Position 1 for the neutral word sequence at 1000 ms and Position 3 for the neural word sequence at 1000 ms). Additionally, participant 17 was identified as an outlier on Position 1 for the neutral sequence at 2000 ms along with participant 28 on Position 3 for the neutral sequence at 32 ms. As a result these participants had their data removed from those respective positions, in an effort to restore normality. After deletion of the outliers, standardised skew and kurotisis values were recalculated. Skew was still problematic on Position 5 for the negative emotion sequence at 1000 ms , Position 1 for the neutral word sequence at 1000 ms and Position 4 for the negative emotion sequence at 2000 ms . Additionally there was still evidence of kurtosis on Position 1 for the neutral word sequence at 1000 ms and Position 3 for the neural word sequence at 1000 ms . Despite this, the extent of skew and kurtosis was reduced on each of these variables.

Appendix H: Anxiety Analyses between Participants in Experiments 2, 3, and 5

Table H1 presents the state and trait anxiety scores of Experiment 2, 3, and 5. As can be seen in the table, participants in Experiment 2 had higher state and higher trait anxiety scores.

Table H1

State and Trait Anxiety Scores for Experiment 2, 3, and 5

Anxiety Score	Experiment	*M*	*SD*
State	2	41.93	12.27
	3	36.76	9.54
	5	36.87	10.93
Trait	2	42.49	11.94
	3	41.69	9.65
	5	40.00	10.01

A 3 (Experiment: 2, 3, and 5) x 2 (Anxiety score: State and Trait) mixed factorial ANOVA was conducted to examine whether there were differences in the anxiety levels of participants between the three Stroop Experiments. There was a significant main effect of anxiety, $F(1, 293) = 24.92$, $p <.001$, $\eta_p^2 = .08$, observed power = .99, with participants across the three experiments reporting higher levels of trait anxiety ($M = 41.40$, $SE = 0.62$) in comparison to state anxiety ($M = 38.52$, $SE = 0.64$).

There was also a significant main effect of Experiment, $F(2, 293) = 4.20$, $p = .016$, $\eta_p^2 = .03$, observed power = .74, with participants reporting higher levels of anxiety in Experiment 2 ($M = 42.21$, $SE = .97$), followed by Experiment 3 ($M = 39.22$, $SE = .92$) and Experiment 5 ($M = 38.44$, $SE = .99$). The difference between the anxiety levels in Experiments 2 and 5 was significant ($p = .021$).

However, of most interest was the significant two-way interaction between anxiety level and experiment, $F(2, 293) = 4.97$, $p = .007$, $\eta_p^2 = .03$, observed power = .81. This interaction was followed up by comparing the state and trait anxiety levels between Experiments 2, 3, and 5. There were no significant differences between the trait anxiety scores of the experiments, $F(2, 293) = 1.37$, $p = .256$, $\eta_p^2 = .01$, observed power = .29. However, there were significant differences between the state anxiety scores of the experiments, $F(2, 293) = 7.18$, $p = .001$, $\eta_p^2 = .05$, observed power = .93. Pairwise comparisons revealed that individuals in Experiment 2 were significantly more state anxious, than individuals in both Experiments 3 ($p = .002$) and 4 ($p = .005$). There was no difference between the state anxiety levels of Experiments 2 and 5 ($p = 1.00$).

Appendix I: Anxiety Analyses between Anxiety groups within Experiments 2, 3, and 5

A series of one-way ANOVAs with Bonferroni adjusted pairwise mean comparisons (where appropriate) were conducted to test whether there were significant differences between the anxiety groups in each experiment with regards to levels of state and trait anxiety. These were conducted to ensure the anxiety groups differed on the relevant STAI aspect (where appropriate). For Experiments 2 and 3, it was expected that the low anxious and the trait anxious groups would have significantly lower state anxiety scores than the state anxious and state-trait anxious groups however no differences would be observed between the low anxious and trait anxious individuals with regards to state anxiety. It was also expected that the low anxious group and the state anxious group would have significantly lower trait anxiety scores than the trait anxious and state-trait anxious groups however no differences would be observed between the low anxious and state anxious individuals with regards to trait anxiety. For Experiment 5, it was expected that the anxious group would have significantly higher levels of state and trait anxiety levels in comparison to the low anxious group.

State anxiety scores in Experiment 2 did significantly differ between the groups (*M*s and *SD*s are presented in Chapter 6, section 6.2.1.1), $F(3, 93) = 49.99$, $p < .001$, $\eta_p^2 = .62$, observed power = .99. As expected, the low anxious and trait anxious individuals had significantly lower state anxiety scores than both the state and state-trait anxiety groups ($p < .001$ for each comparison). Also as predicted, there was no difference in the state anxiety scores between the low anxious and the trait anxious group ($p = .999$). Additionally, as expected, there was no difference in state anxiety scores between the state and state-trait groups ($p = .999$).

Trait anxiety scores in Experiment 2 did significantly differ between the groups (*M*s and *SD*s are presented in Chapter 6, section 6.2.1.1), $F(3, 93) = 50.57$, $p < .001$, $\eta_p^2 = .62$, observed power = .99. As expected, the low anxious and state anxious individuals had significantly lower trait anxiety scores than both the trait and state-trait anxiety groups (*p* <.001 for each comparison). Also as predicted, there was no difference in the trait anxiety scores between the low anxious and the state anxious group (*p* = .999). Additionally, as expected, there was no difference in trait anxiety scores between the trait and state-trait groups (*p* = .273).

State anxiety scores in Experiment 3 did significantly differ between the groups (*M*s and *SD*s are presented in Chapter 7, section 7.2.1.1), $F(3, 99)= 60.41$, $p <.001$, $\eta_p^2 = .65$, observed power = .99. As expected, the low anxious and trait anxious individuals had significantly lower state anxiety scores than both the state and state-trait anxiety groups (*p* <.001 for each comparison). There was also, however, a significant difference in the state anxiety scores between the low anxious and the trait anxious group (*p* = .039) with the trait anxious individuals reporting higher levels of state anxiety. As expected, there was no difference in state anxiety scores between the state and state-trait groups (*p* = .999).

Trait anxiety scores in Experiment 3 did significantly differ between the groups (*M*s and *SD*s are presented in Chapter 7, section 7.2.1.1), $F(3, 93)= 57.56$, $p <.001$, $\eta_p^2 = .64$, observed power = .99. As expected, the low anxious and state anxious individuals had significantly lower trait anxiety scores than both the trait and state-trait anxiety groups (*p* <.001 for each comparison). Also as predicted, there was no difference in the trait anxiety scores between the low anxious and the state anxious group (*p* = .999). There was, however, a significant difference in trait anxiety scores between the trait and state-trait groups (*p* = .001) with individuals in the state-trait group reporting higher levels of trait anxiety.

State anxiety scores in Experiment 5 were significantly higher (*M*s and *SD*s are presented in Chapter 9, section 9.2.1.1) for the anxious group in comparison to the low anxious group, $F(1,92) = 90.93$, $p <.001$, $\eta_p^2 = .50$, observed power = .99. Additionally, as expected, trait anxiety scores were also significantly higher for the anxious group in comparison to the low anxious group, $F(1,92) = 71.45$, $p < .001$, $\eta_p^2 = .44$, observed power = .99.