Slowing and Stopping in Schizophrenia

Presented By

Anna Suraev

B Psych (Hons)

(The University of Sydney)

This thesis is submitted to the
School of Psychology, University of Newcastle,
in fulfilment of the requirements of the degree of

Professional Doctorate in Clinical Psychology

July 2014
Declaration

1. The thesis contains no material which has been accepted for 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. I give consent to this copy of my thesis, when deposited in the University Library, being made available to this loan and photocopying subject to the provisions of the Copyright Act 1968.

2. I hereby certify that the work embodied in this thesis has been done in collaboration with other researchers. I have included as part of the thesis a statement clearly outlining the extent of collaboration, with whom and under what auspices.

3. I hereby certify that the work embodied in this thesis contains a published paper of which I am a joint author. I have included as part of the thesis a written statement, endorsed by my supervisor, attesting to my contribution to the joint publication.

4. The work in this thesis was carried out under the supervision of Professor Andrew Heathcote, Australian Professorial Fellow at the School of Psychology, the University of Newcastle; and Emeritus Professor Patricia Michie at the School of Psychology, the University of Newcastle.

5. The conduct of this research was approved by the Hunter New England Human Research Ethics Committee and the University of Newcastle Human Research Ethics Committee (approval number 12/07/18/4.05).

Signed:……………………………………. Date:……………………
Table of Contents

Acknowledgements
List of tables
List of figures
Structured abstract

1. A CRITICAL REVIEW OF THE LITERATURE 1

1.1 Schizophrenia 1
   1.1.1 Description of the illness 1
   1.1.2 Cognitive deficits in Schizophrenia 1
   1.1.3 Impact on functional outcomes 3
   1.1.4 The effect of antipsychotic medication on cognitive functioning 3
   1.1.5 The focus of the current literature review 4

1.2 Slowing in Schizophrenia 5
   1.2.1 Slowing of simple reaction time in Schizophrenia 5
   1.2.2 The introduction of choice 7
   1.2.3 A review of choice reaction time literature in Schizophrenia 10
   1.2.4 Variability in choice reaction time performance 14
   1.2.5 Motor slowing in Schizophrenia 16
   1.2.6 Summary 19

1.3 Stopping in Schizophrenia 19
   1.3.1 Executive functioning 19
   1.3.2 The stop-signal paradigm 20
   1.3.3 Measuring response inhibition in the stop-signal paradigm 21
   1.3.4 Response inhibition deficits in Schizophrenia 23
   1.3.5 Response inhibition and symptoms of Schizophrenia 26

1.4 The present study 27
   1.4.1 Scope of the experiment in the manuscript 27
   1.4.2 Meta-analysis 27
   1.4.3 Modelling approaches 28
1.4.4 Nature of the task used 33
1.4.5 Hypotheses 33

2. RESEARCH MANUSCRIPT 36

2.1 Abstract 37
2.2 Introduction 38
2.3 Meta-analysis of Choice RT Studies 41
2.4 Experiment 46
2.5 Method 47
   2.5.1 Participants 47
   2.5.2 Experimental Apparatus and Stimuli 49
   2.5.3 Psychometric measures 50
   2.5.4 Procedure 51
2.6 Results 51
   2.6.1 Sequential effects 52
2.7 Discussion 53
2.8 Model-based analysis 55
   2.8.1 The Drift-Diffusion Model (DDM) 56
   2.8.2 The Linear Ballistic Accumulator (LBA) model 60
   2.8.3 Results 62
   2.8.4 Parameter analysis 65
2.9 Discussion 67
2.10 General discussion 69
2.11 References 74
2.12 References for meta-analysis 88

3. EXTENDED DISCUSSION 96

3.1 The present study 96
3.2. Discussion of the findings 97
   3.2.1 Results of the meta-analysis 97
   3.2.2 Speed and accuracy of performance 98
3.2.3 Model-based analyses
3.2.4 Sequential effects
3.2.5 Flexibility in responding
3.2.6 Response caution
3.2.7 Motion perception in Schizophrenia
3.2.8 Correlations with other measures
3.2.9 Medication effects

3.3 Strengths and limitations
3.4 Future directions and recommendations
3.5 Clinical implications
3.6. Conclusion
3.7 Full reference list

4. APPENDICES

Appendix A: Diffusion Drift Model Parameter Analysis
Appendix B: Analysis of covariate effects
Appendix C: Extended Method section
Appendix D: Ethics Approval
Appendix E: Information and consent forms for clinical participants
Appendix F: Information and consent forms for control participants
Appendix G: Demographics questionnaire
Appendix H: Notes for Contributors
Acknowledgements

Firstly I would like to thank my wonderful supervisor Professor Andrew Heathcote. Without his help and support I would not have completed this thesis. I feel so lucky to have had Andrew’s guidance during my thesis journey as he is incredibly knowledgeable, supportive, and very reliable. Many times I have entered his office feeling worried about this research study and always left feeling reassured, more confident, and most importantly motivated. I have also had the privilege of having Emeritus Professor Patricia Michie’s input and collaboration in this project, as her extensive knowledge in the field has been extremely valuable in this project and helped to shape its direction. Of course this research project was a team effort and I would really like express my gratitude for all the help and support I received from Samuel Curley, Charlene Gong, and Jonathon Love, who were always so helpful, proactive and collaborative.

I would also like to acknowledge the Newcastle Community Mental Health Service for their support during the recruitment process, as this was not an easy task and the staff on the team were always warm, welcoming and extremely helpful. Similarly, I am very appreciative that we were able to access the Hunter Medical Research Institute during the recruitment for healthy participants.

To all the wonderful friends and family in my life, I cannot thank you enough for the love, care and support you have given me over the past three and a half years. You looked after me through the terrifying lows, the dizzying highs and the creamy middles. And for that I am entirely grateful. Without this support I would have not been able to cope through the difficult times. The past six months have been particularly testing as I have essentially been buried in a “study cave” almost every hour that I was not at work or asleep, and I cannot wait to return into the world of socialising and free time again. Thank you to my parents Marina and Val for all your sacrifices and hard work to ensure that my sister and I have been able to get access to all the education opportunities we have dreamt of. You risked a lot when you immigrated to Australia and words cannot express the gratitude that I feel for the life and opportunities that you have provided for us. To my darling boyfriend Thom, thank you for helping me get through this, I really could not have gotten through this without you. You were always so kind and patient during my “freak out” moments and always reassured me that I would get to the finish line…and here I am!
A big thank you goes out to my wonderful colleagues at STEPS. You were always there to lend an ear when I was panicking about deadlines or when things went wrong, and I am so grateful that I was able to have this support and encouragement in my workplace.
List of Tables

**Table 1:** Participant characteristics  48

**Table 2:** Definitions of model factors  55

**Table 3:** Definition of Drift-Diffusion Model (DDM) parameters (two left columns)  59

**Table 4:** Definition of LBA parameters (two left columns)  62
List of Figures

Figure 1: The Drift-Diffusion Model (DDM) for a left vs. right decision. 30

Figure 2: The Linear Ballistic Accumulator (LBA) model for a left vs. right decision. 31

Figure 3: Average RT for correct responses and percentage of correct responses for choice RT tasks. 43

Figure 4: The Drift-Diffusion Model (DDM) for a left vs. right decision. 58

Figure 5: The Linear Ballistic Accumulator (LBA) model for a left vs. right decision. 61

Figure 6: Error rates as a function of difficult and current and last stimulus (left or right motion) with superimposed model fits (left column DDM model, right column, LBA model). 64

Figure 7: RT distribution (10th, 50th and 90th percentiles) for correct responses as a function of difficult and current and last stimulus (left or right motion) with superimposed model fit (left column DDM model, right column LBA model). 65
Structured Abstract

Background: Individuals with Schizophrenia have been described to have extensive cognitive impairments that span across several domains and can significantly impact functional outcomes and quality of life. Slowing in reaction time paradigms has been consistently documented in Schizophrenia such as in simple and choice reaction time tasks. In addition to slowing, the performance by individuals with Schizophrenia in choice reaction time tasks has also been documented to be more variable and error prone relatively to healthy participants. Executive functioning deficits in Schizophrenia are profound and as a result, response inhibition difficulties have been reported across various paradigms. Model-based analysis have not yet been conducted in regards to choice reaction time performance in Schizophrenia, and this method has the potential of uncovering further underlying cognitive processes in decision-making. Method: A meta-analysis was conducted to extend and expand the investigations by Schatz (1999) to include information of accuracy and standard deviation as well as reaction time, and performance of participants with Schizophrenia and health control groups was compared. An experiment was also conducted that took place across two sessions on separate days. Nineteen participants with Schizophrenia or Schizoaffective disorder, as well as control participants matched by age and gender were recruited. In the first session, participants completed a choice reaction task, completed measures of working memory and premorbid intelligence, and participants with Schizophrenia also completed a clinical interview. The second session included a stop-signal task, data from which was not analysed further in the research manuscript due to the time-frame limitations of the project. The data from the choice reaction time task were fit by two cognitive models of choice processes: the Drift-Diffusion model (DDM, Ratcliff & McKoon, 2008) and the Linear Ballistic Accumulator model (LBA, Brown & Heathcote, 2008). Results: The meta-analysis revealed a consistent pattern of control groups performing faster and more accurately relative to
participants with Schizophrenia in choice reaction time tasks. Reaction time and accuracy comparisons from the experiment indicated that participants with Schizophrenia were slower and less accurate in their responding, however this finding was not significant. Model-based analyses revealed that the LBA fit the data better than the DDM and produced a greater number of significant results, which are described in further detail. Sequential effects were found in the Schizophrenia group and model-based analyses further confirmed a bias towards participants with Schizophrenia repeating the immediately past response. A positive correlation was found between mean reaction time and negative symptoms in the Schizophrenia group. Furthermore, the combined effects of the threshold and rate parameters in the model-based analysis suggested a differential response strategy occurring in the group of participants with Schizophrenia relative to controls. **Conclusions:** The findings in the present study echo previous reports of slower and less accurate performance in Schizophrenia in choice reaction time tasks. A more in-depth discussion is provided regarding the possible interpretations of the threshold and rate parameter results. Relevant research findings regarding perseveration, flexibility in responding, as well as motion perception deficits in Schizophrenia are described and integrated with the results obtained. Finally, the strengths and limitations of the present study are highlighted and recommendations for future research and the potential implications of the present study are proposed.