State-Trace Analysis of Associative Recognition:

Comparing Single-Process and Dual-Process Models

Nicholas Hamm

School of Psychology

The University of Adelaide

February 2014

Contents

Abstract v

Declaration vii

Acknowledgements viii

1 Associative Recognition Memory 1

1.1 Associations, Associative Memory & Associative Information 2

1.2 Recent Associative Recognition Research: The Single-Process versus Dual-Process Debate 4

1.2.1 The Unequal-Variance Signal-Detection Model: Development in Item Recognition 6

1.2.2 The Unequal-Variance Signal-Detection Model: Application to Associative Recognition 12

1.2.3 The High-Threshold Signal-Detection Model: Development in Item Recognition 14

1.2.4 The High-Threshold Signal-Detection Model: Application to Associative Recognition 19

1.2.5 The Single Process versus Dual-Process Debate: Summary 21

1.3 Unitisation 21

1.3.1 Unitisation Summary 28

1.4 Other Recent Models of Associative Recognition 30

1.5 Model Fitting 32

1.5.1 Single and Dual-Process Model-Fitting in Associative Recognition 34

1.5.2 Model Fitting Summary 39

2 State-Trace Analysis 41

2.1 State-Trace Analysis: General Introduction 41

2.2 State-Trace Analysis of Unidimensional and Bidimensional Models 43

2.3 Application to Models of Associative Recognition 49

2.3.1 Differential Activation and State-Trace Interpretation 52

2.4 Implementation 57

2.4.1 Outcome Space 57

2.4.2 Monotonic Regression 59

2.4.3 Bootstrapping 62

2.5 Summary 63

2.6 Thesis Overview 63

3 Experiment 1 – State-Trace Analysis of Non-Unitised Associative Recognition 65

3.1 Method 67

3.1.1 Participants 67

3.1.2 Design 68

3.1.3 Materials 68

3.1.4 Procedure 69

3.2 Results 72

3.2.1 Attention Study Task Performance 72

3.2.2 Associative Recognition Performance 72

3.2.3 State-Trace Analysis 75

3.3 Discussion 78

4 Experiment 2 – State-Trace Analysis of Unitised Associative Recognition 81

4.1 Method 83

4.1.1 Participants 83

4.1.2 Design 84

4.1.3 Materials 84

4.1.4 Procedure 86

4.2 Results 89

4.2.1 Working Memory Study Task Performance 89

4.2.2 Associative Recognition Performance 90

4.2.3 Unitisation 92

4.2.4 State-Trace Analysis 93

4.3 Discussion 96

5 Experiment 3 – Reinvestigating Unitisation 98

5.1 Method 99

5.1.1 Participants 99

5.1.2 Design 100

5.1.3 Materials 100

5.1.4 Procedure 101

5.2 Results 102

5.2.1 Associative Recognition Performance 102

5.2.2 Unitisation 105

5.2.3 State-Trace Analysis 106

5.3 Discussion 109

6 Experiment 4 – The Dimensionality of Unitised Morphed Face Stimuli 112

6.1 Method 116

6.1.1 Participants 116

6.1.2 Design 117

6.1.3 Materials 118

6.1.4 Procedure 120

6.2 Results 122

6.2.1 Associative Recognition Performance 122

6.2.2 Unitisation 125

6.2.3 Conditionalised ROC curves and State-Trace Analysis 126

6.2.4 State-Trace Analysis 129

6.3 Discussion 132

7 Discussion 137

7.1 Single-Process and Dual-Process Interpretation of Empirical Unidimensionality 139

7.2 The Implications of Unidimensional Associative Recognition 142

7.2.1 Unitisation 142

7.2.2 Neuroimaging Data and Lesion Studies 146

7.2.3 Other Models of Associative Recognition 148

7.3 Concluding Remarks 149

8 References 151

Appendix A 160

Appendix B 161

Appendix C 162

Appendix D 163

Appendix E 164

Abstract

The aim of this thesis is to investigate competing explanations of the processes underlying associative recognition. Like recognition memory for individual items, associative recognition is currently understood through two different classes of model. The first is the single-process model class which holds that associative recognition decisions are based on a continuum of associative memory strength. The second is the dual-process model class, which holds that associative recognition decisions are based on two sources of information, called familiarity and recollection. Familiarity is conceptualised as a fast-acting, context-free 'feeling of knowing', while recollection is said to be a slower, more conscious process allowing for the recall of detail and context. Familiarity may play a role in associative recognition through a mechanism called unitisation, whereby two distinct stimuli are bound into a single individual memory trace.

State-trace analysis is a method to determine the number of latent variables or processes that contribute to performance on a set of tasks, under mild assumptions. A critical diagnostic feature is the dimensionality of the state-trace plot – a plot of performance on one dependent variable against the other. If associative recognition depends on a single latent variable then manipulation of experimental factors affecting memory should result in a unidimensional state-trace plot. If associative recognition depends on two or more latent variables which are differentially affected by the experimental factors then a bidimensional state-trace will result. State-trace analysis therefore provides a method of discriminating a class of single-process models from a class of dual-process models.

State-trace analysis was applied to associative recognition in four experiments. Each experiment utilised two independent variables that previous research had suggested could differentially affect familiarity and recollection. Experiment 1 investigated associative recognition of word pairs by manipulating attention and study presentation frequency. Experiments 2 investigated associative recognition of word pairs under conditions designed to encourage unitisation by pairing an encoding-based unitisation manipulation with a working memory load manipulation. Experiment 3 manipulated the same unitisation instructions as well as varying study time. Experiment 4 examined the effect of unitisation using pairs of faces and manipulated visual similarity and study time.

State-trace analysis of the four experiments consistently revealed unidimensional state-trace plots. Using a recently developed monotonic regression statistical test, unidimensionality could not be rejected at either aggregate or individual participant level. Therefore, no evidence was found for the differential activation of familiarity and recollection in associative recognition. The results of this thesis are therefore consistent with a single-process account of associative recognition. These results also pose a challenge to dual-process models to identify alternate experimental manipulations that reveal the involvement of different component processes such as recollection and unitized familiarity.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for joint-award of this degree. I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968. I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library catalogue and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Nicholas Hamm

February 2014

Acknowledgements

Many people have provided support throughout my candidature, and I hope that this section may provide some measure of gratitude for the help that has been so graciously provided to me these past few years.

First, I would like to extend thanks to The University of Adelaide for providing the necessary resources, funding and structured development that led to me to and through my candidature. Many thanks especially to the teaching staff of Psychology and Philosophy who provided so much insight, guidance and inspiration.

I would like to thank my supervisors, Dr Anna Ma-Wyatt and especially Professor John Dunn. Without John, my candidature would have been far less rewarding and I owe a great deal of professional and personal development to his sustained efforts. I have learned a great deal from John and I am greatly appreciative of being able to serve under his supervision.

To Fernando, Victoria, Angela, Rachel, Dragana, Annemarie, my friends from the lab, with whom were had many enjoyable meetings, lunches and various other social events I will always remember. A special mention to my friend Matt, whose contact helped preserve my sanity.

And finally to my mother, who suffered through conversation after conversation about monotonicity and parameter estimation and various other topics, ever the patient sounding board. Of her continued support, both emotionally and financially, I am deeply grateful.