Evaluation of a continuum model of psychotic symptoms: Evidence from neuroanatomical, neuropsychological and clinical correlates

Margaret Tasma Nelson

A thesis submitted in total fulfillment of the degree of Doctor of Philosophy

December 2012
The Melbourne School of Psychological Sciences
The University of Melbourne
Abstract

The fully dimensional model of psychosis posits that schizotypal personality traits in psychologically healthy people lie on a continuum with the psychotic symptoms experienced by people with a psychotic illness. Therefore, it was anticipated that psychotic and psychotic-like symptoms would show similar correlates for both individuals with a psychotic illness and psychologically healthy individuals. The validity of this notion was evaluated across three studies, which examined relationships between positive symptom traits and a range of neuroanatomical, neuropsychological and psychological variables. Case participants involved in the three studies had a diagnosis of schizophrenia or schizoaffective disorder, and control participants were psychologically healthy.

In Study 1, comprehensive phenomenological information was acquired from cases ($n=20$) and controls ($n=30$) regarding the nature and frequency of positive symptom traits. Significant differences were identified between groups in terms of how they responded to and appraised their own positive psychotic and psychotic-like experiences. Four of these responses (immersion, external and impersonal attributions, and lack of social understanding) were also associated with the frequency and severity of positive psychotic and psychotic-like experiences across all participants’ lifetimes.

Study 2 examined both between-group differences and within-group relationships in relation to neurocognitive functioning. Cases ($n=167$) had significantly lower mean scores than controls ($n=222$) on measures of Full Scale IQ, immediate memory, visual construction, language, attention, delayed memory and working memory. Participants’ scores on a measure of working memory were
negatively associated with the frequency and severity of positive psychotic and psychotic-like experiences across their lifetimes.

In Study 3, diffusion weighted MRI was used to assess whether groups differed according to structural brain connectivity, and whether connectivity was related to the frequency and severity of psychotic and psychotic-like experiences. One measure of white matter connectivity (fractional anisotropy) was significantly lower for cases ($n = 93$) as compared to controls ($n = 80$) across diffuse areas of the brain. For control participants, fractional anisotropy measurements in the corpus callosum and inferior frontal and temporal areas were negatively associated with the frequency and severity of positive psychotic and psychotic-like experiences across participants’ lifetimes.

The findings of the three studies identified similar relationships for both cases and controls between positive symptom traits and a range of neuroanatomical, neuropsychological and psychological variables. These were taken to broadly support a fully dimensional model of schizotypy and psychosis.
Declaration

This is to certify that:

i. The thesis comprises only my original work towards the PhD.

ii. Due acknowledgement has been made in the text to all other material used.

iii. The thesis is fewer than 100 000 words in length, exclusive of tables, maps, bibliographies and appendices.

[Signature]
Acknowledgements

Firstly, I would like to thank my supervisors, Associate Professor Lisa Phillips and Dr. Marc Seal. In the last five years working with you both, I have learnt that the best way to deal with stress is with humour and with music. It is thanks to your support, encouragement and confidence that I have been able to begin a career in psychology. Not only are you my colleagues, my mentors and my friends, you are in every sense of the term, my professional parents.

Thank you to all those who had a role to play in the project. Including the architects of the Australian Schizophrenia Research Bank (ASRB), and those responsible for its maintenance. I would like to note the financial support of the Schizophrenia Research Institute (SRI). Thank you also to the Melbourne Neuropsychiatry Centre (MNC) for the provision of testing space. Similarly, I have the Murdoch Childrens Research Institute (MCRI) to acknowledge for both financial support and technical equipment. Thank you to those from The University of Melbourne, MNC, MCRI and SRI, who provided both labour and advice. Most notably; Associate Professor Graham Hepworth, Dr. Rachel Ellis, Dr. Chris Adamson, Dr. Richard Beare, Antonia Merritt, Rebecca Wilson, Sarah Gale, Danielle Lowe, Hannah Cross, Barbara Stachlewski, Stephanie Leota, Tony Dann, Jason Bridge, Janette Howell, Dr. Carmel Loughland, and especially Professor Christos Pantelis.

I would also like to thank my employers for their patience and understanding while I juggled work, study and placement commitments. Specifically; the Melbourne School
of Psychological Sciences, The University of Melbourne; the Child and Family Psychology Clinic, The Royal Children’s Hospital; and The Victorian Infant Hearing Screening Program, The Royal Children’s Hospital. In particular, thank you Dr. Zeffie Poulakis for providing me with employment opportunities to support my study, while remaining infinitely flexible and reasonable in the face of short-notice shift changes, holiday and conference leave. Also, thank you for reading my thesis manuscript and providing vital feedback.

Thanks to my dear friends and family whose support of me, and unending patience with me over the last four years, has been invaluable and incalculable. Dr. Niles Nelson, your pursuit of excellence is a constant inspiration, and you make my life richer, warmer, lighter and more interesting. Elizabeth Cruise Nelson – Mum, you laid the path that led us to here. Dr. John Lowe, thank you for orchestrating the AANEX software, and for writing my syntax, and for everything, and I love you.

Finally, thank you to all the participants both with psychosis and without, who shared their time and their stories with me. Within the first three weeks of recruitment I had an overwhelming response from participants, with over fifty consent forms signed and returned. This enthusiasm continued throughout the project, so much so that my colleagues were making remarks about how I had no right to complain about having too many volunteers. Participants were consistently reliable, open, honest, and committed in their involvement in psychosis research. Not only was this reflective of the professionalism and advocacy of the ASRB with whom participants had had prior contact, but it was also reflective of the wider community’s acknowledgment and understanding of the importance of psychosis research.
Table of Contents

List of Figures ............................................................................................................................................... 12
List of Tables .................................................................................................................................................. 19
List of Abbreviations ................................................................................................................................... 22
List of Appendices ......................................................................................................................................... 24

Chapter 1: Schizotypy and Psychosis ........................................................................................................ 25
  1.1. Psychosis ............................................................................................................................................... 25
  1.2. Categorical Notions of Psychosis ........................................................................................................ 26
  1.3. Traditional Conceptualizations of Schizotypy .................................................................................... 30
  1.4. The Quasi-Dimensional Approach .................................................................................................... 32
  1.5. The Fully Dimensional Approach ....................................................................................................... 35
  1.6. The Symptom Approach .................................................................................................................... 39
  1.7. Some Terminology .............................................................................................................................. 40
  1.8. The Fully Dimensional Approach: Evidence from the Literature .................................................... 42
      1.8.1. Genetic Research: Family, Twin and Adoption Studies .............................................................. 42
      1.8.2. Genetic Research: Molecular Genetics ....................................................................................... 47
      1.8.3. Neurocognitive Research .......................................................................................................... 49
      1.8.4. Environmental and Social Research ............................................................................................ 51
      1.8.5. Biological Research: Neuroanatomical Abnormalities ............................................................... 53

Chapter 2: Connectivity ................................................................................................................................. 59
  2.1. Brain Connectivity ............................................................................................................................... 59
  2.2. Brain Connectivity and Psychopathology .......................................................................................... 61
  2.3. Diffusion Weighted Imaging (DWI) .................................................................................................... 63
  2.4. Methods of Diffusion Weighted Imaging Analysis Part I: Constructing A Visual Representation ........................................................................................................................................................................ 65
2.4.1. Strengths and Limitations of Diffusion Tensor Imaging (DTI) ........................................65
2.4.2. Quantitative Measurements from Diffusion Tensor Imaging ........................................68
2.4.3. Alternatives to Diffusion Tensor Imaging .....................................................................70

2.5. Methods of Diffusion Weighted Analysis Part 2: Comparing Data Between
Groups ......................................................................................................................................72
   2.5.1. Whole Brain Versus Region of Interest Techniques ......................................................72
   2.5.2. Tractography ................................................................................................................74

Chapter 3: Cognition ..................................................................................................................76
   3.1. ‘Cognition’ and ‘Cognitions’ ..........................................................................................77
   3.2. Positive Anomalous Experiences and Cognition ............................................................78
   3.3. Positive Anomalous Experiences and Cognitions ............................................................79

Chapter 4: Aims and Hypotheses .............................................................................................85
   4.1. Aims and Hypotheses .......................................................................................................85

Chapter 5: Method ......................................................................................................................88
   5.1. Participants and Procedure ..............................................................................................88
   5.2. Measures ........................................................................................................................92
      5.2.1. Diagnostic Interview for Psychoses ..............................................................................92
      5.2.2. Wechsler Abbreviated Scale of Intelligence ...............................................................93
      5.2.3. Repeatable Battery for the Assessment of Neuropsychological Status .......................93
      5.2.4. Letter-Number Sequencing Task ...............................................................................94
      5.2.5. Schizotypal Personality Questionnaire .........................................................................94
      5.2.6. Appraisals of Anomalous Experiences Interview ......................................................95
   5.3. MRI Data Acquisition .....................................................................................................101
   5.4. DWI Preprocessing .........................................................................................................102

Chapter 6: Study 1 Results and Comment – An Investigation of the Relationship
between Cognitive Appraisals and Positive Anomalous Experiences ............................. 103
9.3. Linking the Neuroanatomical, the Neuropsychological, and the Clinical........193
9.5. Limitations...........................................................................................................200
9.6. Future Research....................................................................................................202
9.7. Conclusions...........................................................................................................203

References..................................................................................................................206
List of Figures

Figure 1. The fully dimensional approach to schizotypy. Diagrammatic representation adapted from Claridge and Beech (1995). ............................................ 36

Figure 2. Illustrations of the diffusion ellipsoid. Anisotropic diffusion is on the left and isotropic diffusion is on the right (sourced from Kubicki et al., 2007)......... 66

Figure 3. Graphic example of crossing fibers. Image shows i) bending, ii) fanning, iii) interdigitating, and iv) adjacent fiber bundles (sourced from Tournier et al., 2011). ........................................................................................................ 68

Figure 4. An example orientation plot comparing CSD and DTI. The image was constructed using data from a control participant involved in the present research. CSD is shown on the right and DTI on the left. .............................. 71

Figure 5. An example of the uncinate fasciculus constructed via CSD as compared to the DTI. Both images use probabilistic tractography. As can be seen, the tract constructed from DTI ends prematurely (left), whereas the tract constructed from CSD continues into the anterior frontal cortex (right). Data used in these images were from a control participant involved in the present research....... 75

Figure 6. Garety and colleagues’ (2001; 2007) cognitive model of the positive symptoms of psychosis (sourced from Garety et al., 2007).................................. 80

Figure 7. Summary of ASRB components completed by participants whose data were used in the present research................................................................. 91

Figure 8. The AANEX software interface. ............................................................... 98

Figure 9. Frequency distribution of the averaged AANEX Frequency/Intensity Ratings. ............................................................................................................ 105

Figure 10. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the first thinking
style item .................................................................................................................. 112

**Figure 11.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the second thinking style item ........................................................................................................ 112

**Figure 12.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the third thinking style item .................................................................................................................... 113

**Figure 13.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the fourth thinking style item ........................................................................................................ 113

**Figure 14.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the fifth thinking style item ........................................................................................................ 114

**Figure 15.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the sixth thinking style item ........................................................................................................ 114

**Figure 16.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the seventh thinking style item ..................................................................................................... 115

**Figure 17.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the eighth thinking style item ..................................................................................................... 115

**Figure 18.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the ninth thinking style item ..................................................................................................... 116
Figure 19. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the tenth thinking style item. ................................................................. 116

Figure 20. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the eleventh thinking style item. ................................................................. 117

Figure 21. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the twelfth thinking style item. ................................................................. 117

Figure 22. Frequency distribution of the SPQ Cognitive-Perceptual Factor. ........ 131

Figure 23. Frequency distribution of the SPQ Interpersonal Factor. ................. 131

Figure 24. Frequency distribution of the SPQ Disorganized Factor. ............... 132

Figure 25. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and WASI Full Scale IQ. ...... 137

Figure 26. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Immediate Memory Index. ....................................................................................... 138

Figure 27. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Constructional Index. ....................................................................................... 138

Figure 28. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Language Index. ....................................................................................... 139

Figure 29. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Attention Index.
Figure 30. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Delayed Memory Index.

Figure 31. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the LNS.

Figure 32. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and WASI Full Scale IQ.

Figure 33. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Immediate Memory Index.

Figure 34. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Constructional Index.

Figure 35. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Language Index.

Figure 36. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Attention Index.

Figure 37. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Delayed Memory Index.

Figure 38. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the Letter-Number Sequencing Task.

Figure 39. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the Letter-Number Sequencing Task.
between the SPQ Disorganized Factor and WASI Full Scale IQ. .................. 148

**Figure 40.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Immediate Memory Index. .................................................................................................................. 149

**Figure 41.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Constructional Index. 149

**Figure 42.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Language Index. 150

**Figure 43.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Attention Index. 150

**Figure 44.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Delayed Memory Index. ................................................................. 151

**Figure 45.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the Letter-Number Sequencing Task. .................................................................................................................. 151

**Figure 46.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and WASI Full Scale IQ. .................................................................................................................. 156

**Figure 47.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Immediate Memory Index. .................................................................................................................. 156

**Figure 48.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Constructional Index. .................................................................................................................. 157
**Figure 49.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Language Index. ................................................................. 157

**Figure 50.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Attention Index. ........................................................................... 158

**Figure 51.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Delayed Memory Index. ................................................................. 158

**Figure 52.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the LNS. ....... 159

**Figure 53.** Frequency distribution of the SPQ Cognitive-Perceptual Factor. ........ 171

**Figure 54.** Sagittal slice: Areas of the brain in which cases had significantly lower FA compared to controls. Image from FSLView (neurological orientation). MNI coordinates: $x = 14$; $y = 25$; $z = 91$................................................................. 173

**Figure 55.** Sagittal slice: Areas of the brain in which cases had significantly lower FA compared to controls. Image from FSLView (neurological orientation). MNI coordinates: $x = 14$; $y = 25$; $z = 91$................................................................. 173

**Figure 56.** Axial slice: Areas of the brain in which cases had significantly lower FA compared to controls. Image from FSLView (neurological orientation). MNI coordinates: $x = 14$; $y = 25$; $z = 91$................................................................. 174

**Figure 57.** Areas of the brain in which there was both significantly lower FA, and correspondingly higher RD for cases as compared to controls ($p < 0.1_{\text{FWE CORRECTED}}$). Images are from FSLView (neurological orientation). Reading left to right and top to bottom; axial slices represent coordinates $z = -24$, -4, 4, 24, 44, 46.
and 64.......................................................................................................................... 175

Figure 58. Coronal slice: Areas of the brain where there was a significant negative relationship between the SPQ Cognitive-Perceptual Factor and FA for the control group. Image obtained from FSLView (neurological orientation). MNI coordinates: \(x = 8, y = 15, z = 19\). ............................................................................................................. 176

Figure 59. Sagittal slice: Areas of the brain where there was a significant negative relationship between the SPQ Cognitive-Perceptual Factor and FA for the control group. Image obtained from FSLView (neurological orientation). MNI coordinates: \(x = 8, y = 15, z = 19\). ............................................................................................................. 177

Figure 60. Axial slice: Areas of the brain where there was a significant negative relationship between the SPQ Cognitive-Perceptual Factor and FA for the control group. Image obtained from FSLView (neurological orientation). MNI coordinates: \(x = 8, y = 15, z = 19\). ............................................................................................................. 177

Figure 61. Comparison of results from Seal et al., (2008) and results from the present study. Results from Seal et al. (2008) are shown above, with MNI z-axis coordinates included. Corresponding slices from the present research are represented in the lower half of the figure. Images are represented on the MNI52 template, with mean FA skeletons in green. Red areas are voxels in which FA was significantly higher for control participants as compared to case participants \((p < 0.05_{\text{FWE CORRECTED}})\). ............................................................................................................. 180
List of Tables

**Table 1.** Summary of evidence for etiological factors found to be related to both schizotypal traits and psychotic symptoms.................................................................58

**Table 2.** Thinking style items relevant to the present research, drawn from the AANEX-CAR (Brett et al., 2007).........................................................................................84

**Table 3.** Format of the AANEX for N =50. .........................................................................................99

**Table 4.** Demographic data for the subsample of participants who had completed the AANEX.........................................................................................................................104

**Table 5.** Results of independent samples t-tests comparing thinking style between cases and controls (N = 50)..................................................................................................107

**Table 6.** Results of multiple linear regression analyses (‘Enter’ method) testing interaction effects for N = 50, with diagnostic group and thinking style items used as predictors (x1 and x2 respectively), and with the averaged AANEX Frequency/Intensity Ratings consistently used as the dependent variable (y). 110

**Table 7.** Results of multiple linear regression analyses (‘Enter’ method) testing main effects for N = 50, with diagnostic group and thinking style items used as predictors (x1 and x2 respectively), and with the averaged AANEX Frequency/Intensity Ratings consistently used as the dependent variable (y). 111

**Table 8.** Summary of results from Study 1. .................................................................................................118

**Table 9.** Demographic data for participants who had completed the WASI, RBANS, LNS and SPQ measures .........................................................................................................130

**Table 10.** Results of the independent samples t-tests comparing neurocognitive measures between cases and controls for N =389 .................................................................133

**Table 11.** Results of multiple negative binomial regression analyses testing interaction effects for N = 389, with diagnostic group and the neurocognitive
variables as predictors (x1 and x2 respectively), and with the SPQ Cognitive-Perceptual Factor consistently used as the dependent variable (y). ................. 134

**Table 12.** Results of multiple negative binomial regression analyses testing main effects for \( N = 389 \), with diagnostic group and the neurocognitive variables as predictors (x1 and x2 respectively), and with the SPQ Cognitive-Perceptual Factor consistently used as the dependent variable (y). ................................ 136

**Table 13.** Results of multiple negative binomial regression analyses testing main effects for \( N = 389 \), with diagnostic group and the neurocognitive variables as predictors (x1 and x2 respectively), and with the SPQ Cognitive-Perceptual Factor consistently used as the dependent variable (y). ................................ 137

**Table 14.** Results of multiple negative binomial regression analyses testing interaction effects for \( N = 389 \), with diagnostic group and the neurocognitive variables as predictors (x1 and x2 respectively), and with the SPQ Interpersonal Factor consistently used as the dependent variable (y). .......... 142

**Table 15.** Results of multiple negative binomial regression analyses testing interaction effects for \( N = 389 \), with diagnostic group and the neurocognitive variables as predictors (x1 and x2 respectively), and with the SPQ Disorganized Factor consistently used as the dependent variable (y). .......... 142

**Table 16.** Results of multiple negative binomial regression analyses testing main effects for \( N = 389 \), with diagnostic group and the neurocognitive variables as predictors (x1 and x2 respectively), and with the SPQ Interpersonal Factor consistently used as the dependent variable (y). ............................................. 143

**Table 17.** Results of multiple negative binomial regression analyses testing main effects for \( N = 389 \), with diagnostic group and the neurocognitive variables as predictors (x1 and x2 respectively), and with the SPQ Disorganized Factor
consistently used as the dependent variable (y). ................................................. 143

Table 18. Summary of within-group relationships between the SPQ factors and neurocognitive variables. ................................................................. 152

Table 19. Results of multiple linear regression analyses (‘Enter’ method) testing interaction effects for N = 50, with diagnostic group and the neurocognitive variables used as predictors (x1 and x2 respectively), and with the averaged AANEX Frequency/Intensity Ratings consistently used as the dependent variable (y). ................................................................. 155

Table 20. Results of multiple linear regression analyses (‘Enter’ method) testing main effects for N =50, with diagnostic group and the neurocognitive variables used as predictors (x1 and x2 respectively), and with the averaged AANEX Frequency/Intensity Ratings consistently used as the dependent variable (y). . 155

Table 21. Demographic data for N = 173 participants who had completed the MRI and, SPQ measures.................................................................................... 170
### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AANEX</td>
<td>Appraisals of Anomalous Experiences Interview</td>
</tr>
<tr>
<td>AANEX-CAR</td>
<td>Appraisals of Anomalous Experiences Interview – Context, Appraisals and Responses</td>
</tr>
<tr>
<td>ASRB</td>
<td>Australian Schizophrenia Research Bank</td>
</tr>
<tr>
<td>AD</td>
<td>Axial Diffusivity</td>
</tr>
<tr>
<td>BET</td>
<td>Brain Extraction Tool</td>
</tr>
<tr>
<td>CAPE</td>
<td>Community Assessment of Psychotic Experiences</td>
</tr>
<tr>
<td>CBT</td>
<td>Cognitive-Behavioural Therapy</td>
</tr>
<tr>
<td>DTI</td>
<td>Diffusion Tensor Imaging</td>
</tr>
<tr>
<td>DSM-IV-TR</td>
<td>Diagnostic System of Mental Disorders, Fourth Edition, Text Revision</td>
</tr>
<tr>
<td>DWI</td>
<td>Diffusion Weighted Imaging</td>
</tr>
<tr>
<td>FA</td>
<td>Fractional Anisotropy</td>
</tr>
<tr>
<td>FDT</td>
<td>FMRIB Diffusion Toolbox</td>
</tr>
<tr>
<td>fMRI</td>
<td>Functional Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>FMRIB</td>
<td>Oxford Centre for Functional MRI of the Brain</td>
</tr>
<tr>
<td>FSIQ</td>
<td>Full Scale Intelligence Quotient</td>
</tr>
<tr>
<td>FSL</td>
<td>FMRIB Software Library</td>
</tr>
<tr>
<td>ICD-10</td>
<td>International Classification of Diseases, Tenth Edition</td>
</tr>
<tr>
<td>IQ</td>
<td>Intelligence Quotient</td>
</tr>
<tr>
<td>LNS</td>
<td>Letter-Number Sequencing Task</td>
</tr>
<tr>
<td>MCQ</td>
<td>Metacognition Questionnaire</td>
</tr>
<tr>
<td>MD</td>
<td>Mean Diffusivity</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>MMPI-2</td>
<td>Minnesota Multiphasic Personality Inventory</td>
</tr>
<tr>
<td>MNI:</td>
<td>Montreal Neurological Institute</td>
</tr>
<tr>
<td>MRI:</td>
<td>Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>MRS:</td>
<td>Magnetic Resonance Spectroscopy</td>
</tr>
<tr>
<td>O-LIFE:</td>
<td>Oxford-Liverpool Inventory of Feelings and Experiences</td>
</tr>
<tr>
<td>RBANS:</td>
<td>Repeatable Battery for the Assessment of Neuropsychological Status</td>
</tr>
<tr>
<td>RD:</td>
<td>Radial Diffusivity</td>
</tr>
<tr>
<td>PANSS:</td>
<td>Positive and Negative Syndrome Scale</td>
</tr>
<tr>
<td>PAS:</td>
<td>Perceptual Aberration Scale</td>
</tr>
<tr>
<td>PET:</td>
<td>Positron Emission Tomography</td>
</tr>
<tr>
<td>PLIKs:</td>
<td>Psychotic-Like Experiences</td>
</tr>
<tr>
<td>PLEs:</td>
<td>Psychotic-Like Experiences</td>
</tr>
<tr>
<td>SANS:</td>
<td>Scale for the Assessment of Negative Symptoms</td>
</tr>
<tr>
<td>SAPS:</td>
<td>Scale for the Assessment of Positive Symptoms</td>
</tr>
<tr>
<td>SCAN:</td>
<td>Schedules for Clinical Assessment in Neuropsychiatry</td>
</tr>
<tr>
<td>SPECT:</td>
<td>Single-Photon Computed Emission Tomography</td>
</tr>
<tr>
<td>SPQ:</td>
<td>Schizotypal Personality Questionnaire</td>
</tr>
<tr>
<td>TBSS:</td>
<td>Tract-Based Spatial Statistics</td>
</tr>
<tr>
<td>WAIS-III:</td>
<td>Wechsler Adult Intelligence Scale, Third Edition</td>
</tr>
<tr>
<td>WASI:</td>
<td>Wechsler Abbreviated Scale of Intelligence</td>
</tr>
</tbody>
</table>
List of Appendices

<table>
<thead>
<tr>
<th>Appendix A:</th>
<th>Ethics Approval Documents</th>
<th>232</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix B:</td>
<td>Consent forms</td>
<td>235</td>
</tr>
<tr>
<td>Appendix C:</td>
<td>Items Corresponding to Each of the Nine SPQ Subscales</td>
<td>243</td>
</tr>
<tr>
<td>Appendix D:</td>
<td>Subscales Corresponding to Each of the Three SPQ Factors</td>
<td>245</td>
</tr>
<tr>
<td>Appendix E:</td>
<td>Appraisals of Anomalous Experiences (AANEX) Interview</td>
<td>246</td>
</tr>
<tr>
<td>Appendix F:</td>
<td>Probe Questions for Eliciting Anomalous Experiences</td>
<td>261</td>
</tr>
<tr>
<td>Appendix G:</td>
<td>Scoring Guide and Examples for Anomalous Experiences Inventory</td>
<td>265</td>
</tr>
<tr>
<td>Appendix H:</td>
<td>AANEX-CAR Scoring Guide</td>
<td>279</td>
</tr>
<tr>
<td>Appendix I:</td>
<td>Example SPSS Syntax (Study2)</td>
<td>286</td>
</tr>
</tbody>
</table>
Chapter 1: Schizotypy and Psychosis

‘We speak our own language. We speak a language you do not understand. We are defenseless and rendered helpless because we, me, and the world can’t understand each other.’ (Johnson, 2012)

This chapter defines and describes the psychological constructs of schizotypy and psychosis, as they are currently understood in the literature. Two competing models of the relationship between schizotypy and psychosis are outlined and compared, namely the quasi-dimensional and fully dimensional approaches. Lastly, this chapter reviews recent research evidence pertaining to the underlying latent structure of the two constructs.

1.1. Psychosis

Conceptualizations of psychosis are rapidly changing. Indeed, even the word ‘psychosis’ has evolved to describe a cluster of symptoms that have refused to stay within the artificial boundaries of the concept of schizophrenia. Broadly, psychosis describes a loss of contact with reality – characterized by experiences such as hallucinations, delusions, personality change, thought disorder, bizarre behavior, impaired social interaction, and/or difficulties in carrying out daily activities (Compton & Broussard, 2009). These experiences are usually subsumed under three main categories. They are; positive symptoms including hallucinations and delusions; disorganized symptoms including thought disorder and bizarre behaviour; and negative symptoms including impaired social interaction (e.g. alogia, apathy) and difficulties in carrying out daily activities (e.g. anhedonia, amotivation). Psychotic symptoms are most commonly associated with schizophrenia. However, there are
also other psychiatric disorders in which psychosis presents, such as schizophreniaform disorder, schizoaffective disorder, and delusional disorder. Symptoms of psychosis can also be seen both in neurological disorders such as dementia, and in psychiatric disorders that are not generally considered under the rubric of psychotic disorders, for example severe major depressive disorder.

1.2. Categorical Notions of Psychosis

The foundations of current understandings of psychotic disorders were based on the writings of Emil Kraepelin (1919/1971), Eugene Bleuler (1911/1950), and Kurt Schneider (1959). These clinicians worked during the late 19th and early 20th centuries, in the large asylums of Western Europe (Allardyce, Suppes, & van Os, 2007). Kraepelin, Bleuler and Schneider identified and described the onset, presentation and course of schizophrenia, and differentiated it from manic depression (now re-conceptualised as bipolar disorder). Their writings led to reliable diagnoses that could be used as a basis for ongoing research into the incidence and prevalence of psychotic disorders. In essence, Kraepelin, Bleuler and Schneider built the foundation of knowledge on which current diagnostic systems are based, including the Diagnostic System of Mental Disorders (DSM-IV-TR; APA, 2000) and International Classification of Diseases (ICD-10; WHO, 1992).

Like Kraepelin, Bleuler and Schneider, the DSM-IV-TR and ICD-10 consider the latent constructs of mental disorders (including psychotic disorders) to be categorical (WHO, 1992; APA, 2000). That is, psychotic disorders are viewed as discrete, bounded entities that are distinctly different from normal experience (Allardyce et al., 2007). This assumption is useful for clinicians in a number of ways. For example, categorical diagnoses help to ensure disorders are easily identifiable,
with specific symptom criteria for clinicians to refer to and check. They serve as a basis for treatment decision-making, and aid communication between practitioners (Livesley & Jackson, 1992; Kraemer, Noda, & O'Hara, 2004). Importantly, they provide clear and reliable diagnoses regardless of context, which can be used for both practice and research (van Os et al., 1999; Kraemer et al., 2004).

However, there are also a number of problems with the assumption that psychotic disorders are categorical phenomena. First, despite their original aim of identifying and categorizing groups of symptoms which seem to commonly cluster together, psychotic disorders are inherently heterogeneous (Beck, Rector, Stolar, & Grant, 2009). For instance, under the DSM-IV-TR, there are five characteristic symptoms of schizophrenia – delusions, hallucinations, disorganized speech, disorganized or catatonic behaviour, and negative symptoms (APA, 2000). Only two of these five characteristic symptoms of schizophrenia need be present for a confirmed DSM-IV-TR diagnosis. Indeed, only one symptom need be present if it is particularly severe – for example when two voices are providing a running commentary on behaviour (APA, 2000). An implication of this diagnostic rule is that it is possible for two people to receive a diagnosis of schizophrenia, yet have no symptoms in common at all (Wing & Agrawal, 2003; Beck et al., 2009).

Second, as well as considerable heterogeneity within diagnostic categories, there is also considerable overlap between diagnostic categories. For instance, hallucinations are characteristic symptoms of schizophrenia. However, as has already been mentioned, they are also found both in other psychiatric conditions such as bipolar disorder and severe depression, as well as neurological conditions such as dementia (APA, 2000). Similarly, delusions are often seen in schizophrenia, but they are also symptoms of delusional disorder, bipolar disorder, schizoaffective disorder,
shared psychotic disorder, and so forth.

Third, current diagnostic systems assume psychotic disorders are stable across a person’s lifetime (McGorry, Allot, & Jackson, 2009). In reality, an individual may meet criteria for a number of disorders throughout their lifetime (McGorry et al., 2009). For example, they may present with undifferentiated and non-specific psychological difficulties in the early stages of a disorder, before developing a full blown psychotic episode – which, as we have seen, may be defined by any number of categorical diagnoses including but not limited to schizoaffective disorder, schizophrenia, schizophreniform disorder, bipolar disorder or major depression (McGorry et al., 2009). Then, at a later stage of their life, an individual may relapse, but this does not necessarily mean that they will meet criteria for the initial disorder (McGorry et al., 2009). Consequently, someone initially diagnosed with schizophrenia may later meet criteria for schizoaffective disorder, and so forth.

Indeed, it is not until an individual has had repeated episodes and persistent disability, that their diagnosis may become both stable and clear-cut (McGorry et al., 2009). This introduces a fourth limitation – that of the clinician’s illusion (Cohen & Cohen, 1984). The clinician’s illusion is said to occur when chronic, end-stage disorders come to define a given diagnostic category, solely because of their over-exposure within care institutions, where clinicians are more likely to come into contact with them (Cohen & Cohen, 1984). Like most current conceptualizations of psychosis, the problem of the clinician’s illusion is reflected in the writings of Kraepelin (1919/1971), when he described schizophrenia as a chronic condition with deteriorating course (McGorry et al., 2009). The asylums in which Kraepelin (1919/1971), Bleuler (1911/1950), and Schneider (1959) worked were created to house people with severe and debilitating illnesses (Allardyce et al., 2007).
Therefore, these researchers’ clinical observations were of the most dysfunctional individuals, who were not necessarily typical of the entire population of people with psychotic symptoms (Allardyce et al., 2007; McGorry et al., 2009).

A related fifth problem with categorical diagnoses is that of Berkson’s fallacy (Berkson, 1946). Berkson’s fallacy describes a situation where symptoms appear to cluster together, when in fact they are independent risk factors for hospital admission – and their additive effects make it more likely that someone with two or more risk factors will present to institutional care (Allardyce et al., 2007). For example, it has been demonstrated that the positive and negative symptoms of schizophrenia are independently related to need for care (Maric et al., 2004). This bias may have resulted in the current understandings of schizophrenia as a single entity – comprised of both negative and positive symptoms (Allardyce et al., 2007). However, in fact it might be that individuals with both of these symptom groups are more likely to seek care, whereas in non-help-seeking populations it may be possible for positive and negative symptoms to exist more commonly in isolation of one another.

Finally, despite numerous studies into the physiological correlates of schizophrenia, concerns have been raised about an apparent lack of biological markers (Beck et al., 2009). There is no test (biological or otherwise) that will distinguish someone with psychosis or at risk for psychosis, from someone who is psychologically healthy (Wing & Agrawal, 2003; Wong & van Tol, 2003; Beck et al., 2009). This unclear delineation between normal and abnormal is reflected in Heinrichs’ (2005) review of biological studies, which describes a substantial overlap between samples of people with schizophrenia, and samples of people who are psychologically healthy.

The above difficulties with current categorical diagnostic systems hamper
research efforts into psychosis considerably. The heterogeneity of psychotic symptom presentations, variation between different stages of disorders, overlap between disorders, biases of clinicians, and absence of a biological marker, strongly suggests we have not ‘carved up’ the psychoses in the correct way (Wing & Agrawal, 2003; Wong & van Tol, 2003; Beck et al., 2009). In other words, these limitations could reflect a misrepresentation of latent psychotic constructs, and may lead to erroneous diagnosis, inappropriate treatment, and conflicting research findings. As Allardyce et al. (2007) said:

'There is no doubt that the work of Kraepelin, Bleuler and Schneider respectively (and the classification systems which evolved from their insights), has greatly facilitated the acquisition of the knowledge we now have about psychosis. However, the walls of the asylum confined their observations, perhaps obscuring the true nature of the psychosis phenotype' (pp. s34-s35).

Furthermore, it would appear that over one hundred years later, and into the foreseeable future, we continue to struggle with a legacy of inaccurate and inefficient diagnostic systems.

1.3. Traditional Conceptualizations of Schizotypy

Similar concerns about psychiatric disorders have also been raised regarding psychological constructs within the general community. Specifically, the term schizotypy refers to a cluster of personality traits that represent what is considered to be a ‘propensity to develop psychotic disorders’ within psychologically healthy populations (Matthews, Deary, & Whiteman, 2003, p. 316). Like traditional conceptualisations of psychosis, traditional understandings of schizotypy have met with theoretical criticism, which will be elucidated below. The schizotypy construct includes odd or bizarre behavior, strange speech, magical thinking, unusual
perceptual experiences, and social anhedonia. There is some disagreement regarding its underlying factor structure (Stefanis et al., 2004; Mason & Claridge, 2006; Fonseca-Pedrero, Paino, Lemos-Giraldez, Sierra-Baigrie, & Muniz, 2011). However, the prevailing view is that schizotypy is comprised of three identifiable factors, which broadly correspond to the positive, negative and disorganized dimensions of psychosis mentioned previously (Fonseca-Pedrero et al., 2011). The first factor is the ‘cognitive-perceptual’ factor, which includes magical thinking, unusual perceptual experiences, ideas of reference, and paranoia (Raine, 1991; 2006). The second is the ‘interpersonal factor’, which includes constricted affect, social anxiety, lack of personal relationships, and suspiciousness (Raine, 1991; 2006). The final factor associated with schizotypy is the disorganized factor, which includes odd behaviour and odd speech (Raine, 1991; 2006).

Like psychosis and most other mental phenomena, schizotypy is a latent construct that can only be inferred from observable behavior or self-report (Beauchaine, Lenzenweger, & Waller, 2008). In turn, observable behaviour is affected not only by intrinsic mental phenomena like thoughts and feelings, but also by many other influences such as family upbringing, personal history, culture, ethnicity, interpersonal context, and the effects of drugs, alcohol and medications (Beauchaine et al., 2008). Therefore it is much more difficult to identify, describe and measure mental constructs such as schizotypy, than it is to identify, describe and measure physical constructs such as height or weight (Beauchaine et al., 2008). This leaves room for competing theories, different methods of measurement, and contrasting evidence relating to most psychological constructs. In relation to schizotypy in particular, there are two competing schools of thought regarding the distribution of schizotypy in the general population. The first is called the ‘quasi-
dimensional approach’, and the second is called the ‘fully dimensional approach’. Both models have contributed to current understandings of schizotypy, and are described below. However, it will be argued that a fully dimensional model better accounts for the range of findings related to both schizotypy and psychosis.

1.4. The Quasi-Dimensional Approach

The quasi-dimensional approach to schizotypy is based on a disease model of mental illness. It posits that schizotypy is a personality organization specific to a small group of individuals within the population (approximately 10%), who are at genetic risk of developing schizophrenia, and who are labeled ‘schizotypes’ (Rado, 1953; Meehl, 1990; Lenzenweger, 1994; Beauchaine et al., 2008). They are compared to a larger group (approximately 90%) who are not at risk. As reviewed by Lenzenweger (2006), the model can be attributed to Paul Meehl’s (1962) theory, which described a specific genetic vulnerability toward developing psychosis. This vulnerability was said to exist in the form of a specific genetic predisposition, which manifests as a neurointegrative defect called schizotaxia. According to Meehl (1962), schizotaxia was necessary, but not sufficient, to cause schizophrenia. Rather, it interacts with environmental influences throughout a person’s lifetime to determine the degree of decompensation they experience in response to stress (Lenzenweger, 2006). From this perspective, genetic vulnerability toward developing psychotic symptoms is considered to be ‘taxonic’, or categorical (Korfine & Lenzenweger, 1995; Waller, Yonce, Grove, Faust, & Lenzenweger, 2006). The approach is quasi-dimensional only because it refers to levels of expression of a proposed disease process. Otherwise, it is a discontinuous, categorical theory wherein any one individual in the general population is considered to either possess a genetic vulnerability, or they do
Support for the quasi-dimensional approach can be found in studies that employ taxometric analyses (Waller & Meehl, 1998; Rawlings, Williams, Haslam, & Claridge, 2008b). Taxometric analyses are a group of statistical procedures that are used to determine the underlying structure of latent constructs. They are able to determine whether a given construct is categorical (taxonic) or dimensional. In 2008, a review of nineteen published taxometric studies pertaining to schizotypy reported that fifteen supported a categorical model (Rawlings et al., 2008b). Furthermore, the taxonic base rate estimates in these studies, ranging between 0.03 and 0.13, appeared to support Meehl’s (1990) postulation that 10% of the population are schizotypes (Rawlings et al., 2008b).

Yet, there are criticisms of the quasi-dimensional model, and some of these focus particularly on the sampling methods used when conducting taxometric analyses (Rawlings et al., 2008b). For instance, studies have often used either clinical samples with insufficient power for the purposes of taxometrics, or they have used large student samples, which may not be representative of the general population (Rawlings et al., 2008b). Additionally, often only one aspect of schizotypy is investigated, using only one taxometric procedure (Rawlings et al., 2008b). Last and most importantly, Rawlings et al. (2008b) have argued that evidence from taxometric analyses supporting both a categorical viewpoint, and a base rate in the range of 10% may actually arise as an artefact of positively skewed sample distributions (Rawlings et al., 2008b). Their own investigation attempted to address these criticisms by using more than one taxometric procedure, a large diverse adult sample, multiple measures of schizotypy, and by taking skew into account. Its findings supported a dimensional rather than a categorical latent structure (Rawlings et al., 2008b).
Another problem with the quasi-dimensional approach has been highlighted by research showing that the anomalous perceptual experiences associated with schizotypy are much more prevalent in the general population than the 10% estimate proposed by Meehl (1990). For example, Verdoux et al. (1998) asked 790 individuals from primary care services to fill in a self-report measure comprised of items assessing experiences that resembled hallucinations and delusions. Examples included: ‘Do you ever feel as if there is a conspiracy against you?’, Do you ever feel as if people are looking oddly at you?’, and ‘Do you ever think that people can communicate telepathically?’. For participants with no history of psychiatric disorder ($N = 462$), individual item endorsement varied from between 5% and 70%, with 46.9% of people believing they could communicate telepathically, 25.5% believing they had been persecuted in some way, and 4.8% believing that they could hear voices conversing (Verdoux et al., 1998). Another study investigated the prevalence of psychotic-like experiences in 2441 young people (aged 18-23) in Australia (Scott et al., 2008). Individual item endorsement in this study ranged from between 5.5% (‘do you ever feel as if you are a robot or zombie without a will of your own?’) to 77% (‘do you ever feel as if some people are not what they seem to be?’).

Indeed, one estimate from a longitudinal study looking at mental health in the Dutch adult general population indicated that the incidence of positive subclinical psychotic experiences in otherwise healthy cohorts is up to 100 times greater than traditional estimates such as Meehl’s (1990) would suggest (Hanssen, Bak, Bijl, Vollebergh, & van Os, 2005). This higher than previously acknowledged prevalence of anomalous experiences in the general population blurs the line between what may be considered ‘normal’ and ‘abnormal’. It indicates that schizotypy may not be a discrete, bounded entity affecting only a small proportion of the population, as would
be consistent with a quasi-dimensional model.

1.5. The Fully Dimensional Approach

A more recent model of the potential relationship between schizotypal personality and psychosis has been outlined by Gordon Claridge and colleagues (Claridge & Beech, 1995; Claridge & Davis, 2003; Rawlings, Williams, Haslam, & Claridge, 2008a). They describe the fully dimensional approach, which is represented in Figure 1. According to this model, schizotypy is understood as a dimensional personality trait that represents ‘natural central nervous system variations’, which in their extreme, manifest as vulnerability to mental illness (Rawlings et al., 2008a, p. 1669). The main contention advocated by the fully dimensional approach is that the latent structure of schizotypy is on a continuum applying to all members of the population. It is considered to range from low schizotypy and good psychological health, to extremely high schizotypy and dysfunction in the form of psychosis.
As the fully dimensional approach describes schizotypy as continuously distributed throughout the general population, it can account for the high rates of anomalous experiences reported by researchers such as van Os and his colleagues (Verdoux et al., 1998; Johns & van Os, 2001; van Os, Linscott, Myin-Germeys, Delespaul, & Krabbendam, 2009). In this way, the fully dimensional appears to prove superior to the quasi-dimensional approach.

Further evidence for the dimensional approach is based on analyses supporting the three factor structure of schizotypy (cognitive-perceptual, interpersonal and disorganized), which is analogous to the three factor structure of psychosis (positive, negative and disorganized; Liddle, 1987; Rossi & Daneluzzo, 2002; Wuthrich & Bates, 2006). Moreover, there is evidence that individuals with psychotic disorders tend to score highly on measures of schizotypy (Lenzenweger, 1994; Camisa et al., 2005).
However, it should be remembered that not all people with high levels of schizotypy are necessarily impaired in their day-to-day functioning. For example, it has also been shown that individuals scoring highly on measures of schizotypy can (and do) function well in terms of subjective wellbeing (Goulding, 2004). Here, subjective wellbeing is defined as a self-rated sense that a person has control over their own life, can balance and cope with both positive and negative life events, and can maintain stability (Goulding, 2004). Many people who score highly on measures of schizotypy also exhibit adaptive strengths such as creativity, as evidenced by increased involvement in creative activities including painting and drawing, writing, music, gardening and web design (Batey & Furnham, 2008; Rawlings & Locarnini, 2008; Nelson & Rawlings, 2010).

Instead, similar to the quasi-dimensional approach, the fully dimensional approach does not assume schizotypal traits are sufficient in and of themselves, to indicate risk for psychopathology (Rawlings et al., 2008a). Rather, it is only when high levels of schizotypy are combined with other aetiological risk factors (such as a family history of psychosis, cannabis use, and/or a personal history of trauma) that an individual may be considered at risk for psychosis. Otherwise, schizotypy is considered neutral in regards to psychopathology (Rawlings et al., 2008a).

In this way, the fully dimensional approach is consistent with what is termed the ‘continuum hypothesis’ of psychosis (van Os, Hanssen, Bijl, & Ravelli, 2000; Verdoux & van Os, 2002; Allardyce et al., 2007; van Os et al., 2009). This is the understanding that psychosis is similar to chronic physical problems such as diabetes and heart disease. It is considered to have multifactorial aetiology, wherein multiple genes interact both with each other and with the environment to determine outcome (Allardyce et al., 2007; Rawlings et al., 2008a). These different combinations of
genes and environmental risk factors result in a range of different phenotypic expressions lying on a continuum from normal through to clinical psychosis.

Consequently by adopting the fully dimensional theory, research into schizotypy becomes relevant because it directly aids investigation into the aetiology of psychosis. Furthermore, it does so whilst avoiding confounds often associated with psychosis research, such as illness chronicity, medication, and hospitalization. From this perspective, it is important to assess not only similarities between various levels of schizotypy and psychosis, but also dissimilarities (Fanous & Kendler, 2004). For example, it has been proposed that possible biological endophenotypes common to the two constructs may represent underlying genetic factors, while findings specific to psychosis may represent environmental factors (Cannon, van Erp, & Glahn, 2002; Fanous & Kendler, 2004).

Regardless of whether the quasi-dimensional or dimensional approach is taken, some common conclusions can be drawn from both models. Specifically, there is evidence that schizotypy and psychosis are conceptually related, and that in some cases, high schizotypy can mean that an individual is at risk of developing a psychotic illness (Camisa et al., 2005). However, this relationship is not necessarily a clear linear continuum with low schizotypy equating to normality, and high schizotypy equating to abnormality. Rather, it may be that certain schizotypal factors are related to psychosis and dysfunction, while others promote strengths such as increased involvement in creative occupations, and subjective wellbeing. For example, it may be that individuals who score highly on the cognitive-perceptual factor of schizotypy, but low on the interpersonal factor are able to channel their experiences toward creative endeavours, or gain social support via affiliation with spiritual or religious communities (Goulding, 2004; Nelson & Rawlings, 2010;
Cottam et al., 2011). Furthermore, it seems likely that there are risk factors other than schizotypy alone that contribute to the difference between someone being high in schizotypy and functional, or high in schizotypy and dysfunctional.

Further empirical evidence that psychotic symptoms and certain schizotypal personality features in psychologically healthy people lie on a common continuum will be discussed further, however it is first important to outline the background to symptom research, and to define some of the terminology used in this area.

1.6. The Symptom Approach

As has been demonstrated above, there is reason to believe that the diagnostic categories for psychosis may not have been ‘carved up’ in the correct way, which limits research conclusions. One strategy to address this problem has been suggested by Richard Bentall (2003), and involves looking at separate symptoms of schizotypy and psychosis in isolation of one another. In particular, a number of researchers have successfully studied the positive symptoms of psychosis at the exclusion of negative and disorganized symptoms (Kuipers & Bebbington, 2006; Garety, Bebbington, Fowler, Freeman, & Kuipers, 2007; Allen, Laroi, McGuire, & Aleman, 2008b).

One reason why it is important to look at separate dimensions and types of symptomatology, rather than schizotypy and psychosis in a more broad sense is evidenced in a paper by Cochrane, Petch and Pickering (2010). They gave an established self-report measure of schizotypy (the Oxford-Liverpool Inventory of Feelings and Experiences, or O-LIFE; Mason, Claridge, & Jackson, 1995), and two scales of positive and negative psychotic symptoms (the Scale for the Assessment of Positive Symptoms and the Scale for the Assessment of Negative Symptoms, or SAPS and SANS; Andreasen, 1983; Andreasen, 1984) to a group of people with
schizophrenia, and a group of healthy control participants. For the schizophrenia group, positive and disorganized schizotypy were associated with SAPS scores. However, disorganized schizotypy was not associated with disorganized symptoms assessed by the SAPS, and negative schizotypy was not associated with SANS scores. Similarly, Kwapi, Barrantes-Vidal and Silvia (2008) reported varying correlates for positive schizotypy as opposed to negative schizotypy in a sample of 6137 college students. The findings of these studies indicate that it is likely that various schizotypal traits are related to analogous psychosis symptom clusters in complex and different ways. If this type of outcome is not considered from the outset, there is potential for erroneous findings to arise out of research into the relationship between schizotypy and psychosis.

Thus, one advantage of the symptom approach is that it does not confine symptoms or experiences to any one artificially prescribed psychological disorder. It also avoids Berkson’s fallacy because it does not assume positive and negative symptoms necessarily hang together in subclinical populations. It is for these reasons that the current research focuses predominantly on positive symptoms and experiences specifically.

1.7. Some Terminology

At this stage it is also important to note that the terminology used in this area can be somewhat confusing – with terms such as ‘positive symptoms’, ‘anomalous experiences’, ‘subclinical psychotic symptoms’, ‘psychotic-like experiences’ and ‘cognitive-perceptual experiences’ being used interchangeably and without clear definition. This confusion seems to have arisen because there is a risk of pathologizing every day human experiences that are considered to be healthy, by
labeling them as ‘psychotic’ or ‘psychotic-like’. Therefore, it is necessary to be both careful and clear about the manner in which different aspects of these phenomena are described.

Specifically, the present research is based on a model of positive anomalous experiences that views them as lying on a fully dimensional continuum. This continuum ranges from anomalous experiences in psychologically healthy people, through to positive symptoms associated with florid psychosis (hallucinations and delusions). Anomalous experiences are also known as ‘subclinical psychotic experiences’ (van Os et al., 2009), ‘PLIKs’ and ‘PLEs’, or ‘psychotic-like experiences’ (Zammit et al., 2009; Kelleher & Cannon, 2011). Furthermore – as well as being considered foci of research in their own right, anomalous experiences comprise the cognitive-perceptual factor of schizotypy (Raine, 1991; 2006).

‘Anomalous experiences’ refer to a full range of perceptual phenomena, all falling below the threshold of what we would consider to be positive psychotic symptoms, or hallucinations and delusions (Raballo & Parnas, 2011). They can include thought interference and odd speech, odd behaviour, anhedonia, subjective isolation from others and derealization from the world, magical thinking, loud thoughts, phenomenological changes in vision, hearing and sense of smell, overvalued ideas, and many others (Raine, 1991; 2006; Brett et al., 2007; Raballo & Parnas, 2011). Concrete examples of these types of experiences are an isolated incident of hearing a voice, an unfounded belief that others are talking behind one’s back, or an occurrence of ‘seeing a ghost’. They resemble the positive symptoms of psychosis such as derealization, paranoid delusions or visual hallucinations, and are conceptually related to those experiences. However, it must be made clear that they are not representative of a disordered state by any means, but instead are considered
to be part of the broad spectrum of normal human experience.

For the purposes of this thesis, the term ‘anomalous experiences’ will be used from this point onwards to describe these subclinical psychotic-like phenomena. This is because it is a term that differs most from, and is least likely to be confused with the positive symptoms of psychosis. When talking about the other end of the spectrum, and referring to hallucinations and delusions which are clearly disordered, the term ‘positive symptoms’ will be used. Finally, when referring to all phenomena on the continuum as a whole, the term ‘positive anomalous experiences’ will be used. Again, this is not to say that those experiences on the lower end of the continuum are necessarily representative of dysfunction. Rather, it is simply a short hand way of referring to a broad spectrum of experiences as a whole.

1.8. The Fully Dimensional Approach: Evidence from the Literature

Some evidence that schizotypal personality traits and symptoms of psychosis lie on a common continuum has already been discussed in the context of the fully dimensional approach to schizotypy. Further evidence that the positive anomalous experiences associated with both schizotypy and psychosis lie on a common continuum can be gleaned from genetic, neurocognitive, environmental, and biological research, which is reviewed in the following sections.

1.8.1. Genetic Research: Family, Twin and Adoption Studies

Evidence for a dimensional model of psychosis comes from family studies in which behavioural geneticists measure a given trait or construct in people who are related to varying degrees (Siegler, Deloache, & Eisenberg, 2003). Correlations of the measured construct are compared between different pairs of related individuals (e.g.
siblings versus non-relatives, parents versus siblings; Siegler et al., 2003). If correlations are higher between related pairs of individuals than between non-related pairs of individuals, then it can be broadly concluded that the construct confers some level of heritability (Siegler et al., 2003). These correlational analyses usually result in an estimate of genetic risk, expressed as a percentage. For example in relation to schizophrenia, original estimates were that in the general population there was a 1% chance that any one individual will develop the disorder (Gottesman, 1991). This risk increased to 6% if a particular individual had a parent with schizophrenia, 9% if they had a sibling with schizophrenia, and 48% if they had an identical twin with schizophrenia (Gottesman, 1991). More recent estimates posit that the heritability of schizophrenia might be up to 90% (Sullivan, Kendler, & Neale, 2003; Lichtenstein et al., 2009).

Family studies, though, are confounded by the likelihood that family members who share the same genetics also share the same environment. This makes it difficult to conclude whether correlations with a particular trait are due to genetic similarities, or due to environmental similarities, or a combination of both factors. One form of family study which attempts to address this confound is the twin study. Both monozygotic and dizygotic twins share the same pre-natal environment, are born at the same time in the same place, share the same parents, the same family, the same community and so on (Siegler et al., 2003). However, the two types of twin differ in their genetic make up. That is, monozygotic twins share 100% of their genes, whereas dizygotic twins share only 50% of their genes (Siegler et al., 2003). Therefore, if correlations with a given trait or construct are found to be higher for pairs of monozygotic twins than for pairs of dizygotic twins, then it can be concluded that that particular trait is to some extent genetically predetermined.
The twin study is further enhanced when it is combined with the *adoption study*, which compares identical twins who were raised together with identical twins who were separated at birth and raised apart (Siegler et al., 2003). If twins who were raised apart have similar profiles on a given trait to those reared together, a strong argument for genetic influence can be inferred (Siegler et al., 2003). On the other hand, if twins who were raised apart have dissimilar profiles, then it can be inferred that the environment accounts for more variation than genetics (Siegler et al., 2003).

In regards to the topic of the present research – both Kraepelin (1919/1971) and Bleuler (1911/1950) first observed that relatives of individuals with schizophrenia appeared notably more odd and eccentric than people in the general population. Since then, much behavioural genetic research throughout the 20th and early 21st centuries has indicated that schizotypal traits and psychosis show some level of genetic inheritance (Kety, Rosenthal, Wender, Shulsinger, & Jacobson, 1975; Baron, Gruen, Asnis, & Kane, 1983; Kendler, Thacker, & Walsh, 1996; Mata et al., 2003).

For example, it has been clearly established from family, twin, and adoption studies that psychosis is heritable (McCue, Gottesman, & Rao, 1983; Cannon, Kaprio, Lonqvist, Hutunen, & Koskenvuo, 1998; McClellan, Susser, & King, 2007). Similarly, there is growing evidence that heightened schizotypy can also be experienced by multiple generations of the one family. For instance, Kendler et al. (1991) administered four measures of schizotypy (including self-report and interview) to 29 monozygotic and dizygotic twin pairs. Distributions of schizotypy in this sample were normal, indicating dimensionality rather than taxonicity, which would have been represented by a bimodal distribution (Kendler et al., 1991). Comparison of correlations between monozygotic and dizygotic pairs in this sample
also indicated that both positive and negative schizotypal traits showed family-specific variation (Kendler et al., 1991).

More recent support of the dimensional and genetically-based nature of schizotypy within psychologically healthy populations comes from Hanssen, Krabbendam, Vollema, Delespaul, and van Os (2006), who gave three measures of schizotypy (again both self-report and interview) to 272 individuals from 82 families. All three measures showed family-specific variation for both positive and negative traits. However, only one measure showed family-specific variation for the negative trait once variation due to the positive trait was controlled for, indicating that the positive dimension of schizotypy (anomalous experiences) specifically varied with family membership. Interestingly, these results were obtained in families that were not selected on the basis of pre-existing diagnosis of any psychiatric disorder, providing evidence for dimensional variation within the general population as well as heritability (Hanssen et al., 2006).

It is acknowledged, of course, that evidence for the heritability of anomalous experiences, and separate evidence showing the positive symptoms of psychosis are heritable does not mean the two phenomena are necessarily related. That would be akin to showing that brown hair runs in families and intelligence runs in families, therefore brown hair and intelligence are related. Yet, there is research indicating that both schizotypy and psychosis occur in the same families, suggesting they may be heritable together (Kety et al., 1975; Baron et al., 1983; Kendler, Lieberman, & Walsh, 1989; Kendler et al., 1996; Mata et al., 2003).

One example is a study by Kremen, Faraone, Toomey, Siedman and Tsuang (1998), wherein 44 controls and 40 biological relatives of people with schizophrenia completed the Schizotypal Personality Questionnaire (SPQ; Raine, 1991). Relatives
had higher scores on the Cognitive-Perceptual (positive) Factor than controls. Similar results using the same measure were reported in a smaller study of 13 participants with a family history of psychosis, 38 participants with a family history of substance use disorder and 51 control participants (Yaralian et al., 2000). In a more recent study, 263 relatives of people with psychosis completed three measures of schizotypy – including two self-report measures and a semi-structured interview (Mata et al., 2003). In this investigation, it was the positive symptoms of psychosis, as reported by the patients, which were related to schizotypy in their relatives. A cluster of symptoms reported by the patients (delusions, hallucinations and thought disturbance) was positively correlated with outcomes from all three measures of schizotypy in relatives, including both positive and negative traits.

Two other family studies have reported more mixed findings as to heritability between schizotypy and psychosis. Kendler et al. (1996) found no differences in levels of schizotypy between relatives of patients with psychotic illnesses, and relatives of controls. Furthermore, Appels, Sitskoorn, Vollema & Kahn (2004) reported that parents of schizophrenia patients actually had lower scores on the Cognitive-Perceptual Factor of the SPQ than control participants. However, the authors of both of these studies account for their theoretically anomalous findings by highlighting the problems of conducting research into schizotypy using self-report measures (Kendler et al., 1996; Appels et al., 2004). Appels et al. (2004) also reasoned that including both parents (mothers and fathers) of schizophrenia patients in their analysis may have resulted in a loss of power. It is more likely that only one parent passes on a genetic risk of psychosis, not necessarily both parents (Appels et al., 2004). Indeed, Appels et al. (2004) then conducted an alternative investigation, wherein parents of individuals with schizophrenia, who reported a family history of
schizophrenia spectrum disorder in earlier generations (i.e. their own parents or earlier), reported higher levels of both positive and negative schizotypal traits than parents with no family history.

Further to the above family-based research, there have been some investigations that have used a twin design to assess a possible relationship between schizotypy and schizophrenia. Self-reported experiences of perceptual aberration and social anhedonia in particular were found to be at least partly inherited in a study of 98 monozygotic and 59 same sex dizygotic twins pairs (MacDonald, Pogue-Geile, Debski, & Manuck, 2001). Another study of 105 monozygotic and 90 dizygotic twins described common family specific variation between psychosis and schizotypy as measured by the O-LIFE (Jang, Woodward, Lang, Honer, & Livesley, 2005).

1.8.2. Genetic Research: Molecular Genetics

In summary, considerable evidence from family, adoption, and twin studies indicates that psychotic disorders and schizotypy in healthy populations share common genetic underpinnings. These family, twin and adoption studies are informative in terms of describing heritability, but they cannot identify specific chromosomal regions giving rise to any one phenotype (Fanous et al., 2007). Around 25 years ago, Gottesman, McGuffin and Farmer (1987) remarked that the results of behavioural genetic studies gave only clues to the genetic basis of schizophrenia, and that molecular genetics would provide clear answers. However despite years of genetic research, no single gene, or even a clear number of possible genes have been identified for schizophrenia, nor for psychosis more broadly (Allardyce et al., 2007; Tandon, Keshavan, & Nasrallah, 2008b), despite large samples in recent studies (Ripke et al., 2011).
Indeed, there are no genes proposed to be related to psychosis that are not controversial or subject to conflicting findings. For instance, in a recent review and meta-analysis of genetic research into schizophrenia, it was estimated that there have been in excess of 1000 genetic association studies exhibiting largely inconsistent results (Allen et al., 2008a). This review found that across 118 different meta-analyses, there were nominally significant effects in 24 variants of 16 different genes – namely, APOE, COMT, DAO, DRD1, DRD2, DRD4, DTNBP1, GABRB2, GRIN2B, HP, IL1B, MTHFR, PLXNA2, SLC6A4, TP53, and TPH1 (Allen et al., 2008a).

To date there has been limited molecular genetic research into a potential relationship between schizotypy and psychotic disorders specifically. In a linkage study, Fanous et al. (2007) demonstrated that a number of genes thought to be related to schizophrenia in patients, were also associated with levels of schizotypy in non-psychotic relatives. Two other studies have indicated a significant level of association between schizotypy and the COMT gene (Avramopoulos et al., 2002), and between schizotypy and the DTNB1, NRG1 and DAAO genes (Stefanis et al., 2007). However, consistent with the conflicting findings in regards to molecular genetic research and psychosis, another investigation with a relatively large sample size of 465 participants, found no clear relationship between schizotypy and the COMT gene (Ma et al., 2007).

As reviewed by Fanous and Kendler (2004), the following conclusions can be drawn from the genetic research on schizotypy and schizophrenia. Notably, behavioural genetic research has shown that both psychosis and schizotypy are heritable, and that schizotypy and psychotic disorders aggregate in families together. Yet despite the optimism surrounding early molecular genetic research into the
genetic causes of both schizotypy and psychosis (Gottesman et al., 1987; Tandon et al., 2008b), findings in this area are still unclear. Further research is needed before it can be confidently established that there are shared genetic abnormalities between schizotypy and psychosis, and even more before we can break these down into specific traits. This is reflective of the state of genetic research into psychiatric disorders more broadly (Meyer-Lindenberg & Weinberger, 2006; Psychiatric GWAS Consortium Coordinating Committee et al., 2009), and particularly the difficulties of finding commonalities in inherently heterogeneous populations. In fact, genetic research into schizotypy and psychosis is also good case in point where traditional categorical diagnostic structures appear to be hampering the validity of conclusions that can be drawn.

1.8.3. Neurocognitive Research

Another major vein of research has consistently shown that psychosis is associated with cognitive deficits (Tandon, Nasrallah, & Keshavan, 2009). These include generalized cognitive dysfunction (Heinrichs & Zakzanis, 1998; Fioravanti, Carlone, Vitale, Cinti, & Clare, 2005; Reichenberg & Harvey, 2007; Simonsen et al., 2011), as well as deficits in verbal IQ (Heinrichs & Zakzanis, 1998; Reichenberg & Harvey, 2007), working memory (Haenschel & Linden, 2011; Simonsen et al., 2011), episodic memory (Reichenberg & Harvey, 2007), executive functioning (Heinrichs & Zakzanis, 1998; Fioravanti et al., 2005; Reichenberg & Harvey, 2007), verbal fluency (Simonsen et al., 2011), processing speed (Simonsen et al., 2011), and attention (Heinrichs & Zakzanis, 1998; Fioravanti et al., 2005), amongst others (Heinrichs & Zakzanis, 1998; Fioravanti et al., 2005; Reichenberg, 2010). These neurocognitive deficits are more often associated with negative and disorganized symptoms than
with positive symptoms (Basso, Nasrallah, Olson, & Bornstein, 1998; Pantelis, Stuart, Nelson, Robbins, & Barnes, 2001; Galderisi et al., 2009; Lindsberg, Poutiainen, & Kalska, 2009).

Heightened schizotypy has also been associated with subtle neurocognitive deficits in psychologically healthy people (Moritz, Andresen, Naber, Krausz, & Probstein, 1999; Noguchi, Hori, & Kunugi, 2008). Specifically, inverse associations have been found between schizotypy and verbal IQ (Noguchi et al., 2008), attention (Chen, Hsiao, & Lin, 1997), and working memory (Park & McTigue, 1997; Schmidt-Hansen & Honey, 2009). Furthermore, at least one paper has explicitly evaluated neurocognitive functioning in both schizotypy and schizophrenia together, on the basis of a fully dimensional model (Cochrane, Petch, & Pickering, 2012).

Cochrane et al. (2012) conducted two separate studies. In the first, it was reported that in 99 psychologically healthy people, the Interpersonal (negative) Factor of the SPQ was related to reduced verbal fluency, and the Disorganized Factor was related to reduced negative priming. In the second, corresponding symptom measures from the SAPS and SANS showed similar relationships with verbal fluency and negative priming in 20 participants with a diagnosis of schizophrenia. Again, similar to outcomes of research focused on psychosis, cognitive deficits associated with schizotypy appear to relate to negative (interpersonal) and disorganized traits rather than positive (cognitive-perceptual) traits (Chen et al., 1997; Park & McTigue, 1997; Moritz et al., 1999).

One point of departure in neurocognitive findings between schizotypy and psychosis is that effect sizes appear to be larger in psychosis research compared to schizotypy research. Specifically, significant reductions in cognitive skills in people with psychotic disorders are often reported alongside medium to large effect sizes.
(e.g. Reichenberg & Harvey, 2007; Simonsen et al., 2011); whilst effect sizes in studies of schizotypy are often small (e.g. Chen et al., 1997; Park & McTigue, 1997). As previously suggested, this may indicate that cognitive decline is much more prominent for people with psychotic disorders, and indeed may be a significant defining feature of clinical psychosis (Bora, Yucel, & Pantelis, 2010).

1.8.4. Environmental and Social Research

Further support for a continuum model of schizotypy and psychosis can be gleaned from research examining environmental and social correlates of the two constructs. Identified environmental and social risk factors for psychosis are wide-ranging. They include antenatal and birth complications such as maternal infections (Stober, Kocher, Franzek, & Beckmann, 1997; Brown, 2006; Xiao et al., 2009), nutritional deficiency (St Clair et al., 2005; Markham & Koenig, 2011), maternal stress during pregnancy (Markham & Koenig, 2011), fetal hypoxia (Cannon et al., 2000), and older parental age at conception (Malaspina et al., 2001; Petersen, Mortensen, & Pederson, 2011). They also include childhood trauma (Lardinois, Lataster, Mengelers, van Os, & Myin-Germeys, 2011), migration and minority group membership (Morgan, Charalambides, Hutchinson, & Murray, 2010), urbanicity (Kelly et al., 2010), cannabis use (Richardson, 2010), parental separation (including death; Morgan et al., 2007), adverse child rearing (Willinger, Heiden, Meszaros, Formann, & Aschauer, 2002), and childhood infection (Rantakallio, Jones, Moring, & von Wendt, 1997).

Similar environmental and social risk factors have been implicated in the development of anomalous experiences associated with schizotypy. Zammit et al. (2009) report in their longitudinal study of 6356 children, that ‘PLIKs’ (‘psychotic like experiences’) were positively associated with pregnancy and birth complications.
These included maternal infection, maternal diabetes, and need for resuscitation following birth (Zammit et al., 2009). Additionally, anomalous experiences have been associated with childhood trauma (Steel, Marzillier, Fearon, & Ruddle, 2009; Lovatt, Mason, Brett, & Peters, 2010), urbanicity (Scott et al., 2009), and ethnicity and minority group membership (Sharpley & Peters, 1999; Johns, Nazroo, Bebbington, & Kuipers, 2002; Morgan et al., 2009). Parental separation has been associated with symptoms of schizotypal personality disorder, which is said to lie on the continuum between schizotypy in healthy populations and full blown psychotic disorders (see Figure 1; Anglin, Cohen, & Chen, 2008). However there does not appear to be any research to date in addressing parental separation and schizotypy in healthy populations.

With respect to cannabis use, a large study involving 1049 students showed that high levels of cannabis use were associated with both positive and negative ‘non-clinical psychotic experiences’, as measured by the Community Assessment of Psychotic Experiences (CAPE; Stefanis et al., 2002) questionnaire (Skinner, Conlon, Gibbons, & McDonald, 2011). Furthermore, the earlier students began their cannabis use, the more likely they were to report positive anomalous experiences (Skinner et al., 2011). This study along with numerous others, echoes psychosis research and demonstrates a positive association between schizotypy and cannabis use (Barkus & Lewis, 2008; Compton, Chien, & Bollini, 2009; Esterberg, Goulding, McClure-Tone, & Compton, 2009; Cohen, Buckner, Najolia, & Stewart, 2011).

In addition, unlike the neurocognitive findings reported above, it is worth noting that effect sizes for these environmental findings appear on the whole to be of similar magnitude for both anomalous experiences (Morgan et al., 2010) and psychosis (Morgan et al., 2009). This may be because most studies investigating
environmental variables in relation to schizotypy have used measurement tools that assess for positive anomalous experiences specifically (such as the Psychotic-Like Experiences Structured Interview and Psychosis Screening Questionnaire; Bebbington & Nayani, 1995; Horwood et al., 2008; Morgan et al., 2009; Zammit et al., 2009), rather than all aspects of schizotypy (as is assessed via the SPQ and O-LIFE). This may have increased power, as effects did not get ‘washed out’ when averaging across qualitatively different aspects of schizotypy.

1.8.5. Biological Research: Neuroanatomical Abnormalities

Several of the key neuroanatomical findings relating to psychosis have also been replicated in schizotypy research. For instance, neurological soft signs are subtle deficits in areas such as motor coordination, laterality and sensory-perceptual performance (Obiols, Serrano, Caparros, Subira, & Barrantes, 1999). Unlike hard neurological signs, they do not indicate any specific neurological disease (Obiols et al., 1999). Higher rates of neurological soft signs have been identified in people with psychotic disorders compared to controls (Leask, Done, & Crow, 2002), and they have also been shown to correlate with schizotypy in non-clinical samples (Bollini et al., 2007; Kaczorowski, Barrantes-Vidal, & Kwapihl, 2009; Chan et al., 2010). In two studies, this relationship with schizotypy appeared to be driven by associations with interpersonal (negative) and disorganized factors rather than by associations with the cognitive-perceptual (positive) factor (Bollini et al., 2007; Kaczorowski et al., 2009). However, two studies have also found associations between neurological soft signs and positive aspects of schizotypy (Barkus, Stirling, Hopkins, & Lewis, 2006; Chan et al., 2010).

Furthermore, people with psychosis also have higher levels of the subtle
variations in bone structure, cartilage and soft tissue known as minor physical anomalies (McGrath et al., 2002). These minor physical anomalies have been significantly associated with levels of overall schizotypy, as well as cognitive-perceptual and interpersonal factors specifically (Bollini et al., 2007).

Lastly, there are wide reports of eye tracking dysfunction in relation to psychosis (Levy, Sereno, Gooding, & O'Driscoll, 2010), such as impairments in smooth pursuit and antisaccade eye movements (Lipton, Levy, Holzman, & Levin, 1983). Like neurological soft signs and minor physical anomalies, findings of oculomotor deficits have also been replicated in high schizotypy groups (O'Driscoll, Lenzenweger, & Holzman, 1998).

More recently, developments in neuroimaging technologies have identified structural, metabolic and functional brain abnormalities in relation to psychosis. These technologies include magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), diffusion weighted imaging (DWI), magnetic resonance spectroscopy (MRS), single-photon computed emission tomography (SPECT), and positron emission tomography (PET). There are a multitude of reviews and meta-analyses summarizing the field of neuroimaging and psychosis (Shenton, Dickey, Frumin, & McCarley, 2001; Pantelis et al., 2005; Gur, Keshavan, & Lawrie, 2007; Keshavan, Tandon, Boutros, & Nasrallah, 2008; Fornito, Yucel, Patti, Wood, & Pantelis, 2009; Wood, Yung, McGorry, & Pantelis, 2011), therefore only main findings are reported here.

Briefly, structural MRI studies have shown reduced whole-brain volume and complimentary enlargement of lateral ventricles and increases in cerebrospinal fluid (Gur et al., 2007; Keshavan et al., 2008). Affected cortical regions include, but are not limited to, medial temporal lobe areas - most notably the hippocampus and
amygdala (Velakoulis et al., 2006; Gur et al., 2007; Keshavan et al., 2008). DWI studies report deficits in white matter connectivity across the whole brain, corpus callosum, cingulum bundle, and superior longitudinal fasciculus, amongst others (Kubicki et al., 2007; Kyriakopoulos, Bargiotas, Barker, & Frangou, 2008; Seal et al., 2008; Zalesky et al., 2011). MRS research seems to have focused on findings of reductions in N-acetyl aspartate metabolites (Gur et al., 2007). PET and SPECT research has examined the role of over activation of dopamine receptors (particularly D2 receptors) in psychosis (Gur et al., 2007; Keshavan et al., 2008). Lastly, fMRI research has explored decreases in activation of the dorsolateral prefrontal cortex, especially when participants are presented with challenging cognitive tasks (Berman & Meyer-Lindenberg, 2004; Keshavan et al., 2008). This tendency is reinforced by outcomes of PET and SPECT research focusing on the same area (Keshavan et al., 2008).

Although there is substantial neuroimaging research into schizotypal personality disorder (Hazlett, Goldstein, & Kolaitis, 2012), as outlined below very few neuroimaging studies have been conducted looking at neuroanatomical correlates of schizotypy in psychologically healthy people. One MRI study reported that schizotypy was associated with reduced brain volume in prefrontal areas (Raine, Sheard, Reynolds, & Lencz, 1992). In another investigation, Modinos et al. (2010) gave a self-report measure of schizotypy to six hundred university students. Thirty-eight of the highest and lowest scorers subsequently underwent MRI scans. Differences between groups included significantly larger volumes in the whole brain, medial posterior cingulate cortex and precuneus for the high schizotypy group (Modinos et al., 2010). This was the reverse of what is normally seen in psychosis research, in which there are reductions in volume (Keshavan et al., 2008). However,
the authors concluded that their findings were consistent with a continuum model, citing previous research reports of increases in volume in schizotypal personality disorder and first-episode psychosis samples (Modinos et al., 2010), as opposed to reductions in volume in chronic schizophrenia samples (Keshavan et al., 2008). Increases in grey matter in the middle, superior temporal, angular, and orbitofrontal gyri have also been associated with PLEs (‘psychotic-like experiences’) in a young adolescent sample (Jacobson et al., 2010).

In another adolescent sample (aged 12-20), Lagioia, van den Ville, Debbane, Lazeyras and Eliez (2010) examined brain networks relating to schizotypy using fMRI. They report a discontinuity between their findings, and those investigating to psychosis. However, their study was limited by its small sample size of only thirty-nine across a relatively large developmental age range.

Then using diffusion weighted imaging, generalized ‘psychotic personality traits’ as measured by the Schizophrenia, Paranoia and Psychopathic Deviate subscale of the Minnesota Multiphasic Personality Inventory (MMPI-2), have been associated with white matter deficits in the corpus callosum, right arcuate fasciculus, and fronto-parietal fibers (Volpe et al., 2008). Similarly, the author’s own research has identified negative correlations between measures of white matter health and anomalous experiences in seven white matter tracts within frontal and temporal areas (Nelson et al., 2011). These tracts were the uncinate fasciculus bilaterally, the temporal part of the right superior longitudinal fasciculus, the left cingulum, forceps minor, and the bilateral anterior thalamic radiation. Currently, there are no known investigations of the neurobiological basis of schizotypy using MRS, PET, or SPECT imaging modalities.

The above evidence for a fully dimensional model of schizotypy and
psychosis is summarized in Table 1. In short, any assumption that schizophrenia, or even psychosis, is a discontinuous, stand-alone entity is problematic. It also flies in the face of an increasing body of literature detailing similarities between psychotic symptoms and anomalous experiences in psychologically healthy people. That is, positive symptoms and anomalous experiences show similar patterns of genetic inheritance, and similar environmental, neuropsychological and neurological correlates. To more closely examine one of these similarities (compromised white matter health), and to expand on our previous study, it is first necessary to describe how white matter health can be examined in the living human brain.
Table 1. Summary of evidence for etiological factors found to be related to both schizotypal traits and psychotic symptoms.

<table>
<thead>
<tr>
<th>Evidence from the Literature: Psychotic Symptoms</th>
<th>Evidence from the Literature: Schizotypal Traits</th>
<th>Evidence of Overlap between Psychosis and Schizotypy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemiological Studies</td>
<td>✓ Three symptom clusters; Positive, Negative and Disorganized.</td>
<td>✓ Three traits; Cognitive-Perceptual, Interpersonal and Disorganized.</td>
</tr>
<tr>
<td>Behavioural Genetics</td>
<td>✓ Psychotic disorders seen to be heritable.</td>
<td>✓ Schizotypal traits seen to be heritable.</td>
</tr>
<tr>
<td>Molecular Genetics</td>
<td>? Many various genes proposed to give rise to psychosis.</td>
<td>? Some genes proposed to give rise to schizotypal traits.</td>
</tr>
<tr>
<td>Neurocognitive Research</td>
<td>✓ Psychosis related to reductions in IQ, verbal IQ, working memory, executive function, and attention.</td>
<td>✓ Schizotypal traits related to reductions in Verbal IQ, attention and working memory.</td>
</tr>
<tr>
<td>Social and Environmental Research</td>
<td>✓ Psychosis associated with pregnancy and birth complications, trauma, minority group membership, urbanicity, and cannabis use.</td>
<td>✓ Schizotypal traits associated with pregnancy and birth complications, trauma, minority group membership, urbanicity and cannabis use.</td>
</tr>
<tr>
<td>Biological Research</td>
<td>✓ Psychosis associated with neurological soft signs, minor physical anomalies, eye tracking dysfunction, reduced whole brain volume, overactive dopamine receptors, and white matter changes.</td>
<td>? Schizotypal traits associated with neurological soft signs, minor physical anomalies, eye tracking dysfunction, reduced prefrontal volume, and white matter changes. However research is limited.</td>
</tr>
</tbody>
</table>
Chapter 2: Connectivity

This chapter describes recent developments in the literature on brain structure and function. More specifically, it describes how white matter connectivity can be examined *in vivo* via diffusion weighted imaging. Strengths and limitations of some of the various methods of diffusion weighted imaging are compared, as well as several quantitative measures pertaining to white matter organization.

2.1. Brain Connectivity

As was highlighted in Chapter 1, there is a paucity of research examining schizotypy using neuroimaging techniques. This is pertinent given the range of neuroimaging findings regarding psychosis (Shenton et al., 2001; Pantelis et al., 2005; Gur et al., 2007; Keshavan et al., 2008; Fornito et al., 2009; Wood et al., 2011). A fully dimensional model would suggest that similar (yet not necessarily pathological) findings would be seen in schizotypy, however to date this has not been examined in detail. Therefore, it was one aim of the current project to examine brain structural connectivity in relation to schizotypy, as it is a recent and particularly well-replicated and important neuroimaging area in psychosis research (Keshavan et al., 2008; Kyriakopoulos et al., 2008; Pettersson-Yeo, Allen, Benetti, McGuire, & Mechelli, 2011; Wang et al., 2012; Zhang et al., 2012). Brain connectivity, and in particular structural connectivity is therefore described in the following sections.

Up until very recently, research into the human brain did not focus on connections within the brain. Rather, it was focused on mapping brain areas according to function (Friston, 2002; Sporns, Chialvo, Kaiser, & Hilgetag, 2004; Sporns, 2011a). For example, it is now known that the occipital cortex is largely
responsible for vision, the hippocampus for memory, the frontal lobe for executive functions, and so on. This knowledge has been invaluable for understandings of the human brain, and for diagnosis and treatment of neurological conditions such as brain tumours, epilepsy, stroke, dementia, and traumatic brain injury (George et al., 1995; Assaf & Pasternak, 2008).

However, it has been somewhat less useful in the diagnosis and treatment of psychiatric disorders, including psychotic disorders. For instance, it has been shown that people with schizophrenia tend to do poorly on neuropsychological tests targeting the frontal lobes, compared to people who do not have schizophrenia (Heinrichs & Zakzanis, 1998). It is also known that people with schizophrenia tend to have larger ventricles in the brain than people without schizophrenia (Shenton et al., 2001). However, a diagnosis of schizophrenia, and treatment decisions cannot be made on the basis of these investigations into isolated areas of the brain. Nor do these investigations explain the full range of symptoms experienced by people with schizophrenia or other psychotic disorders. This may be due to limitations inherent in psychosis studies - including heterogeneous samples, subjective diagnoses, the confounding effects of medications, and so forth. Another very likely reason for this relatively slow progress in regards to biological research is simply that not enough is known about the brain.

What is beginning to be understood though, is that it is very probable that the brain as a whole is ‘greater than the sum of its parts’ (Damoiseaux & Greicius, 2009, p. 525). That is, the brain cannot be understood solely in terms of isolated areas being responsible for certain functions. Rather, it is more likely operating as an intricate network (or series of networks), achieving functions that would not be possible if brain areas operated in isolation of one another (Sporns et al., 2004). In particular,
recent moves toward the study of brain connectivity are based on the idea that the brain is made up of complex and interactive networks. These networks are comprised of individual neurons at the microscopic level, neuronal populations at the mesoscopic level, and brain regions connected by white matter tracts at the macroscopic level (Sporns, 2007).

2.2. Brain Connectivity and Psychopathology

Research on brain networks and connectivity is becoming increasingly useful in furthering knowledge about a broad range of psychiatric disorders; such as attention deficit disorder (Konrad & Eickhoff, 2010), obsessive compulsive disorder (Zhang et al., 2011), substance abuse (Yuan et al., 2010), and others (see Broyd et al., 2009; Menon, 2011; Thomason & Thompson, 2011; Whitfield-Gabriel & Ford, 2012 for review). In relation to psychosis in particular, it has been suggested that brain connectivity may play a central role in its etiology (Pettersson-Yeo et al., 2011). The ‘dysconnectivity hypothesis’ of schizophrenia specifically posits that its symptoms may be due to abnormal functional integration between various areas of the brain (Friston & Frith, 1995; McGuire & Frith, 1996; Pettersson-Yeo et al., 2011).

Support for the dysconnectivity hypothesis comes from a wide range of research studies, including those showing disrupted structural connectivity in schizophrenia as assessed via DWI (Schlosser et al., 2003; Kubicki et al., 2007; Kyriakopoulos et al., 2008; Liu et al., 2008; Rubinov et al., 2009; Pettersson-Yeo et al., 2011; Wang et al., 2012). In relation to psychotic disorders more broadly, disrupted structural connectivity has been reported not only in people with schizophrenia, but also in people with first episode psychosis (Szesko et al., 2005; Kyriakopoulos & Frangou, 2009), bipolar disorder (Adler et al., 2004), and
schizoaffective disorder (Szesko et al., 2005). This disrupted structural connectivity is most often manifested as altered white matter integrity involving frontal lobe afferent and efferent connections (Pettersson-Yeo et al., 2011).

Despite these findings, and as briefly indicated in the previous chapter, research into schizotypy and connectivity in psychologically healthy populations has substantially lagged behind that of psychosis research. There have been no studies evaluating functional or effective connectivity in relation to schizotypy. There have only been two studies investigating structural connectivity using DWI – one in relation to ‘psychosis-proneness’ (Volpe et al., 2008), and the other in relation to schizotypy itself (Nelson et al., 2011).

In the first study (as mentioned briefly in Chapter 1), thirteen healthy control participants were allocated to ‘low psychotic’ and ‘high psychotic’ groups, based on their scores on the Schizophrenia, Paranoia and Psychopathic deviate subscales of the MMPI-2 (Volpe et al., 2008). Using DWI, an index measuring white matter (fractional anisotropy; FA) was compared between groups across all areas of the brain. FA was lower in the corpus callosum, right arcuate fasciculus, and fronto-parietal fibers for the ‘high psychotic’ group (Volpe et al., 2008). In this context, lowered FA can be understood as altered white matter integrity.

The second study reported similar findings (Nelson et al., 2011). For twenty-one participants, scores on the SPQ were investigated in relation to FA in twenty white matter tracts. Significant relationships were identified between the SPQ Cognitive-Perceptual Factor (assessing anomalous experiences), and seven white matter tracts located within frontal and temporal areas (Nelson et al., 2011). As the number of self-reported anomalous experiences increased, FA decreased in the left uncinate fasciculus, right uncinate fasciculus, right superior longitudinal fasciculus,
left cingulum, forceps minor, left anterior thalamic radiation, and right anterior thalamic radiation (Nelson et al., 2011). Again, lower FA was taken as a broad indication of altered white matter integrity.

However, some limitations of both of these studies can be identified. Notably, both had very small sample sizes, and lacked clinical psychosis groups for comparison. Furthermore, the first study statistically dichotomized their control group, which is likely to have resulted in loss of statistical power. It also used a voxel-wise approach for imaging analysis, which as will be seen below, is not an optimal method. Therefore, the present research sought to further elucidate these previous findings by investigating connectivity and positive anomalous experiences in a sample that included both schizotypy and psychosis groups, that employed regression analyses, and that used an optimal method for DWI.

2.3. Diffusion Weighted Imaging (DWI)

In order to adequately compare the quality of DWI studies, it is necessary to first understand the mechanisms through which it works. DWI is an MRI technique that can provide specific information about the structural connectivity of the brain. It measures the diffusivity of water molecules through brain tissue and in so doing, provides an indirect estimate of both the architecture and health of the brain’s white matter. DWI enables assessment of the structure of white matter tracts, or connections between neurons in the brain (Catani, 2006). It is particularly useful in the analysis of pathological processes involved in diseased and disordered states (Johansen-Berg & Behrens, 2006); such as stroke (Moseley et al., 1990; Eliassen et al., 2008), multiple sclerosis (Ge, Law, & Grossman, 2005; Zhou, Shiroishi, Gong, & Zee, 2010), tumour (Sanghvi, 2009; Giussani et al., 2010), traumatic brain injury (Huang et al., 2009;
Maller et al., 2010), epilepsy (Dumas de la Rogue et al., 2005; Luat & Chugani, 2008), and notably - schizophrenia (Kubicki et al., 2007; Kyriakopoulos et al., 2008) and schizotypal personality disorder (Nakamura et al., 2005; Hazlett et al., 2011). It is also useful for assessment of variability in white matter within healthy populations. For instance, DWI has been used to assess variation in white matter integrity in relation to musicality (Schmithorst & Wilke, 2002; Bengtsson et al., 2005), reading ability (Qui, Tan, Zhou, & Khong, 2008), and personality (Xu & Potenza, 2012).

During a diffusion weighted MRI sequence, the flow of water molecules through, between, and around cells in the brain is measured and quantified (Basser & Jones, 2002). This measurement is based on the phenomenon of Brownian motion, or the constant random movement of water molecules (Kubicki et al., 2007). In an unconstrained environment, the diffusion of water molecules is described as isotropic; i.e. water molecules are equally likely to move in all directions. However the brain is a highly organized structure consisting of a range of different tissue types, with different membrane properties that constrain diffusion. Tissue which acts to constrain the diffusion of water (such as myelinated cell membrane) is said to be anisotropic (Hoptman et al., 2002). In white matter in particular, water molecules tend to flow more freely along (parallel to) an axon than across (perpendicular) to an axon (Pierpaoli & Basser, 1996; Hoptman et al., 2002). In a diffusion weighted scanning sequence, this water movement can be measured and subsequently quantified in order to reconstruct three-dimensional images of the brain’s white matter.
2.4. Methods of Diffusion Weighted Imaging Analysis Part I: Constructing A Visual Representation

Not surprisingly for such a young research field there is currently no gold standard for analysis of DWI data (Johansen-Berg & Behrens, 2006). As DWI is currently one of the only methods available to examine white matter in vivo, this does not render it useless (Johansen-Berg & Behrens, 2006); but it does mean that any chosen approach to DWI analysis should be carefully considered in detail. Therefore, the following sections describe and evaluate some of the various methods of DWI, beginning with Diffusion Tensor Imaging (DTI).

2.4.1. Strengths and Limitations of Diffusion Tensor Imaging (DTI)

DTI is the most widely used method of analysis of diffusion weighted MRI scans. DTI models overall diffusion in a voxel in terms of a predominant tensor, and requires an acquisition of at least six non-collinear and non-planar diffusion measurements within a three-dimensional voxel during a diffusion weighted sequence (Kubicki et al., 2007). This allows diffusion within each voxel to be described as a 3x3 matrix, or diffusion tensor (Kubicki et al., 2007). Measurements of diffusion along each of the three dimensions (axes) can be visualized as spherical if diffusion is isotropic, or as ellipsoidal if diffusion is anisotropic (Figure 2; Kubicki et al., 2007).
As is shown in Figure 2 above, the shape of the diffusion ellipsoid thus depends on the relative size of diffusion along the three mutually perpendicular and orthogonal axes (Pierpaoli & Basser, 1996). The eigenvectors of the diffusion tensor ($\varepsilon_1$, $\varepsilon_2$ and $\varepsilon_3$) represent the direction of each axis, and the corresponding eigenvalues ($\lambda_1$, $\lambda_2$ and $\lambda_3$) represent the relative magnitude of the vector (Pierpaoli & Basser, 1996; Dwork, Mancevski, & Rosoklija, 2007). If diffusion is anisotropic, the largest eigenvalue ($\lambda_1$) will denote the diffusion coefficient parallel to the axonal fibers (the axial diffusivity; AD; Song et al., 2002), while $\lambda_2$ and $\lambda_3$ will denote the diffusion perpendicular to the axonal fibers (the radial diffusivity; RD; Pierpaoli & Basser, 1996). If diffusion is isotropic, all eigenvectors and eigenvalues should be relatively equal.

Most research findings in regards to psychosis and white matter are derived from DTI, and both the Volpe et al. (2008) and Nelson et al. (2011) studies used DTI. However, despite being commonly used and reasonably robust, one notable problem with DTI lies in the model’s (Gaussian) assumption that there is only one diffusion...
ellipsoid within each three-dimensional voxel (Descoteaux, Deriche, Knosche, & Anwander, 2009). In this way, the diffusion tensor model is only able to represent white matter fibers in one direction going into, and out of a voxel.

In structural brain imaging, most voxels are between 1-2ml in size (Lenroot & Giedd, 2006), and may contain thousands of axons (Johansen-Berg & Behrens, 2009). Therefore, the idea that these fibers all follow one uniform direction is conceptually unlikely. It is now understood that voxels containing fibers that all follow one direction are the exception rather than the rule, with multiple fiber directions identified in up to 90% of brain voxels (Behrens, Berg, Jbabdi, Rushworth, & Woolrich, 2007; Jeurissen, 2010; Tournier, Mori, & Leemans, 2011; Jeurissen, Leemans, Tournier, Jones, & Sijbers, In Press). This can occur in a number of different ways – all referred to heuristically as ‘crossing fibers.’ Examples of crossing fibers within a three-dimensional voxel can be seen in Figure 3, which shows bending, fanning, interdigitating and adjacent fiber bundles respectively (Tournier et al., 2011). Fibers that follow multiple directions within a single voxel artificially reduce quantitative measurements of diffusion, particularly the diffusion tensor. This is turn can confound results, especially in light of subsequent imaging analyses such as tractography (mentioned in more detail below).
Figure 3. Graphic example of crossing fibers. Image shows i) bending, ii) fanning, iii) interdigitating, and iv) adjacent fiber bundles (sourced from Tournier et al., 2011).

2.4.2. Quantitative Measurements from Diffusion Tensor Imaging

After images have been processed using DTI, a number of quantitative measures can be obtained from the data. After the eigenvectors and eigenvalues of the diffusion tensor for each voxel have been estimated, it is possible to calculate measures of diffusivity (Hoptman et al., 2002). These include the trace, relative anisotropy (Basser, 1995), fractional anisotropy (FA; Basser, 1995), mean diffusivity (MD), axial and radial diffusivity (AD and RD; mentioned above), volume ratio (Basser, 1995), and intervoxel coherence (Pfefferbaum et al., 2000). Slightly different inferences about underlying white matter structure can be made from each of these measures, and four of them – FA, MD, AD and RD – are described in more detail.
Fractional anisotropy (FA) describes the degree of anisotropic diffusion in one single direction, with a value of 0 representing complete isotropic diffusion, and a value of 1 indicating diffusion constrained completely in one direction (Hoptman et al., 2002). FA is calculated via the following equation (Pierpaoli & Basser, 1996):

\[
FA = \sqrt{\frac{3}{2} \left( \lambda_1 - \lambda \right)^2 + \left( \lambda_2 - \lambda \right)^2 + \left( \lambda_3 - \lambda \right)^2}
\]

\[
\sqrt{\lambda_1^2 + \lambda_2^2 + \lambda_3^2}
\]

where \( \lambda = \frac{\lambda_1 + \lambda_2 + \lambda_3}{3} \)

It has become increasingly evident that observed reductions in FA could be attributed to a range of factors including axonal disorganization (Hoptman et al., 2002), reduced fiber size and/or density (Madler, Drabycz, Kolind, Whittall, & Mackay, 2008), and demyelination (Filippi, Cercignani, Inglese, Horsfield, & Comi, 2001). However, reduced FA is also observed in voxels that contain crossing fibers (Papadakis et al., 1999; Kubicki et al., 2003). Therefore, it is important not to rely on FA alone when making inferences about the underlying white matter pathology that may give rise to changes in diffusivity measurements.

Another measure, mean diffusivity (MD) represents the magnitude of diffusion within a voxel, without regard to direction. It is calculated with this equation:

\[
MD = \frac{\lambda_1 + \lambda_2 + \lambda_3}{3}
\]

Then, axial diffusivity (AD) measures diffusion parallel to the axonal fiber. It
corresponds to the value $\lambda_1$ of the diffusion tensor (Pierpaoli & Basser, 1996; Song et al., 2002; Kubicki et al., 2007). Reduced AD has previously been interpreted as relating to axonal damage (Song et al., 2005; Kim et al., 2006; Kraus et al., 2007), as well as reduced axonal coherence (Dubois et al., 2008).

In contrast, radial diffusivity (RD) corresponds to the magnitude of diffusion perpendicular to the axonal fiber. Increases in RD have been speculated as relating to demyelination (Song et al., 2005; Kraus et al., 2007), and reductions in fiber density (Beaulieu, 2006). RD is calculated with the following equation (Song et al., 2002):

$$\frac{\lambda_2 + \lambda_3}{2}$$

2.4.3. Alternatives to Diffusion Tensor Imaging

The limitations of the DTI model reviewed above have resulted in the more recent development of methods to construct visual brain images that can model multiple fiber directions within a single voxel. These will not be described in detail, but include q-space approaches which are usually derived from data acquired from high-angular-resolution diffusion imaging (HARDI; Tournier, Calamante, & Connelly, 2007; Tournier et al., 2011). Examples are diffusion spectrum imaging (Wedeen, Hagmann, Tseng, Reese, & Weisskoff, 2005), q-Ball imaging (Tuch, Reese, Wiegell, & Wedeen, 2003), composite hindered and restricted model of diffusion (CHARMED; Assaf & Basser, 2005), techniques based on persistent angular structure (Jansons & Alexander, 2003), and techniques based on spherical deconvolution (Alexander, 2005; Tournier et al., 2011).

One technique for modeling fiber orientations which is gaining popularity is
constrained spherical deconvolution. It was developed by Tournier and colleagues, and has many advantages when compared against other methods (Tournier, Calamante, Gadian, & Connelly, 2004; Tournier et al., 2007; Tournier et al., 2008; Tournier et al., 2011). Most notably, it is able to resolve narrow fiber crossing angles while remaining robust to noise (Tournier et al., 2004; Tournier et al., 2007; Tournier et al., 2008). This facilitates more accurate subsequent analyses like tractography (Tournier et al., 2004). Figure 4 represents an example of the ability of CSD to resolve and construct multiple fiber orientations within a single voxel.

Figure 4. An example orientation plot comparing CSD and DTI. The image was constructed using data from a control participant involved in the present research. CSD is shown on the right and DTI on the left.
2.5. Methods of Diffusion Weighted Analysis Part 2: Comparing Data Between Groups

Similar to the methodological issues involved in constructing images, and because DWI is a relatively new field of research, there is no current ‘gold standard’ for comparing data between groups (Smith et al., 2004; Kanaan et al., 2005). As such, a number of methods have been developed for the quantitative analysis of diffusion within an image. Methods include voxel-based analysis, region of interest approaches, deterministic tractography, and probabilistic tractography. There are certain strengths and limitations involved with each one, and it is important to again remember that despite the variance in findings arising from these methods, DWI is currently the only means by which to assess the orientation, development and health of white matter tracts in vivo (Johansen-Berg & Behrens, 2006).

2.5.1. Whole Brain Versus Region of Interest Techniques

When conducting whole brain analyses, (specifically voxel-based analysis), diffusion measurements for every voxel in the brain are compared with diffusion measurements for every other voxel in the brain. This allows the identification of groups of voxels that show significant differences in white matter measures between samples, as well as the identification of groups of voxels that correlate with variables of interest (Smith et al., 2006). One advantage of voxel-based analysis is that it allows for whole brain exploratory analysis. It is also relatively ‘operator independent’ in that it does not necessitate any expert knowledge of brain anatomy prior to analysis (Catani, 2006). However, by comparing hundreds of voxels against each other, the chance of Type 1 error is high. Furthermore, voxel-based techniques require brain images to be registered to a standardized template and spatially smoothed. This increases the
chances of distorted and misaligned data. In other words, white matter structures vary in location between participants, and there is no way of ensuring that they will align after all images are registered to a standard space (Smith et al., 2006; Evans, Janke, Collins, & Baillet, 2012). Another whole brain approach, tract-based spatial statistics (TBSS) assists in ameliorating this problem (Smith et al., 2006; http://fsl.fmrib.ox.ac.uk/fsl/fslwi/TBSS).

Via this approach, analysis is conducted on only those white matter voxels shared by all participants. First participants’ FA images are registered to a standard space. Then a common white matter skeleton is created from the FA images, which essentially follows the center of each major white matter tract. Voxelwise statistics are performed for the voxels within this skeleton, greatly reducing the likelihood of including misaligned data. Another major benefit of TBSS is its method for statistical comparison of data, which is performed using its associated Randomise software (Nichols & Holmes, 2002). Where many studies still use parametric analysis techniques for group comparison, via Randomise it is possible to perform nonparametric tests (Nichols & Holmes, 2002). This is a conservative method appropriate for the multiple comparisons inherent in neuroimaging research, and it is not affected by outliers or skewed data.

An alternative to taking a voxel-based approach is to take a region of interest approach. These involve a priori specification and isolation of brain regions from which to investigate and compare statistically. Regions of interest can either be broad, non-specific white matter areas like frontal regions, or particular points within tracts (Kubicki et al., 2007). The most obvious advantage of region of interest approaches is the ability to compare specific brain regions (Catani, 2006). However, this means that it may not be possible to discern whether differences are specific to the particular
brain regions sampled, or whether differences are widespread over the whole brain – unless voxel-based analysis is carried out first. As with voxel-based analysis, there are also problems of registration and variability in white matter structures between participants, with the possibility of sampled areas not being uniformly comparable (Kubicki et al., 2007). Furthermore, these approaches are most often ‘operator dependent’ and rely on a priori anatomical knowledge to identify and create particular regions of interest.

2.5.2. Tractography

Another method used to compare diffusion weighted brain imaging data between groups is tractography. Both deterministic and probabilistic tractography are used to estimate actual fiber tract regions of interest by following the direction of maximum diffusion within each voxel, from a seed point. This constructs a three dimensional pathway that is assumed to correspond to that of the underlying fiber bundle (Johansen-Berg & Behrens, 2006). Deterministic tractography considers a single orientation at each voxel, whereas probabilistic tractography considers a distribution of orientations. Tractography is performed on each individual separately, and avoids problems associated with registration (Hagler et al., 2009). It is a hodological approach that investigates connections between brain areas, rather than identifying the white matter of particular regions in isolation of one another (Catani, 2006). As we have seen in terms of connectivity, investigating white matter connections in this way is more representative of current understandings of brain architecture and function.

However, tractography is similarly not without limitations. It becomes problematic if there are crossing fibers within a voxel, as constructed pathways then
can begin to follow unlikely or impossible routes (Jones, 2008; Hagler et al., 2009). This is especially true of deterministic tractography using the diffusion tensor model above. The problem can be addressed by ensuring operators have expert anatomical knowledge, and can remove nonsensical pathways manually. It can also be improved if an alternative to the diffusion tensor model is implemented (Descoteaux et al., 2009; Pannek et al., 2011). For instance, via the MRtrix software program (Tournier et al., 2007) it is possible to perform tractography quickly and easily using either the diffusion tensor model, or the alternative constrained spherical deconvolution model. Two tracts constructed using each method are presented for comparison in Figure 5.

**Figure 5.** An example of the uncinate fasciculus constructed via CSD as compared the DTI. Both images use probabilistic tractography. As can be seen, the tract constructed from DTI ends prematurely (left), whereas the tract constructed from CSD continues into the anterior frontal cortex (right). Data used in these images were from a control participant involved in the present research.

### 2.6. Choosing a Method of Analysis

In choosing a method of diffusion weighted analysis for the current project, considerations of speed, accuracy, validity, operator independence and most importantly reliability were taken into account. In meeting these requirements, it was decided that the TBSS technique would provide robust whole-brain analysis without the limitations of conventional VBM approaches. TBSS has been very widely used in
a range of different diseased and healthy samples (e.g. Anjari et al., 2007; Focke et al., 2008; Giorgio et al., 2008; Silk, Vance, Rinehart, Bradshaw, & Cunnington, 2008; Yeh, Simpson, Durazzo, Gazdzinski, & Meyerhoff, 2009; Fernandez-Espejo et al., 2011). It has also been used in a number of studies comparing people with schizophrenia to healthy controls (Douaud et al., 2007; Karlsgodt et al., 2008; Seal et al., 2008; Camchong, Lim, Sponheim, & MacDonald, 2009). To the best of our knowledge, TBSS has never been used for research into schizotypy in psychologically healthy participants, however the previous studies employing TBSS for schizophrenia provide a good basis for comparison of results in the present research.

The present research into structural brain connectivity and positive anomalous experiences should expand on the author’s previous findings, which indicated a relationship between structural connectivity and the cognitive-perceptual factor of schizotypy (Nelson et al., 2011). This relationship between biological variables and anomalous experiences, which in turn corresponds to research indicating a relationship between biological variables and psychosis, has important implications. It provides impetus for investigation into phenomena that may account for differences between the two constructs. That is, it prompts an assessment of possible distinguishing factors between someone who has anomalous experiences but is psychologically healthy, and someone whose anomalous experiences develop into clinical psychosis. Based on a fully dimensional model of schizotypy, and the research described in the following chapter, it is proposed that two important distinguishing areas between schizotypy and psychosis may be those of cognition and cognitions.
Chapter 3: Cognition

In addition to white matter organization reviewed in Chapter 2 above, this chapter briefly reviews two areas proposed to further contribute to the development of schizotypal and psychotic experiences. First, evidence for the ability of neurocognitive functioning to distinguish between a range of levels on the schizotypy-psychosis continuum is briefly described. Then, also based on recent evidence, it is proposed that unhelpful responses to and appraisals of positive anomalous experiences may contribute to their development and ongoing maintenance.

3.1. ‘Cognition’ and ‘Cognitions’

For the purposes of this research, the difference between cognition and cognitions can be understood in terms of the difference between thinking and thoughts, and it is proposed that both are important in the etiology of psychosis. Cognition (or ‘neurocognition’) refers to thinking abilities and processes. It is an umbrella term for neurocognitive constructs such as Full Scale IQ (FSIQ), Verbal and Performance IQ, executive functioning, working memory, attention, and processing speed. Cognitions on the other hand, refer to specific thoughts and/or thinking styles. Metacognition, or ‘thoughts about thoughts’ can also be subsumed under the umbrella term ‘cognitions’. Research regarding positive anomalous experiences and ‘cognition’, as well as research regarding positive anomalous experiences and ‘cognitions’ will be examined in the following sections.
3.2. Positive Anomalous Experiences and Cognition

Research in relation to positive anomalous experiences and neurocognitive (‘cognition’) variables has already been reviewed in Chapter 1. To briefly re-visit it; a range of relative neurocognitive deficits have been consistently reported in relation to psychosis (Fioravanti et al., 2005; Reichenberg, 2005; Tandon et al., 2009; Simonsen et al., 2011). They have also been reported in samples of people who score highly on measures of schizotypal personality (Chen et al., 1997; Park & McTigue, 1997; Noguchi et al., 2008; Schmidt-Hansen & Honey, 2009), most notably in areas of verbal IQ, attention and working memory (Chen et al., 1997; Park & McTigue, 1997; Noguchi et al., 2008).

However, despite well-replicated findings across the continuum, investigations have not previously been directly comparable. This is because although studies usually use uniform, standardised neurocognitive tasks (e.g. Cochrane et al., 2012), different symptom measures have been used for psychosis as compared to schizotypy. For example, neurocognitive findings regarding psychosis are usually investigated in relation to diagnostic group, as well as symptom scales such as the SAPS, SANS and the Positive and Negative Syndrome Scale (PANSS; e.g. Basso et al., 1998; Galderisi et al., 2009; Lindsberg et al., 2009). In contrast, neurocognitive findings in relation to schizotypy are usually investigated in terms of dimensional factor correlates derived from questionnaire-based measurements such as the SPQ (e.g. Chen et al., 1997; Park & McTigue, 1997). A clear example of this comes from Cochrane et al. (2012), who directly compared two neurocognitive tasks and symptom correlates in both schizotypy and schizophrenia. However, this was completed via two separate studies, one which used the SPQ to measure schizotypy in psychologically healthy people, and another which used the SAPS and SANS to
measure psychotic symptoms in people with schizophrenia. Although similar relationships were found between neurocognitive tasks and symptoms across both studies, it could be argued that they were not comparable, as different symptom measures were used.

To our knowledge, there are no studies that have looked at neurocognitive findings and symptom correlates using the same measure/s in relation to both schizotypy and psychosis together. It is for this reason that the present research seeks to investigate and compare the relationship between neurocognitive variables and positive anomalous experiences in both schizotypy and psychosis using the same measures of positive anomalous experience for both groups. Although research has suggested that neurocognition may be more related to negative symptomatology and experiences as opposed to positive (Chen et al., 1997; Park & McTigue, 1997; Galderisi et al., 2009; Lindsberg et al., 2009), there is growing research evidence to support a hypothesis that positive anomalous experiences may be independently related to neurocognition (Chen et al., 1997; Schmidt-Hansen & Honey, 2009).

3.3. Positive Anomalous Experiences and Cognitions

It has been proposed that another important difference between the occurrence of anomalous experiences as compared to positive symptoms may be characterized by ‘unhelpful thinking styles’, or appraisals of experience (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001; Morrison, 2001; Garety et al., 2007). That is, the way in which an individual responds to and thinks about their own positive anomalous experiences may have an effect on the frequency and severity of subsequent experiences.

Garety and colleagues (Garety et al., 2001; 2007) have developed a model for
how this may occur, which is shown in Figure 6. The model describes how bio-
psycho-social vulnerabilities, as well as stress and resulting emotional changes
(usually negative affect) may come together to increase the probability that an
individual has anomalous experiences. Then, individuals who have ‘dysfunctional’
(negative) schemas about themselves and others; who respond to their anomalous
experiences with unhelpful thinking styles (such as avoidance, cognitive control, and
immersion); and who experience isolation and adversity as a result of their anomalous
experiences - are more likely to experience further stress and emotionality. This
results in more frequent and severe positive anomalous experiences subsequently, and
may even develop into full-blown positive symptoms. In turn, positive symptoms are
further maintained by those same unhelpful thinking styles, appraisals and responses.

**Figure 6.** Garety and colleagues' (2001; 2007) cognitive model of the positive
symptoms of psychosis (sourced from Garety et al., 2007).
Elements of this theory have been formally tested using an instrument specifically developed for this purpose; the Appraisals of Anomalous Experiences Interview (AANEX; see Appendix E), developed by Brett, Peters, Johns, Tabraham, Valmaggia, and McGuire (2007). The AANEX is a two-part semi-structured interview. The first part (the AANEX Inventory), seeks to comprehensively document any positive anomalous experiences an individual may have had in the past, or is having currently. The second part of the AANEX (the AANEX-CAR) assesses the Context, Appraisals, and Responses associated with any anomalous experiences endorsed during the Inventory.

The structure, reliability and validity of the AANEX is further discussed in the method section (Chapter 5). However in terms of the validity of findings derived from the AANEX; Brett et al. (2007) used it to differentiate nonclinical individuals from high-risk and clinical psychosis groups. In this investigation, there were differences between groups in terms of their emotional responses to positive anomalous experiences, with more negative and anxious responses in the clinical psychosis group and more positive and excited responses in the nonclinical group. There were also differences in attributions of experiences, with the clinical psychosis group more likely to attribute their experiences to biological factors and other people, and the nonclinical group more likely to attribute their experiences to psychological factors. The nonclinical group reported higher perceived control over their positive anomalous experiences, and were more likely to report a belief that their experiences would be understood by others in their social group. In terms of participants’ cognitive and behavioural responses to positive anomalous experiences, individuals in the clinical psychosis group were more likely use strategies of avoidance, cognitive control and immersion (Brett et al., 2007). These reported findings were considered
to largely support the model of Garety et al. (2001; 2007) in Figure 6 (Brett et al., 2007).

Further evidence for the ability of cognitions, or what is described as an overarching category of ‘thinking style’ to differentiate between a range of levels on the psychosis continuum has been documented by a number of studies (e.g. Garcia-Montes, Perez-Alvarez, Balbuena, Garcelan & Cangas, 2006; Brett et al., 2007; Morrison French & Wells, 2007). For example, Cangas, Errasti, Garcia-Montes, Alvarez and Ruiz (2006) showed that in a sample of 81 university students, negative beliefs about the uncontrollability of thoughts, about the potential danger of thoughts, and cognitive confidence (one’s belief in their own thinking abilities), as measured by the Metacognitions Questionnaire (MCQ; Cartwright-Hatton & Wells, 1997), were related to scores on a measure of subclinical hallucinatory-like experiences. Another study completed by Morrison, French and Wells (2007) also showed that mean scores on the MCQ were higher for a group of 43 participants defined as at-risk for developing psychosis as compared to 188 controls, and higher for a group of 73 participants with psychotic disorders as compared to both at-risk and control groups.

These findings of unhelpful thinking styles present in people with psychotic disorders supports recent attempts to expand the use of cognitive-behavioural therapy (CBT) as a treatment for psychosis (Rector & Beck, 2001; Zimmerman, Favrod, Trieu, & Pomini, 2005; Wykes, Steel, Everitt, & Tarrier, 2008). CBT may assist in preventing the progression of the ‘vicious cycle’ of unhelpful thinking and ongoing positive anomalous experiences as described in Garety et al.’s (2001; 2007) model (Kuipers & Bebbington, 2006).

Drawing on previous research, particularly that of Morrison (2001; 2007), Garety et al. (2001; 2007), and Brett et al. (2007); the following interpretations,
appraisals, and responses as measured by the AANEX-CAR are proposed to comprise the overarching category of ‘unhelpful thinking’ in the present research.

Interpretation of an anomalous experience is described as unhelpful if the experience is viewed as negative, dangerous, personally caused, and/or originating from an external source (Garety et al., 2001; 2007; Brett et al., 2007). Emotional appraisal of an anomalous experience is described as unhelpful if it is negative (Garety et al., 2001; 2007; Brett et al., 2007). Cognitive and behavioural responses to an anomalous experience are described as unhelpful if they involve avoidance, attempted cognitive control, immersion in the experience, or rumination (Brett et al., 2007; Morrison, 2001; Garety et al., 2001; 2007). Lastly, the implications of an appraisal are described as unhelpful if they include a sense that self-esteem has been compromised, a perception that others will not be supportive, and a lack of sense of control over the experience (Brett et al., 2007; Garety et al 2001, 2007). Items from the AANEX-CAR that correspond to these elements of unhelpful thinking are shown in Table 2.
Table 2. Thinking style items relevant to the present research, drawn from the AANEX-CAR (Brett et al., 2007).

<table>
<thead>
<tr>
<th>Thinking Style Item</th>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does the person view their experience/s as beneficial or negative?</td>
<td>1 (strongly negative) to 5 (strongly beneficial).</td>
</tr>
<tr>
<td>2. Does the person view their experience/s as potentially or actually dangerous or harmless?</td>
<td>1 (completely harmless) to 5 (definitely dangerous or harmful).</td>
</tr>
<tr>
<td>3. Does the person view their experience/s as essentially having been caused by something internal, or something external?</td>
<td>1 (entirely due to internal factors) to 5 (source of experience and source of change external to the self).</td>
</tr>
<tr>
<td>4. Does the person view the experience/s as having been caused by some person or agency, or by some impersonal process or factors?</td>
<td>1 (source entirely impersonal) to 5 (source entirely personal).</td>
</tr>
<tr>
<td>5. Interviewer rating of negative feelings (bad feelings, worries, fears).</td>
<td>1 (no bad feelings) to 5 (only negative feelings reported).</td>
</tr>
<tr>
<td>6. Interviewer rating of avoidance (turning attention away from the event/s and towards some other activity).</td>
<td>1 (no avoidance) to 5 (only avoidance).</td>
</tr>
<tr>
<td>7. Interviewer rating of rumination (involves intellectual exploration of the meaning or implications of the event/s, either voluntarily or involuntarily and is within the frame of reference engendered by the event as initially interpreted. I.e. lack of secondary appraisal)</td>
<td>1 (no rumination) to 5 (only rumination).</td>
</tr>
<tr>
<td>8. Interviewer rating of cognitive control (cognitive check, such as self-statements, trying to control thoughts or deliberately re-framing the experience/s in another way).</td>
<td>1 (no attempted control) to 5 (only control).</td>
</tr>
<tr>
<td>9. Interviewer rating of immersion (any active response that is completely congruent with the initial experience of the event/s: either in terms of speech or behavior, some kind of mental resistance to the event/s or perceived cause of the event/s, or encouragement or pursuit of the events/s)</td>
<td>1 (no immersion) to 5 (only immersion).</td>
</tr>
<tr>
<td>10. What effect does this experience/s have on how you see yourself?</td>
<td>1 (greatly worse about myself), to 5 (greatly better about myself).</td>
</tr>
<tr>
<td>11. Do you feel your experience/s would be understood by your social group, or do you feel it would be best to keep quiet about it?</td>
<td>1 (definitely keep quiet) to 5 (definitely understand).</td>
</tr>
<tr>
<td>12. When you experienced this, how much control did you have over the experience/s?</td>
<td>1 (no control) to 5 (total control).</td>
</tr>
</tbody>
</table>
Chapter 4: Aims and Hypotheses

Based on the literature reviewed above, this chapter defines the aims and hypotheses of the present research. In addition to an overall aim of the project as a whole, three sets of aims and hypotheses are described, which correspond to three individual studies.

4.1. Aims and Hypotheses

The current project had four aims. The first and overarching aim was to systematically evaluate the fully dimensional model by assessing if similar relationships existed between a range of neuroanatomical, neurocognitive, and clinical variables and both anomalous experiences associated with schizotypy and positive symptoms associated with psychosis. This aim was explored through three different studies, each with their own hypotheses as follows.

Study 1 sought to determine whether the frequency and severity of positive anomalous experiences across individuals' lifetimes are related to thinking style, as would be suggested Garety et al.'s (2007) model (Figure 6). The first hypothesis for Study 1 was that individuals with a psychotic disorder would exhibit differing patterns of thinking style compared to psychologically healthy individuals who have positive anomalous experiences, as evidenced by significant differences on each of the twelve thinking style variables drawn from the AANEX-CAR (represented in Table 2). The second hypothesis for Study 1 was that for both psychologically healthy individuals and for individuals with psychosis, these same twelve thinking styles would be related to the frequency and intensity of positive anomalous experiences across participants' lifetimes.
The aim for Study 2 was to assess whether similar patterns of relationship exist between neurocognitive variables and positive anomalous experiences, across both psychologically healthy and psychosis groups. For this study, uniform measures of positive anomalous experience were required for both groups, as well the inclusion of both interview and self-report data for convergent validity. The first hypothesis for Study 2 was that individuals with a psychotic disorder would demonstrate cognitive impairments compared to psychologically healthy individuals on a range of measures of neurocognitive function; Full Scale IQ, visual construction, language, attention, immediate memory, delayed memory, and working memory. The second hypothesis for Study 2 was that for both psychologically healthy individuals and for individuals with psychosis, scores on these neurocognitive variables would be related to the frequency and intensity of positive anomalous experiences across participants’ lifetimes.

Finally, the aim of Study 3 was to examine the relationship between brain structural connectivity and positive anomalous experiences, across both psychologically healthy and psychosis groups. This would replicate the author’s previous research, where a negative relationship between brain structural connectivity and positive anomalous experiences was identified in a non-clinical sample (Nelson et al., 2011). To improve on previous research, participants with a clinical diagnosis of psychotic disorder (schizophrenia or schizoaffective disorder) were to be included. The first hypothesis for Study 3 was that individuals with a psychotic disorder would show relative deficits in brain structural connectivity compared to control participants as evidenced by between-group differences in key measures of white matter diffusivity (FA, MD, RD and AD). The second hypothesis for Study 3 was that for both psychological healthy individuals and for individuals with psychosis, measures
of connectivity (FA, MD, RD and AD) from whole-brain analysis would be related to the frequency and intensity of positive anomalous experiences across participants’ lifetimes.
Chapter 5: Method

This chapter describes the participants involved in the present research, as well as the measures and procedure. It ends by outlining the process used for neuroimaging analysis of diffusion weighted data.

5.1. Participants and Procedure

Participants and participant data were drawn from the Victorian cohort of the Australian Schizophrenia Research Bank (ASRB; Loughland et al., 2010). The ASRB is a national database that began recruitment in 2008. It operates in five Australian states and territories – namely; New South Wales, Canberra, Queensland, Victoria, and Western Australia. The ASRB collects and stores a range of clinically relevant information from both people with a diagnosis of schizoaffective disorder and/or schizophrenia, as well as from psychologically healthy matched comparison participants. Ethics approval documents both for the ASRB and the present research are shown in Appendix A. As of November 2011, the number of participants involved in the ASRB was over 1700, and recruitment was ongoing at the time of writing. The scope of the ASRB, as well its recruitment and data collection procedures have been published previously, along with preliminary descriptive statistics (Loughland et al., 2010).

Participants with a psychotic disorder whose data were used for the current project were recruited in two ways. First, they were recruited via a nation-wide campaign that consisted of television and radio advertisements, web pages, media interviews, and brochures displayed in hospital waiting rooms, community mental
health services and other relevant public locations (Loughland et al., 2010).

Educational and scientific presentations were conducted to encourage mental health professionals (psychiatrists, psychologists, psychiatric nurses, allied health practitioners etc.) to promote recruitment through educational and scientific presentations. Additionally, a website (www.schizophreniaresearch.org.au), and telephone number (1800 639 295) were set up to provide information and aid recruitment (Loughland et al., 2010). Second, participants were recruited through treatment services such as inpatient units, outpatient clinics and rehabilitation units, community mental health services, and non-government mental illness support organizations (Loughland et al., 2010). Healthy control participants were recruited through cold calling of individuals from the Australian White Pages telephone directory. This assisted in identifying control participants who were representative of the Australian population, and who could be age-, sex-, and handedness-matched with case participants (Loughland et al., 2010).

Inclusion criteria: Case participants met criteria for schizophrenia or schizoaffective disorder as defined by the DSM-IV-TR or ICD-10. All participants were aged between 18 and 65 years, and spoke English as a primary language.

Exclusion criteria: Participants were excluded if they had an organic brain disorder, a history of traumatic brain injury which was accompanied by more than twenty-four hours of post-traumatic amnesia, an IQ less than 70 as assessed using the Wechsler Abbreviated Scale of Intelligence (WASI; The Psychological Corporation, 1999), a movement disorder, a current diagnosis of substance abuse or dependence, or a history of electro-convulsive therapy within the six months prior to assessment. Control participants were further excluded if they had a personal history of, or first degree relative with psychosis or bipolar I disorder.
Participation in the ASRB involved three components. The first was a clinical interview and neuropsychological battery that lasted approximately three hours. Second, a blood sample was taken for the purposes of genetic research. Finally, as many participants as possible underwent a structural MRI scan, which included a diffusion weighted sequence. All scans were completed on Siemens Avanti 1.5 tesla scanners using a standardized protocol (see further details below; Loughland et al., 2010). Participants were reimbursed $20 for each component of the assessment they completed (interview, blood sample, and MRI respectively). All data were collated and reviewed for quality control by the Newcastle (New South Wales) division of the ASRB before being added to the database (Loughland et al., 2010).

For the current project, a subgroup of participants from the Victorian division of the ASRB, who had previously provided their consent to be considered for further research, were re-contacted. (Consent forms for both case and control participants are located in Appendix B). Details of participants who agreed to further contact by writing to the central coordinators of the ASRB were then passed on to the researchers directly involved in the present project. The researchers subsequently initiated telephone contact, in order to arrange a date and time for assessment. This subsample of participants completed the AANEX, which took between one and two hours to complete. All interviews were administered by the investigator MN. To increase participation rates, volunteers were given the option of completing this component of their participation over the phone so as to avoid travelling long distances. Telephone interviews were completed via Skype (www.skype.com; voice only, not video calls). Information and consent forms were obtained via post, fax or email prior to interview. Participants were also given the option of completing the interview over two sessions to reduce fatigue. This option was consistent with the
method employed by Brett et al. (2007). For the two-session interviews, each session lasted approximately one hour. They were held between one and three weeks apart. For completion of the AANEX, participants were reimbursed a further $20. Those who had completed the measures over the phone were reimbursed via mail order.

Figure 7 summarizes the ASRB components completed by the larger sample and subsample.

**Figure 7.** Summary of ASRB components completed by participants whose data were used in the present research.
5.2. Measures

Relevant measures for the current research included demographic data taken from the Diagnostic Interview for Psychoses (Jablensky et al., 2000; Castle et al., 2006), the MRI images (high resolution structural and diffusion weighted images), the Wechsler Abbreviated Scale of Intelligence (WASI; The Psychological Corporation, 1999), the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph, 1998), the Letter-Number Sequencing task (LNS; Wechsler, 1997b), and the Schizotypal Personality Questionnaire (SPQ; Raine, 1991). In addition, the subsample of Victorian participants completed the Appraisals of Anomalous Experiences Interview (AANEX; Brett et al., 2007). These measures are described in more detail below.

5.2.1. Diagnostic Interview for Psychoses

The DIP (Jablensky et al., 2000; Castle et al., 2006) is a semi-structured interview which is used to diagnose psychotic disorders in both clinical and research settings. It is comprised of three modules. The first is the demography and social functioning module, which assesses variables such as age, gender, marital and migrant status, and occupation. The second is the diagnostic module, which assesses diagnosis according to a variety of systems including the DSM-IV-TR and ICD-10. The last is the service utilization module. It is a self-report measure that captures the number and types of health services used by interviewees.

Reliability and validity of the DIP is described by Castle et al. (2006). They report moderate to high inter-rater reliability for over 50% of DIP items, moderate to high test-retest reliability, and good convergent validity with nine out of ten diagnoses matching those assessed by the previously established Schedules for
Clinical Assessment in Neuropsychiatry (SCAN) interview.

5.2.2. Wechsler Abbreviated Scale of Intelligence

The WASI (The Psychological Corporation, 1999) is a standardised and widely-used cognitive test of intelligence. It provides an estimate of Full Scale IQ, as well as Verbal and Performance IQ domains. It takes approximately 30 minutes to administer, and has four subtests. The Matrix Reasoning and Block Design subtests comprise the Performance domain, which is a broad measure of non-verbal and fluid thinking abilities. The Vocabulary and Similarities subtests comprise the Verbal domain, which is a broad measure of verbal and crystallized knowledge abilities.

5.2.3. Repeatable Battery for the Assessment of Neuropsychological Status

The RBANS (Randolph, 1998) measures a range of major neurocognitive abilities, and takes approximately thirty minutes to administer. It contains five indices; the Immediate Memory Index, Visuospatial/Constructional Index, Language Index, Attention Index, and Delayed Memory Index. Scores of these indices can be also summed to form a broad Total Scale score.

The RBANS has a reported test-retest reliability of 0.84 for schizophrenia samples, and 0.77 for control samples (Wilk et al., 2002). In a sample of 36 participants with schizophrenia and schizoaffective Disorder and 14 healthy controls, Chianetta, Lefebvre, LeBlanc and Grignon (2008) report an internal consistency of 0.87 for the RBANS. They also describe good convergent validity with the Wechsler Adult Intelligence Scale (WAIS-III; Wechsler, 1997a). That is, the RBANS was highly correlated with WAIS-III Full Scale IQ ($r = 0.875$), Verbal IQ ($r = 0.747$) and Nonverbal IQ ($r = 0.843$; Chianetta et al., 2008).
5.2.4. Letter-Number Sequencing Task

The LNS task is a subscale of the Wechsler Memory Scale (Wechsler, 1997b). It is a measure of working memory, and involves the verbal presentation of lists of between two and eight alternating letters and numbers. Participants are then required to first repeat back the numbers in ascending order, then the letters in alphabetical order. It has an internal consistency of 0.82, and is well-validated across both clinical and non-clinical samples (Wechsler, 1997b).

5.2.5. Schizotypal Personality Questionnaire

The SPQ (Raine, 1991) is a self-report measure of schizotypal personality which assesses the nine traits associated with schizotypal personality disorder as outlined in the Diagnostic System of Mental Disorders, Third Edition, Revised (APA, 1987; Raine, 1991). Participants are asked to indicate (‘yes’ or ‘no’) if they have had a range of anomalous experiences. Examples include ‘Do you sometimes feel that other people are watching you?’ and ‘I often hear a voice speaking my thoughts out loud’ (see Appendix C). The SPQ comprises three factors – Cognitive-Perceptual, Interpersonal, and Disorganized (Raine, 1991). These factors are in turn comprised of subscales, which are represented in Appendices C and D. Of particular relevance to this project, the Ideas of Reference, Odd Beliefs, Unusual Perceptual Experiences and Suspiciousness subscales are combined to create the Cognitive-Perceptual Factor – which can be taken as a measure of positive anomalous experience. The SPQ is reported to have an internal reliability rating of 0.91, test-retest reliability of 0.82, convergent validity between 0.59 and 0.81, discriminant validity of 0.63 and criterion validity of 0.68 (Raine, 1991).
5.2.6. Appraisals of Anomalous Experiences Interview

The AANEX (Brett et al., 2007) is represented in full in Appendices E, F, G, and H. All positive anomalous experiences an individual may have had in the past, or is having currently are documented using the AANEX Inventory. An interviewer rating for each experience is assigned, which is said to reflect the frequency and/or intensity of that experience across the person’s lifetime. Interviewer ratings range from 1 (no experience) to 5 (chronic or constant experience). The Inventory covers six domains of positive anomalous experience – Schneiderian First Rank Symptoms, Anomalous Perception, Anomalous Cognition, Anomalous Affect, Paranormal, and Anomalous Individuation. Following the AANEX Inventory, the AANEX-CAR is completed. It assesses the Context, Appraisals and Responses associated with any anomalous experiences endorsed during the Inventory. The AANEX-CAR assesses five areas described in the model developed by Garety et al. (2007)(Figure 6). They are; the context, framework of interpretation, emotional and behavioural responses, the context and implications of appraisal, and the long term behavioural response.

The AANEX has satisfactory inter-rater reliability, with an average weighted kappa of 0.67 for the AANEX Inventory items, and weighted kappa of >0.4 for all AANEX-CAR items (Brett et al., 2007). It also has demonstrated construct validity in that it can distinguish between clinical and nonclinical psychosis groups in terms of need for care (Brett et al., 2007). Importantly, the AANEX avoids problems encountered when using self-report measures, as it relies on clinician-ratings rather than participant-ratings. Also, rather than assessing only one part of the continuum, the AANEX is able to document the full range of positive anomalous experiences – from anomalous experiences described by healthy individuals, to positive symptoms.
described by people with psychosis.

As the AANEX is a lengthy interview, it can be complicated to administer. For this reason, a computer software program was developed to aid administration. This digital version of the AANEX used the web2py framework as a back end (Di Pierro, 2011). Although web2py is intended for use as a web server, in this case it was hosted locally on the interviewer’s computer. The web2py framework permitted easy rendering of questions and entry of responses using familiar HTML form elements, and consequently rapid development of the software. Questions were presented to the interviewer individually to minimize confusion. Where the response was multiple choice, the allowed responses were presented, and at every stage there was space for the interviewer to record any additional information that participants provided.

The logic of the AANEX interview was encoded in the software such that only relevant questions were presented, and the interviews proceeded according to the answers provided at each step (although the interviewer could override this if desired). A ‘scoring mode’ allowed the researcher to view the response alongside the AANEX scoring guide and enter scores. Both the verbatim responses and the interviewer scores were stored in an SQLite database (Hipp, 2012) which enabled easy importation into common data analysis software such as SPSS (http://www-01.ibm/software/analytics/spss/products.statistics). Plain text, printer-friendly versions of the interviewer’s responses were saved to a file at the conclusion of each interview for backup and in case a hard-copy record was required. Examples of the AANEX Inventory and AANEX-CAR software interface can be seen in Figure 8. In order to ensure no loss of validity, items in the computer program were worded and structured in exactly the same way as in the original AANEX paper version. The
main advantage of the computer program was that it assisted administration, as it allowed the interview to be easily navigated and completed.
Figure 8. The AANEX software interface.
Table 3 shows the number of participants whose data were used in the present research, according to whether they completed the AANEX by telephone or face-to-face, and the number of participants who completed it in one versus two sessions. Of note, there was no significant difference between case and control groups as to the format of the AANEX interview, with cases being just as likely as controls to choose a telephone interview over a face-to-face interview $\chi^2(1) = 0.751, p = 0.386$.

In assessing whether there was a difference between the groups in terms of whether they completed the AANEX in one versus two sessions, two cells (50%) had an expected count less than 2. Therefore, a chi-squared test was unable to be used in this case, as its assumptions were not met. As suggested by Cochran (1952) and Campbell (2007), a Fisher’s exact test was used instead. Using this conservative test, participants with a diagnosis of schizophrenia or schizoaffective disorder were significantly more likely than controls to complete the AANEX interview over two sessions rather than one, $p = 0.032$.

<table>
<thead>
<tr>
<th></th>
<th>Number of Participants who Completed the AANEX in One Versus Two Sessions</th>
<th>Number of Participants who Completed the AANEX Face-to-Face Versus Via Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One Session</td>
<td>Two Sessions</td>
</tr>
<tr>
<td>Case:</td>
<td>$n = 15$</td>
<td>$n = 5$</td>
</tr>
<tr>
<td>Control:</td>
<td>$n = 29$</td>
<td>$n = 1$</td>
</tr>
<tr>
<td>Total Sample:</td>
<td>$n = 44$</td>
<td>$n = 6$</td>
</tr>
</tbody>
</table>

Following administration of the interview, transcripts were extracted and scored by a rater with clinical training (MN). For each participant who had consented, the AANEX interview was also recorded via a sound recording and editing software.
program – Audacity, Version 1.3.13 (Beta)(http://audacity.sourceforge.net/). Acoustic recording of the AANEX interview further assisted in quality control and scoring.

During scoring, any experiences that appeared to be clinically related to an Axis I disorder other than schizophrenia or schizoaffective disorder were excluded. Examples from control participants were concentration problems and distraction in the context of an anxiety disorder, or feelings of heaviness and lack of energy in the context of a depressive illness. Experiences were also excluded if they were due to the effects of a substance or medication, delirium, or other altered state of consciousness – for example sleep, hypnosis, or meditation. Additionally, experiences that occurred in the context of a medical or physical condition were excluded – for example, spots in front of a participant’s eyes during a migraine. Hallucinations that occurred while falling asleep and/or while waking up, known as hypnagogic and hypnopompic hallucinations respectively, were also excluded. Lastly, experiences that were not clinically recognized as ‘anomalous’ were excluded, for example a mother endorsing the experience of ‘receptivity’, and describing how she can read or work out the needs of her baby without words. Decisions about exclusion of experiences were made by a clinically trained member of the research team (MN).

Due to time restraints and to minimize complexity, the AANEX-CAR was completed only for the first incidence of each positive anomalous experience within in each participant’s lifetime. That is, using the AANEX Inventory, all positive anomalous experiences that participants could recall during their lifetimes were documented. Then, for each endorsed experience, participants were asked to ‘Remember back to when you first had that experience. Can you remember what your life was like at that time?’ And the AANEX-CAR was completed for that time point.
only. Responses were then coded according to the method prescribed by the AANEX scoring guide (Appendix H; Brett et al., 2007). During interview, participants tended to respond in similar ways to multiple experiences. Therefore, after statistical consultation (Hepworth, personal communication), participants’ AANEX Inventory and AANEX-CAR responses were averaged across all experiences they endorsed, in order to obtain one representative score per item per participant.

In summary, quantitative data used from the AANEX for each participant was the average frequency/intensity of his or her lifetime positive anomalous experiences in the first instance. Then added to this were participants’ average appraisals and responses to those experiences when they first encountered them, in terms of what participants thought had happened, the context of the experience, how they felt about the experience, and what they did about it.

5.3. MRI Data Acquisition

MRI data acquisition followed the established ASRB MRI site protocol (Loughland et al., 2010). For Victorian participants, data were acquired on a 1.5T Siemens Avanto whole body scanner at the Murdoch Childrens Research Institute, Royal Children’s Hospital, Parkville, Victoria, Australia. Diffusion weighted data were acquired using an optimized diffusion weighted sequence (Jones, Horsfield, & Simmons, 1999). Diffusion data were acquired in 64 directions ($b = 1000 \text{ s/mm}^2$), plus one $b = 0$ reference image (TR = 8400 ms, TE = 88 ms). Whole brain coverage was achieved with 65 contiguous slices, a matrix of 104x104, and voxel size = 2.4x2.4x2.4. High resolution T1 (MPRAGE) weighted images were also acquired in this session, but were not included in this analysis.
5.4. DWI Preprocessing

All MRI data processing was completed on a Linux workstation located at the Murdoch Childrens Research Institute, Royal Children’s Hospital, Parkville, Victoria, Australia. For the current project, raw DWI data were available for \( N = 180 \) participants (\( n = 96 \) cases, \( n = 84 \) controls) from the Victorian division of the ASRB.

First, raw data were visually inspected for visible artifacts. Subsequently, data from two case participants were excluded; one due to incomplete DWIs, and another due to a braces artifact. Next, raw diffusion weighted images were merged in a 4D file and converted to nifti format using the dti2nii utility. Prior to TBSS analysis, data preprocessing was completed using FMRIB’s Diffusion Toolbox (FDT), part of the FMRIB Software Library (FSL; Smith et al., 2004). Initially, FDT’s Eddy Current Correction was performed on all DWI images. A brain mask separating brain from non-brain voxels was created using FSL’s Brain Extraction Tool (BET; Smith, 2002). For brain masking, very conservative intensity thresholds of 0.5 tended to exclude anterior areas of the frontal lobe, therefore intensity thresholds were set at 0.3 to ensure inclusion of the entire frontal lobe. Then using DTIFIT, a diffusion tensor model was fitted at each voxel of each skull-stripped image, using the weighted least squares (-wls) option as suggested by Jones, Knosche and Turner (In Press). Output from DTIFIT included FA, AD, RD and MD images for each participant.
Chapter 6: Study 1 Results and Comment – An
Investigation of the Relationship between Cognitive
Appraisals and Positive Anomalous Experiences

The first study sought to determine whether the frequency and severity of positive anomalous experiences across individuals’ lifetimes are related to thinking style, as would be suggested Garety et al.’s (2007) model (Figure 6). This chapter describes the statistical analyses and results pertaining to Study 1. The findings are then discussed in relation to the original hypotheses, as well as in relation to previous research.

6.1. Study 1 Demographic Data
For this study, relevant data from the Victorian division of the ASRB were drawn from participants who had completed the Diagnostic Interview for Psychoses (DIP), Appraisals of Anomalous Experiences Interview (AANEX) Inventory, and Appraisals of Anomalous Experiences Interview – Context, Appraisals and Responses (AANEX-CAR). Of the Victorian ASRB volunteers, N = 57 (n = 22 cases and n = 35 controls) agreed to undertake the AANEX. However, two case participants’ AANEX data were subsequently excluded from the analyses; one whose positive anomalous experiences had all occurred under the influence of substances; and another who decided to withdraw from the AANEX part way through. A further five control participants did not endorse any anomalous experiences. After statistical consultation, and because an aim of the present research was to compare people who experience positive psychotic symptoms to people who have anomalous experiences,
these five participants were also excluded (Hepworth, personal communication). This left AANEX data for \( n = 20 \) participants with a diagnosis of schizophrenia or schizoaffective disorder, and \( n = 30 \) control participants (total \( N = 50 \)). Relevant demographic data for these participants is presented in Table 4.

### Table 4. Demographic data for the subsample of participants who had completed the AANEX.

<table>
<thead>
<tr>
<th></th>
<th>Case</th>
<th>Control</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>( n = 7 )</td>
<td>( n = 15 )</td>
<td>( n = 22 )</td>
</tr>
<tr>
<td>Female</td>
<td>( n = 13 )</td>
<td>( n = 15 )</td>
<td>( n = 28 )</td>
</tr>
<tr>
<td><strong>Age at AANEX Interview</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>24-67</td>
<td>26-68</td>
<td>24-68</td>
</tr>
<tr>
<td>Mean</td>
<td>46.80</td>
<td>46.83</td>
<td>46.82</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>12.878</td>
<td>12.698</td>
<td>12.639</td>
</tr>
<tr>
<td><strong>Average AANEX Anomalous Experience Frequency/Intensity Rating</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3.83</td>
<td>2.65</td>
<td>3.12</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.51</td>
<td>0.51</td>
<td>0.74</td>
</tr>
</tbody>
</table>

All statistical analyses for the current research were completed using SPSS (Version 20; [www-01.ibm/software/analytics/spss/products.statistics](http://www-01.ibm/software/analytics/spss/products.statistics)). For the subsample of \( N = 50 \) participants who had completed the AANEX, there was no significant difference in age between cases and controls as assessed via an independent samples t-test (\( t (48) = 0.009, p = 0.887 \)). It should also be noted here that the mean ages for the subsample were higher than in the larger Victorian ASRB sample (reported in Study 2). Furthermore, the maximum age of 68 actually exceeded the cut-off age of 65 for involvement in the ASRB. The reason for this was that recruitment for the ASRB began in 2008, and for some participants in the subsample, between two and three years had passed before they completed the AANEX in 2011/2012.

There was also no significant difference in gender between the two groups who had completed the AANEX, as indicated by a chi-squared test of independence.
(χ²(1) = 1.096, \(p = 0.295\)). In relation to the AANEX Frequency/Intensity Ratings; participants who had been diagnosed with a psychotic disorder were rated as having (on average) more frequent and intense positive anomalous experiences across their lifetimes, as compared to healthy control participants \((t (48) = 8.902, \ p < 0.001)\). A frequency distribution of the AANEX Frequency/Intensity Ratings is shown in Figure 9.

![Figure 9](image)

**Figure 9.** Frequency distribution of the averaged AANEX Frequency/Intensity Ratings.

### 6.2. Study 1 Between-Group Analyses

Independent samples t-tests were used to ascertain whether the two groups differed on twelve *a priori* selected ‘thinking style’ variables drawn from the AANEX-CAR
(Table 2 and Table 5). As mentioned in Chapter 5 above, participants’ scores on these five point rating scales were averaged across all anomalous experiences they endorsed, to obtain one score for each thinking style item per participant. For some of the independent samples t-tests comparing groups on these items, Levene’s test of homogeneity of variances was significant ($p \leq 0.05$). Therefore, t-test calculations were adjusted accordingly, via the standard method used by the SPSS software program (Version 20; www-01.ibm/software/analytics/spss/products.statistics). This was also done for all ensuing t-test calculations throughout the present research, where Levene’s test of homogeneity of variances was significant at $p \leq 0.05$.

Furthermore, the significance level for these t-tests was set at $\alpha \leq 0.004$ after Bonferroni correction. As shown in Table 5, there was a significant difference between cases and controls on seven out of the twelve thinking style items, all with large effect sizes as measured by Cohen’s $d$. Three of the remaining thinking style items also approached significance ($p \leq 0.05$), with moderate to large effect sizes.
Table 5. Results of independent samples t-tests comparing thinking style between cases and controls (N = 50).

<table>
<thead>
<tr>
<th>Thinking Style Item</th>
<th>Rating Scale</th>
<th>Mean (SD)</th>
<th>t</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does the person view their experience/s as beneficial or negative?</td>
<td>1 (strongly negative) to 5 (strongly beneficial).</td>
<td>Case 2.25 (0.73) Control 3.27 (0.87)</td>
<td>t (48) = 4.36</td>
<td>&lt; 0.001**</td>
<td>1.270</td>
</tr>
<tr>
<td>2. Does the person view their experience/s as potentially or actually dangerous or harmless?</td>
<td>1 (completely harmless) to 5 (definitely dangerous or harmful).</td>
<td>Case 3.61 (0.68) Control 2.19 (1.08)</td>
<td>t (47.889) = 5.75</td>
<td>&lt; 0.001**</td>
<td>1.574</td>
</tr>
<tr>
<td>3. Does the person view their experience/s as essentially having been caused by something internal, or something external?</td>
<td>1 (entirely due to internal factors) to 5 (source of experience and source of change external to the self).</td>
<td>Case 3.32 (0.78) Control 2.36 (1.15)</td>
<td>t (47.964) = 3.492</td>
<td>0.001**</td>
<td>0.977</td>
</tr>
<tr>
<td>4. Does the person view the experience/s as having been caused by some person or agency, or by some impersonal process or factors?</td>
<td>1 (source entirely impersonal) to 5 (source entirely personal).</td>
<td>Case 3.57 (0.96) Control 3.80 (1.35)</td>
<td>t (47.733) = 0.69</td>
<td>0.493</td>
<td>0.0196</td>
</tr>
<tr>
<td>5. Interviewer rating of negative feelings (bad feelings, worries, fears).</td>
<td>1 (no bad feelings) to 5 (only negative feelings reported).</td>
<td>Case 3.56 (0.93) Control 1.99 (0.90)</td>
<td>t (48) = 6.28</td>
<td>0.001**</td>
<td>1.716</td>
</tr>
<tr>
<td>6. Interviewer rating of avoidance (turning attention away from the event/s and towards some other activity).</td>
<td>1 (no avoidance) to 5 (only avoidance)</td>
<td>Case 1.97 (0.84) Control 1.33 (0.67)</td>
<td>t (48) = 2.98</td>
<td>0.005*</td>
<td>0.842</td>
</tr>
<tr>
<td>7. Interviewer rating of rumination (involves intellectual exploration of the meaning or implications of the event/s, either voluntarily or involuntarily and is within the frame of reference engendered by the event as initially interpreted. I.e. lack of secondary appraisal)</td>
<td>1 (no rumination) to 5 (only rumination).</td>
<td>Case 1.96 (0.94) Control 1.21 (0.37)</td>
<td>t (22.929) = 3.443</td>
<td>0.002**</td>
<td>1.050</td>
</tr>
<tr>
<td>8. Interviewer rating of cognitive control (cognitive check, such as self-statements, trying to control thoughts or deliberately re-framing the experience/s in another way).</td>
<td>1 (no attempted control) to 5 (only control).</td>
<td>Case 1.91 (0.75) Control 1.37 (0.72)</td>
<td>t (48) = 2.60</td>
<td>0.012*</td>
<td>0.735</td>
</tr>
<tr>
<td>9. Interviewer rating of immersion (any active response that is completely congruent with the initial experience of the event/s; either in terms of speech or behavior, some kind of mental resistance to the event/s or perceived cause of the event/s, or encouragement or pursuit of the events/s)</td>
<td>1 (no immersion) to 5 (only immersion).</td>
<td>Case 3.18 (0.83) Control 1.51 (0.98)</td>
<td>t (48) = 6.26</td>
<td>&lt; 0.001**</td>
<td>1.839</td>
</tr>
<tr>
<td>10. What effect does this experience/s have on how you see yourself?</td>
<td>1 (greatly worse about myself), to 5 (greatly better about myself).</td>
<td>Case 2.41 (1.12) Control 3.09 (0.86)</td>
<td>t (48) = 2.42</td>
<td>0.019*</td>
<td>0.681</td>
</tr>
<tr>
<td>11. Do you feel your experience/s would be understood by your social group, or do you feel it would be best to keep quiet about it?</td>
<td>1 (definitely keep quiet) to 5 (definitely understand).</td>
<td>Case 2.03 (1.08) Control 4.04 (1.23)</td>
<td>t (48) = 5.93</td>
<td>&lt; 0.001**</td>
<td>1.737</td>
</tr>
<tr>
<td>12. When you experienced this, how much control do you have over the experience/s?</td>
<td>1 (no control) to 5 (total control).</td>
<td>Case 1.54 (0.91) Control 1.74 (0.88)</td>
<td>t (48) = 0.81</td>
<td>0.425</td>
<td>0.223</td>
</tr>
</tbody>
</table>

** = Significant at α ≤ 0.004.
* = p ≤ 0.05.
6.3. Study 1 Within-Group Analyses

In the second set of analyses for Study 1, multiple linear regression was used to assess possible relationships between thinking style and the frequency and severity of positive anomalous experiences, as measured by the AANEX Inventory Frequency/Intensity Ratings. The assumptions of linear regression (including linearity, normality and independence of errors, and homoscedasticity) were met for all analyses containing the averaged AANEX Frequency/Intensity Ratings throughout the project. Analyses were completed via SPSS linear regression (‘Enter’ method). In establishing the best model fit of the data, it was initially necessary to determine whether there were any interaction effects. That is, whether the slope of the regression line was significantly different according to group. Table 6 shows interaction equations, with diagnostic group and thinking style items used as predictors, and with AANEX Frequency/Intensity Ratings consistently used as dependent variables. Two equations are reported for each thinking style item – one with unstandardized coefficients \( b \), and the other with standardized coefficients \( \beta \). Collinearity diagnostics did not reveal any tolerances approaching 0 for any predictor variables included in these equations. The significance level was set at \( \alpha \leq 0.004 \) after Bonferroni correction.

As can be seen in Table 6, there were no significant interaction effects for any of these equations. Next, in order to test main effects of the thinking style variables, interaction terms were removed from the regression equations. Tests of main effects assessed whether diagnosis contributed significantly to the variance in AANEX Frequency/Intensity Ratings. They also assessed whether the thinking style items contributed significantly to the variance in AANEX Frequency/Intensity Ratings, independent of diagnosis. In these new equations, diagnostic group and the thinking
style items were used as predictors, and AANEX Frequency/Intensity Ratings were consistently used as dependent variables. Two equations are reported for each thinking style item – one with unstandardized coefficients ($b$), and the other with standardized coefficients ($\beta$). Collinearity diagnostics did not reveal any tolerances approaching 0 for any predictor variables included in these equations. Again, the significance level was set at $\alpha \leq 0.004$ after Bonferroni correction. Results of these multiple linear regressions are represented in Table 7.

As can be seen in Table 7, there were significant main effects of group in every equation, not unexpectedly indicating that diagnosis is a large contributor to variance in AANEX Frequency/Intensity Ratings. There was also a significant main effect for the immersion AANEX-CAR item, and a trend toward significance for individuals being more likely to view their experiences as originating from an external source ($p < 0.05$). Other main effects that approached significance were the AANEX-CAR item referring to experiences originating from an impersonal versus personal source, and the social understanding item (all $p < 0.05$). However, these trends did not remain significant after Bonferroni correction. Finally, at $p = 0.061$ and a moderate model effect size, it might be assumed that with more power a main effect for the AANEX-CAR negative feelings item would have approached significance.

Scatterplots were created to aid understanding and interpretation of the above results. They included linear regression fit lines and confidence intervals for both cases and controls (Figures 10-21). In addition, and to further aid understanding, Table 8 summarizes the results of Study 1.
Table 6. Results of multiple linear regression analyses (‘Enter’ method) testing interaction effects for $N = 50$, with diagnostic group and thinking style items used as predictors ($x_1$ and $x_2$ respectively), and with the averaged AANEX Frequency/Intensity Ratings consistently used as the dependent variable ($y$).

<table>
<thead>
<tr>
<th>Predictor ($x_2$)</th>
<th>Model</th>
<th>$y = a + bx_1 + bx_2 + \frac{b}{(x_1 \times x_2)}$</th>
<th>$y = a + \beta_1 x_1 + \beta_2 x_2 + \frac{\beta}{(x_1 \times x_2)}$</th>
<th>$r^2$</th>
<th>Adjusted $r^2$</th>
<th>$p (x_1)$</th>
<th>$p (x_2)$</th>
<th>$p (x_1 \times x_2)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the person view their experience/s as beneficial or negative?</td>
<td>$F_{3,46} = 26.481, p &lt; 0.001**$</td>
<td>$y = 3.967 - 0.972x_1 - 0.61x_2 - 0.45 (x_1 \times x_2)$</td>
<td>$y = -0.650x_1 - 0.792x_2 - 0.105 (x_1 \times x_2)$</td>
<td>0.633</td>
<td>0.609</td>
<td>0.049**</td>
<td>0.675</td>
<td>0.801</td>
</tr>
<tr>
<td>Does the person view their experience/s as potentially or actually dangerous or harmless?</td>
<td>$F_{3,46} = 26.508, p &lt; 0.001**$</td>
<td>$y = 3.323 - 0.817x_1 + 0.139x_2 - 0.076 (x_1 \times x_2)$</td>
<td>$y = -0.546x_1 + 0.220x_2 - 0.430 (x_1 \times x_2)$</td>
<td>0.634</td>
<td>0.610</td>
<td>0.185</td>
<td>0.130</td>
<td>0.076</td>
</tr>
<tr>
<td>Does the person view their experience/s as having been caused by something internal, or something external?</td>
<td>$F_{3,46} = 31.115, p &lt; 0.001**$</td>
<td>$y = 3.570 - 1.340x_1 + 0.078x_2 + 0.099 (x_1 \times x_2)$</td>
<td>$y = -0.895x_1 + 0.117x_2 + 0.195 (x_1 \times x_2)$</td>
<td>0.670</td>
<td>0.648</td>
<td>0.007*</td>
<td>0.549</td>
<td>0.506</td>
</tr>
<tr>
<td>Does the person view the experience/s as having been caused by some person or agency, or by some impersonal process or factors?</td>
<td>$F_{3,46} = 31.078, p &lt; 0.001**$</td>
<td>$y = 3.966 - 0.740x_1 - 0.038x_2 - 0.114 (x_1 \times x_2)$</td>
<td>$y = -0.494x_1 - 0.368x_2 - 0.330 (x_1 \times x_2)$</td>
<td>0.670</td>
<td>0.648</td>
<td>0.111</td>
<td>0.715</td>
<td>0.350</td>
</tr>
<tr>
<td>Interviewer rating of negative feelings (bad feelings, worries, fears).</td>
<td>$F_{3,46} = 29.198, p &lt; 0.001**$</td>
<td>$y = 3.602 - 0.1311x_1 + 0.064x_2 + 0.123 (x_1 \times x_2)$</td>
<td>$y = -0.876x_1 + 0.105x_2 + 0.195 (x_1 \times x_2)$</td>
<td>0.656</td>
<td>0.633</td>
<td>0.006*</td>
<td>0.226</td>
<td>0.144</td>
</tr>
<tr>
<td>Interviewer rating of avoidance (turning attention away from the event/s and towards some other activity).</td>
<td>$F_{3,46} = 26.247, p &lt; 0.001**$</td>
<td>$y = 3.743 - 1.261x_1 + 0.044x_2 + 0.081 (x_1 \times x_2)$</td>
<td>$y = -0.842x_1 + 0.047x_2 + 0.091 (x_1 \times x_2)$</td>
<td>0.631</td>
<td>0.607</td>
<td>&lt;0.001**</td>
<td>0.731</td>
<td>0.658</td>
</tr>
<tr>
<td>Interviewer rating of rumination (involves intellectual exploration of the meaning or implications of the event/s, either voluntarily or involuntarily and is within the frame of reference engendered by the event as initially interpreted. I.e. lack of secondary appraisal)</td>
<td>$F_{3,46} = 27.268, p &lt; 0.001**$</td>
<td>$y = 3.781 - 1.546x_1 + 0.024x_2 + 0.317 (x_1 \times x_2)$</td>
<td>$y = -1.033x_1 + 0.025x_2 + 0.283 (x_1 \times x_2)$</td>
<td>0.640</td>
<td>0.617</td>
<td>&lt;0.001**</td>
<td>0.830</td>
<td>0.677</td>
</tr>
<tr>
<td>Interviewer rating of cognitive control (cognitive check, such as self-statements, trying to control thoughts or deliberately re-framing the experience/s in another way).</td>
<td>$F_{3,46} = 26.465, p &lt; 0.001**$</td>
<td>$y = 3.520 - 0.086x_1 + 1.162x_2 - 0.168 (x_1 \times x_2)$</td>
<td>$y = -0.577x_1 + 0.168x_2 - 0.197 (x_1 \times x_2)$</td>
<td>0.633</td>
<td>0.609</td>
<td>0.016*</td>
<td>0.261</td>
<td>0.372</td>
</tr>
<tr>
<td>Interviewer rating of immersion (any active response that is completely congruent with the initial experience of the event/s: either in terms of speech or behavior, some kind of mental resistance to the event/s or perceived cause of the event/s, or encouragement or pursuit of the event/s)</td>
<td>$F_{3,46} = 36.331, p &lt; 0.001**$</td>
<td>$y = 3.640 - 1.411x_1 + 0.059x_2 + 0.217 (x_1 \times x_2)$</td>
<td>$y = -0.943x_1 + 0.099x_2 + 0.312 (x_1 \times x_2)$</td>
<td>0.703</td>
<td>0.684</td>
<td>0.001**</td>
<td>0.609</td>
<td>0.127</td>
</tr>
<tr>
<td>What effect does this experience/s have on how you see yourself?</td>
<td>$F_{3,46} = 25.623, p &lt; 0.001**$</td>
<td>$y = 3.928 - 1.155x_1 - 0.041x_2 + 0.001 (x_1 \times x_2)$</td>
<td>$y = -0.772x_1 - 0.057x_2 + 0.001 (x_1 \times x_2)$</td>
<td>0.626</td>
<td>0.601</td>
<td>0.007*</td>
<td>0.670</td>
<td>0.997</td>
</tr>
<tr>
<td>Do you feel your experience/s would be understood by your social group, or do you feel it would be best to keep quiet about it?</td>
<td>$F_{3,46} = 25.623, p &lt; 0.001**$</td>
<td>$y = 3.887 - 0.600x_1 - 0.229x_2 - 0.129 (x_1 \times x_2)$</td>
<td>$y = -0.494x_1 - 0.068x_2 - 0.387 (x_1 \times x_2)$</td>
<td>0.665</td>
<td>0.643</td>
<td>0.097</td>
<td>0.761</td>
<td>0.268</td>
</tr>
<tr>
<td>When you experienced this, how much control do you have over the experience/s?</td>
<td>$F_{3,46} = 29.552, p &lt; 0.001**$</td>
<td>$y = 4.058 - 0.852x_1 - 0.112x_2 - 0.059 (x_1 \times x_2)$</td>
<td>$y = -0.570x_1 - 0.231x_2 - 0.088 (x_1 \times x_2)$</td>
<td>0.658</td>
<td>0.636</td>
<td>0.001**</td>
<td>0.048*</td>
<td>0.533</td>
</tr>
</tbody>
</table>

** = Significant at $\alpha \leq 0.004$.  
* = $p \leq 0.05$.  

110
Table 7. Results of multiple linear regression analyses (‘Enter’ method) testing main effects for N = 50, with diagnostic group and thinking style items used as predictors ($x_1$ and $x_2$ respectively), and with the averaged AANEX Frequency/Intensity Ratings consistently used as the dependent variable ($y$).

<table>
<thead>
<tr>
<th>Predictor ($x_2$)</th>
<th>Model</th>
<th>$y = \alpha + \beta x_1 + \beta x_2$</th>
<th>$r^2$</th>
<th>Adjusted $r^2$</th>
<th>$p (x_1)$</th>
<th>$p (x_2)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the person view their experience/s as beneficial or negative?</td>
<td>$F_{2,47} = 47.497$, $p&lt;0.001^{**}$</td>
<td>$y = 4.035 - 1.087x_1 - 0.92x_2$</td>
<td>0.633</td>
<td>0.617</td>
<td>&lt;0.001**</td>
<td>0.264</td>
</tr>
<tr>
<td>Does the person view their experience/s as essentially having been caused by something internal, or something external?</td>
<td>$F_{2,47} = 46.999$, $p&lt;0.001^{**}$</td>
<td>$y = 3.319 - 1.034x_1 + 0.154x_2$</td>
<td>0.663</td>
<td>0.649</td>
<td>&lt;0.001**</td>
<td>0.022*</td>
</tr>
<tr>
<td>Does the person view the experience/s as having been caused by some person or agency, or by some impersonal process or factors?</td>
<td>$F_{2,47} = 46.279$, $p&lt;0.001^{**}$</td>
<td>$y = 4.271 - 1.153x_1 - 0.124x_2$</td>
<td>0.677</td>
<td>0.652</td>
<td>&lt;0.001**</td>
<td>0.016*</td>
</tr>
<tr>
<td>Interviewer rating of negative feelings (bad feelings, worries, fears).</td>
<td>$F_{2,47} = 43.685$, $p&lt;0.001^{**}$</td>
<td>$y = 3.345 - 0.956x_1 + 0.136x_2$</td>
<td>0.650</td>
<td>0.635</td>
<td>&lt;0.001**</td>
<td>0.061</td>
</tr>
<tr>
<td>Interviewer rating of avoidance (turning attention away from the event/s and towards some other activity).</td>
<td>$F_{2,47} = 39.952$, $p&lt;0.001^{**}$</td>
<td>$y = 3.665 - 1.128x_1 + 0.083x_2$</td>
<td>0.630</td>
<td>0.614</td>
<td>&lt;0.001**</td>
<td>0.356</td>
</tr>
<tr>
<td>Interviewer rating of rumination (involves intellectual exploration of the meaning or implications of the event/s, either voluntarily or involuntarily and is within the frame of reference engendered by the event as initially interpreted. I.e. lack of secondary appraisal)</td>
<td>$F_{2,47} = 39.715$, $p&lt;0.001^{**}$</td>
<td>$y = 3.663 - 1.117x_1 + 0.084x_2$</td>
<td>0.628</td>
<td>0.612</td>
<td>&lt;0.001**</td>
<td>0.411</td>
</tr>
<tr>
<td>Interviewer rating of cognitive control (cognitive check, such as self-statements, trying to control thoughts or deliberately re-framing the experience/s in another way).</td>
<td>$F_{2,47} = 39.449$, $p&lt;0.001^{**}$</td>
<td>$y = 3.707 - 1.146x_1 + 0.064x_2$</td>
<td>0.627</td>
<td>0.611</td>
<td>&lt;0.001**</td>
<td>0.488</td>
</tr>
<tr>
<td>Interviewer rating of immersion (any active response that is completely congruent with the initial experience of the event/s; either in terms of speech or behavior, some kind of mental resistance to the event/s or perceived cause of the event/s, or encouragement or pursuit of the events)</td>
<td>$F_{2,47} = 51.721$, $p&lt;0.001^{**}$</td>
<td>$y = 3.170 - 0.083x_1 + 0.207x_2$</td>
<td>0.688</td>
<td>0.674</td>
<td>&lt;0.001**</td>
<td>0.003**</td>
</tr>
<tr>
<td>What effect does this experience/s have on how you see yourself?</td>
<td>$F_{2,47} = 39.270$, $p&lt;0.001^{**}$</td>
<td>$y = 3.928 - 1.153x_1 - 0.041x_2$</td>
<td>0.626</td>
<td>0.610</td>
<td>&lt;0.001**</td>
<td>0.555</td>
</tr>
<tr>
<td>Do you feel your experience/s would be understood by your social group, or do you feel it would be best to keep quiet about it?</td>
<td>$F_{2,47} = 44.708$, $p&lt;0.001^{**}$</td>
<td>$y = 4.063 - 0.949x_1 - 0.115x_2$</td>
<td>0.665</td>
<td>0.641</td>
<td>&lt;0.001**</td>
<td>0.040*</td>
</tr>
<tr>
<td>When you experienced this, how much control do you have over the experience/s?</td>
<td>$F_{2,47} = 39.846$, $p&lt;0.001^{**}$</td>
<td>$y = 3.931 - 1.167x_1 - 0.066x_2$</td>
<td>0.629</td>
<td>0.613</td>
<td>&lt;0.001**</td>
<td>0.379</td>
</tr>
</tbody>
</table>

$^{**} = \text{Significant at } \alpha \leq 0.004.$

$^* = p \leq 0.05.$
Figure 10. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the first thinking style item.

Figure 11. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the second thinking style item.
Figure 12. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the third thinking style item.

Figure 13. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the fourth thinking style item.
Figure 14. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the fifth thinking style item.

Figure 15. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the sixth thinking style item.
Figure 16. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the seventh thinking style item.

Figure 17. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the eighth thinking style item.
Figure 18. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the ninth thinking style item.

Figure 19. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the tenth thinking style item.
Figure 20. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the eleventh thinking style item.

Figure 21. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the twelfth thinking style item.
Table 8. *Summary of results from Study 1.*

<table>
<thead>
<tr>
<th>AANEX-CAR Item</th>
<th>Significant Between-Group Difference</th>
<th>Significant Within-Group Relationship with AANEX Inventory Frequency/Intensity Ratings</th>
<th>Cases</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does the person view their experience/s as beneficial or negative?</td>
<td>✓</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>2. Does the person view their experience/s as potentially or actually dangerous or harmless?</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Does the person view their experience/s as essentially having been caused by something internal, or something external?</td>
<td>✓</td>
<td>p &lt; 0.05</td>
<td>p &lt; 0.05</td>
<td></td>
</tr>
<tr>
<td>4. Does the person view the experience/s as having been caused by some person or agency, or by some impersonal process or factors?</td>
<td>x</td>
<td>p &lt; 0.05</td>
<td>p &lt; 0.05</td>
<td></td>
</tr>
<tr>
<td>5. Interviewer rating of negative feelings (bad feelings, worries, fears).</td>
<td>✓</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>6. Interviewer rating of avoidance (turning attention away from the event/s and towards some other activity).</td>
<td></td>
<td>p &lt; 0.05</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>7. Interviewer rating of rumination (involves intellectual exploration of the meaning or implications of the event/s, either voluntarily or involuntarily and is within the frame of reference engendered by the event as initially interpreted. I.e. lack of secondary appraisal)</td>
<td>✓</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>8. Interviewer rating of cognitive control (cognitive check, such as self-statements, trying to control thoughts or deliberately re-framing the experience/s in another way).</td>
<td></td>
<td>p &lt; 0.05</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>9. Interviewer rating of immersion (any active response that is completely congruent with the initial experience of the event/s: either in terms of speech or behavior, some kind of mental resistance to the event/s or perceived cause of the event/s, or encouragement or pursuit of the events/s)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>10. What effect does this experience/s have on how you see yourself?</td>
<td></td>
<td>p &lt; 0.05</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>11. Do you feel your experience/s would be understood by your social group, or do you feel it would be best to keep quiet about it?</td>
<td>✓</td>
<td>p &lt; 0.05</td>
<td>p &lt; 0.05</td>
<td></td>
</tr>
<tr>
<td>12. When you experienced this, how much control do you have over the experience/s?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
6.4. Study 1 Comment – Hypothesis 1

The first hypothesis for Study 1 was that individuals with a psychotic disorder would exhibit differing patterns of thinking style compared to psychologically healthy individuals who have positive anomalous experiences, as evidenced by significant differences on each of the twelve thinking style variables drawn from the AANEX-CAR (represented in Tables 2, 6, 7 and 8). This hypothesis was generally supported, with group differences evident for ten of the twelve thinking style items. Case participants with a diagnosis of schizophrenia or schizoaffective disorder viewed their positive anomalous experiences as significantly more negative and harmful than controls. They were also significantly more likely to attribute their positive anomalous experiences to external factors rather than internal factors. In response to their experiences, case participants had more negative feelings, were more likely to ruminate, and were more likely to immerse themselves. Case participants were also significantly less likely than controls to feel they could talk about their experiences with others. Further, there was a trend toward significance ($p < 0.05$) for case participants responding to their experiences by avoiding them and trying to gain cognitive control over them, as well as for case participants tending to feel worse about themselves for having positive anomalous experiences.

Interestingly, there was no difference between cases and controls as to whether they viewed their experience as having originated from a personal or impersonal source. It appeared that participants with a diagnosis of schizophrenia or schizoaffective disorder were equally likely to make personal attributions for their experiences (such as undercover police, the CIA and FBI, and their neighbours), as they were to make impersonal attributions (such as aliens and the devil). Similarly, control participants were equally as likely to attribute their experiences to personal
sources (including their own mind), as they were to attribute their experiences to impersonal sources (such as God). It was noticed subjectively during interview that the main difference between cases and controls seemed to be the valence of the source (positive or negative, spiritual or threatening), rather than the source itself. However this would need further support from empirical research.

Unlike findings reported by Brett et al. (2007), there was also no difference between the groups as to whether they believed they had any control over their experiences. Both cases and controls tended to view their positive anomalous experiences as random occurrences that they could not control or predict. That is, they believed they could not induce positive anomalous experiences, stop them once they had started, or change the likelihood of their occurrence. This finding is in contrast to Brett et al. (2007), who reported that control participants in their sample tended to perceive greater control over their experiences than participants with a psychotic disorder. As was suggested by one reviewer, it may be that both groups believed they could not control their anomalous experiences when they first occurred. However, subsequently people’s sense of control over their experiences may change over time, perhaps increasing in the control group. This notion warrants further investigation in future research.

Apart from the above apparent similarity between the groups in relation to perceived control, the results of Study 1 revealed predominantly significant differences in thinking style between people with a psychotic disorder and people without a psychotic disorder. This is consistent with previous research (Morrison, 2001; Cangas et al., 2006; Brett et al., 2007; Morrison et al., 2007; Brett, Johns, Peters, & McGuire, 2009), and with the cognitive model described by Garety and colleagues (Figure 6; 2001; 2007). More specifically, previous research has shown
that people with psychotic disorders tend to exhibit more unhelpful thinking styles in terms of how they respond to and appraise their own positive anomalous experiences. These include tendencies toward negative and anxious responses and appraisals (Brett et al., 2007; Morrison et al., 2007), use of unhelpful cognitive response strategies such as avoidance, cognitive control and immersion (Brett et al., 2007), external attributions of experience (Brett et al., 2007), and use of positive anomalous experiences as a basis for reduced self-esteem, reduced trust in one’s own thoughts, and reduced connection with others (Cangas et al., 2006; Brett et al., 2007). The cognitive model of Garety and colleagues (2001; 2007) suggests that these unhelpful thinking styles create further stress and emotionality and thus increase the likelihood of further psychosis.

Yet, although findings of differences in thinking style between the case and control groups in Study 1 does support this notion in part, it is acknowledged that data were retrospective, and therefore definitive conclusions about direction of causality cannot be made. That is, via the AANEX-CAR, participants were asked to remember back to how they responded to and appraised their first positive anomalous experiences. For all participants; their first positive anomalous experiences would have been many years prior to the AANEX-CAR interview, and the passage of time may have impacted recall. For case participants especially, their memories and thoughts regarding previous positive anomalous experiences are likely to have been filtered through long periods of chronic illness. Combined with resultant effects of medications, influences of stigma and self-stigma, and hospitalization; it is possible that case participants’ experiences of chronic illness coloured their perceptions and responses to the AANEX-CAR.

Thus in Study 1, direction of causation of a relationship between diagnosis
and thinking style could have occurred in a few different ways. As suggested by Garety et al. (2001; 2007), it could have been that for the case participants, unhelpful responses and appraisals to positive anomalous experiences created further distress and emotionality, which led to further positive anomalous experiences and ultimately diagnosis of a psychotic disorder. Or, it could have been that looking back, participants with a diagnosis of schizoaffective disorder or schizophrenia tended to view their initial positive anomalous experiences in more unhelpful ways because of illness-related experiences they’ve had subsequently. Another possibility is that by the time case participants first began having positive anomalous experiences, they may already have endured months or perhaps years of a psychosis prodrome. This period of subclinical and unspecific psychological distress and dysfunction may already have predisposed participants with psychosis to respond to positive anomalous experiences in a more unhelpful way.

The author is not aware of any longitudinal data to help tease apart these possibilities definitively, however there is research to suggest that unhelpful thinking styles are already present in individuals classified as ‘at risk’ for future development of psychosis (Morrison et al., 2002; Brett et al., 2007; Morrison et al., 2007). This provides some indication that unhelpful responses and appraisals of positive anomalous experiences could be acting as prospective risk factors rather than retrospective filters. Further longitudinal, prospective investigations would shed more light on these questions.

Regardless of direction of causation though, the results of Study 1 showing differences between people with and without psychosis in terms of thinking style supports recent moves toward recognition of the efficacy of psychological therapies. The most notable example being cognitive-behavioural therapy (CBT) for psychosis
(Kuipers & Bebbington, 2006). The present results suggest that if individuals were able to develop more helpful ways of thinking about and responding to their psychotic symptoms, at least some psychological distress could be alleviated. CBT may also assist in preventing more frequent and severe positive symptoms when provided in the recovery stages of psychosis (Addington & Addington, 2005; Garety, 2012). If provided early (i.e. within ‘at-risk’ stages), it has also been suggested that CBT may even prevent decompensation to clinical psychosis in the first place (McGorry et al., 2002; Morrison et al., 2004; Kuipers & Bebbington, 2006; Bechdolf et al., 2011). (However this idea is more controversial; Addington & Addington, 2005; Addington et al., 2011).

This is not to say that all people who score highly on measures of schizotypy are at risk of developing psychosis and should be enrolled in a CBT program. As has been mentioned, according to both the quasi-dimensional and fully dimensional models, high schizotypy is not sufficient in and of itself to indicate risk for psychopathology. To assume otherwise would raise concerns around stigma, treatment for those who do not need it, inappropriate use of financial and therapist resources, and so forth. Rather, following a fully dimensional model, individuals targeted for CBT would be those scoring highly on schizotypy measures and concurrently experiencing other risk factors for psychosis. For example, as suggested by the research reviewed in Chapter 1; CBT might be appropriate for individuals high in schizotypy who also have a family history of psychosis, a personal history of cannabis use and/or trauma, and are experiencing cognitive decline. Although outside the scope of the present project, valuable links could be made here with research into factors associated with ultra-high risk for psychosis states, and transition to psychosis (e.g. Yung, Phillips, Yuen, & McGorry, 2004; Yung et al., 2008).
6.5. Study 1 Comment – Hypothesis 2

The second hypothesis of Study 1 was that for both psychologically healthy individuals and for individuals with psychosis, the twelve thinking style variables would be related to the frequency and intensity of positive anomalous experiences across participants’ lifetimes. This hypothesis was tested using a series of multiple linear regression equations with the AANEX Frequency/Intensity Ratings entered as dependent variables, and diagnostic group and AANEX-CAR thinking style items entered as predictors. As evident in Table 7, there were no significant interaction effects between diagnostic group and the thinking style variables. Therefore, although there were significant differences between the groups on many thinking style variables (see Hypothesis 1 above), main effects of relationships between thinking style and positive anomalous experience were interpreted as applying to both case and control participants.

Results showed main effects of diagnosis, indicating group membership (case or control) was a significant predictor of variance in the lifetime frequency and severity of positive anomalous experiences. In addition to a main effect of group, there was also a significant main effect of the AANEX-CAR immersion variable. This variable was described as ‘any active response that is completely congruent with the initial experience of the event/s: either in terms of speech or behavior, some kind of mental resistance to the event/s or perceived cause of the event/s, or encouragement or pursuit of the events/s’. This indicated that for both participants with a psychotic disorder, and for psychologically healthy people, the frequency and intensity of their positive anomalous experiences were positively related to the extent to which they psychologically immersed themselves in their experiences.
As well as a significant main effect of immersion, there were also three items for which additional main effects were identified ($p < 0.05$), but which did not survive Bonferroni correction for multiple comparisons. These tentative results require replication with larger sample sizes, but they are discussed with caution as follows. First, there was a trend toward significance for a main effect of the internal/external thinking style variable. It appeared that both case and control participants who viewed their experiences as originating from an external source were also more likely to experience more frequent and severe positive anomalous experiences. Examples of external sources included spiritual entities (such as God), supernatural forces, other people (such as neighbours or work colleagues), and societal agencies (such as the CIA). Examples of internal sources included stress, exhaustion, and ‘my mind playing tricks on me’. It is possible that this relationship between more frequent and severe positive anomalous experiences and an external attribution style is explained by the immersion concept described above. While those individuals who ‘explain away’ their experiences as being products of their own minds will likely forget them and move on, those who consider them to originate from an external source (such as God, other people, or supernatural forces) are probably more likely to immerse themselves in those experiences.

Another main effect that approached significance was that of the AANEX-CAR item referring to experiences originating from an impersonal versus personal source. For this item, both cases and controls who indicated a belief their experience originated from an impersonal (non-human) source (such as God or the Devil) rather than a personal (human) source (such as the CIA or undercover police) were more likely to have more frequent and severe positive anomalous experiences across their lifetimes. It should be remembered here that statistical analyses for the first
hypothesis of Study 1 revealed no significant difference between the case and control groups on this item. It is possible that a relationship between impersonal attributions and positive anomalous experiences for both cases and controls is accounted for by connections with religiosity (Maltby, Garner, Lewis, & Day, 2000; Stephen, Smith, & Diduca, 2002; Mohr & Huguelet, 2004; Ng, 2007).

That is, it was noticed during interview that control participants who had frequent spiritual (often positively valenced) anomalous experiences tended to consider them as having originated from God, or a connection with a higher power. People with psychosis experiencing frequent and severe manic-like symptoms also tended to talk about a certain elation and spiritual connectedness to a higher power. People with psychosis experiencing frequent and severe paranoid symptoms occasionally made similarly connections between their positive anomalous experiences and the devil, or another negatively valenced spiritual being. Again, it may be that those who ascribe a spiritual or supernatural meaning to their positive anomalous experiences are more likely to immerse themselves in those experiences and subsequently have (or notice) more of them, compared to those who view their experiences as having originated from personal (human) sources. Although this speculative finding is based on interviewer observation, it would provide an interesting basis for future empirical work.

A final AANEX-CAR item whose relationship with positive anomalous experiences approached significance was the social understanding item. Participants with more frequent and positive anomalous experiences tended to believe they could not talk about their experiences with others. Indeed, during interview it was surprising to hear from many participants (both case and control), who said that they had never previously spoken with anyone about their positive anomalous experiences. As these
findings involve associative data, there may have been many individual reasons for this trend, and different reasons for different types of experience. For some participants (especially those case participants with chronic unremitting symptoms), their experiences would have been truly un-understandable to those close to them, and would have evoked critical responses. Other participants with a psychotic disorder mentioned stigma, or fearing that others would view them as ‘crazy’. Some participants with paranoid symptoms said that they could not have talked about their experiences with others for fear of being ‘found out’ by adversarial agencies. Control participants talking about spiritual experiences appeared to view them as quite private occurrences, which they chose to share only with religious leaders or those very close to them. Still other participants viewed their experiences as fairly inconsequential to the grand scheme of their lives, and they did not consider it necessary to disclose them to others.

Finally, at $p = 0.061$ it might be assumed that with more power, a main effect for a relationship between the AANEX-CAR negative feelings item and the AANEX Frequency/Intensity Ratings would have approached significance. That is, future research may expect that people who have more negative feelings (such as anxiety, fear, frustration, anger) in response to their positive anomalous experiences will be rated as having more severe and frequent experiences. Again, this finding is interpreted with caution as follows. Direction of causation for a potential relationship between the frequency and severity of positive anomalous and negative feelings cannot be determined from the present results. It is probable that severe and frequent positive anomalous experiences which tend to accompany a diagnosis of schizophrenia or schizoaffective disorder are in fact very anxiety provoking, scary and debilitating symptoms – that cause a great amount of distress for their bearers.
Or, it could be that people who are prone to negative feelings are more likely to have positive anomalous experiences, which in turn evoke more negative feelings, and so on in the sort of cyclical fashion which Garety et al.’s (2001; 2007) model would suggest.

What these main effects indicate more broadly, is that for at least four items thinking style appeared to be related to positive anomalous experiences for both cases and controls. In this way, the second hypothesis for Study 1 was partially supported. However, it is acknowledged that relationships were tentative, and there was no main effects for the other eight a priori chosen AANEX-CAR items. This indicates that the types of thinking which are related to positive anomalous experiences are very specific – potentially occurring for immersion, external and impersonal sources, and negative feelings only. Although as evidenced by the negative feelings item, it is possible that more relationships would have been revealed in the current study with more participants and by extension, more power.

To our knowledge, this is the first time a dimensional relationship has been shown between unhelpful thinking styles and positive anomalous experiences across both clinical and nonclinical groups together. Yet it is consistent with previous evidence showing relationships between unhelpful thinking styles and positive anomalous experiences in nonclinical groups (Cangas et al., 2006), and separate evidence of unhelpful thinking styles differentiating nonclinical, at-risk and clinical groups (Brett et al., 2007; Morrison et al., 2007). The results of Study 1 offer support for a fully dimensional model, which would predict a dimensional relationship between positive anomalous experiences and symptom correlates throughout both the populations with psychotic diagnoses and the general community.
Chapter 7: Study 2 Results and Comment - An Investigation of the Relationship between Neurocognitive Functioning and Positive Anomalous Experiences

The aim of the second study was to assess whether similar patterns of relationship exist between neurocognitive variables and positive anomalous experiences, across both psychologically healthy and psychosis groups. This chapter describes the statistical analyses and results pertaining to Study 2. The findings are then discussed in relation to the original hypotheses, as well as in relation to previous research.

7.1. Study 2 Demographic Data

Relevant ASRB data for Study 2 were drawn from the following measures; Diagnostic Interview for Psychoses (DIP), Wechsler Abbreviated Scale of Intelligence (WASI), Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), Letter-Number Sequencing (LNS) task, Appraisals of Anomalous Experiences Interview (AANEX) Inventory, and Schizotypal Personality Questionnaire (SPQ). In total, WASI, LNS, RBANS and SPQ data were available for \( N = 396 \) Victorian participants involved in the ASRB (\( n = 169 \) cases and \( n = 227 \) controls). Of these, 7 participants had not completed the SPQ in full and were therefore excluded from the analyses. This left a total of \( N = 389 \) participants; \( n = 167 \) with a diagnosis of schizophrenia or schizoaffective disorder, and \( n = 222 \) psychologically healthy controls. Demographic data for these participants is represented in Table 9. Furthermore, as reported in Study 1, AANEX Inventory data were available for a smaller subset of \( N = 50 \) participants (\( n = 20 \) cases and \( n = 30 \) controls).
controls). Relevant demographic data for these participants has already been reported in Study 1 (Table 4).

For the larger sample of 389 participants who had completed the SPQ, there was a significant difference between the groups in relation to gender ($\chi^2 (1) = 8.418, p = 0.004$), with a higher proportion of female participants in the control group than in the case group (see Table 9). There was also a significant difference in age between the groups, with control participants tending to be older than participants with psychosis ($t (386.989) = 3.073, p = 0.002$). The mean difference in age between the groups was 3.83 years, and the corresponding effect size was small to moderate (Cohen's $d = 0.315$).

Similar to Study 1, there were significant mean differences between the groups on all three SPQ Factors, with case participants tending to score higher than controls. For the Cognitive-Perceptual Factor, t-test statistics were $t (225.548) = 12.362, p < 0.001$; for the Interpersonal Factor, $t (227.296) = 11.705, p < 0.001$; and for the Disorganized Factor, $t (265.923) = 8.934, p < 0.001$. Also similar to Study 1, there was considerable overlap between cases and controls on all SPQ factors (see Figures 22-24).

Table 9. Demographic data for participants who had completed the WASI, RBANS, LNS and SPQ measures.

<table>
<thead>
<tr>
<th></th>
<th>Case</th>
<th>Control</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>$n = 94$</td>
<td>$n = 92$</td>
<td>$n = 186$</td>
</tr>
<tr>
<td>Female</td>
<td>$n = 73$</td>
<td>$n = 130$</td>
<td>$n = 203$</td>
</tr>
<tr>
<td><strong>Age at Assessment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>20-63</td>
<td>18-65</td>
<td>18-65</td>
</tr>
<tr>
<td>Mean</td>
<td>38.72</td>
<td>42.55</td>
<td>40.90</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>10.49</td>
<td>14.03</td>
<td>12.76</td>
</tr>
<tr>
<td><strong>SPQ Cognitive-Perceptual Factor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>12.39</td>
<td>3.64</td>
<td>7.39</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>8.425</td>
<td>4.19</td>
<td>7.67</td>
</tr>
<tr>
<td><strong>SPQ Interpersonal Factor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>14.22</td>
<td>5.80</td>
<td>9.41</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>7.00</td>
<td>5.46</td>
<td>7.86</td>
</tr>
<tr>
<td><strong>SPQ Disorganized Factor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>6.64</td>
<td>2.86</td>
<td>4.48</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>4.77</td>
<td>3.07</td>
<td>4.317</td>
</tr>
</tbody>
</table>
Figure 22. Frequency distribution of the SPQ Cognitive-Perceptual Factor.

Figure 23. Frequency distribution of the SPQ Interpersonal Factor.
Figure 24. Frequency distribution of the SPQ Disorganized Factor.

7.2. Study 2 Statistical Analyses

Independent samples t-tests were used to assess whether (in the larger sample) there were between-group differences on seven a priori selected neurocognitive variables from the WASI, RBANS and LNS measures (Table 10). The significance level for these comparisons was set at $\alpha \leq 0.007$ after Bonferroni correction. Results represented in Table 10 show that participants with a diagnosis of schizophrenia or schizoaffective disorder scored significantly lower than controls on all seven neurocognitive variables, all with large effect sizes as measured via Cohen’s $d$. 
Table 10. Results of the independent samples t-tests comparing neurocognitive measures between cases and controls for N = 389.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean (SD)</th>
<th>t</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Case</td>
<td>Control</td>
<td>t</td>
<td>p</td>
</tr>
<tr>
<td>WASI IQ Equivalents</td>
<td>101.33 (14.90)</td>
<td>112.62 (11.71)</td>
<td>t (306.478) = 8.092</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>82.74 (18.65)</td>
<td>100.41 (14.61)</td>
<td>t (305.301) = 10.119</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>82.56 (14.00)</td>
<td>97.72 (13.79)</td>
<td>t (387) = 10.666</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>94.16 (13.95)</td>
<td>105.18 (12.24)</td>
<td>t (387) = 8.275</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>86.34 (19.03)</td>
<td>104.20 (16.10)</td>
<td>t (322.543) = 9.78</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>83.49 (16.54)</td>
<td>98.50 (16.54)</td>
<td>t (271.967) = 10.166</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>9.22 (2.91)</td>
<td>11.66 (2.87)</td>
<td>t (387) = 8.265</td>
<td>&lt;0.0001*</td>
</tr>
</tbody>
</table>

* = Significant at α ≤ 0.007.

7.2.1. The SPQ Cognitive-Perceptual Factor

Next for the larger sample of Victorian ASRB participants who had completed the SPQ (N = 389), a possible relationship was examined between the seven neurocognitive variables and positive anomalous experiences as measured by the SPQ Cognitive-Perceptual Factor. Assumptions of linear regression were not met for statistical analyses containing the SPQ factors (i.e. normality and heteroscedasticity). Consistent with the author’s previous research (Nelson et al., 2011), it was determined that the SPQ better fitted a negative binomial distribution than a normal distribution.

Multiple negative binomial regressions were used to determine the best model fit of the data. All regressions were completed via SPSS multiple negative binomial regression, using SPSS syntax (Version 20; www-01.ibm/software/analytics/spss/products.statistics; see Appendix I). Initially it was necessary to determine whether there were any interaction effects between diagnostic
group (case or control) and the neurocognitive variables. That is, whether the slope of the regression lines were significantly different according to diagnostic group (case or control). Table 11 shows the results of seven analyses, with diagnostic group and the neurocognitive measures as predictors, and the SPQ Cognitive-Perceptual Factor consistently used as the dependent variable. The significance level of these regressions was set at $\alpha \leq 0.007$ after Bonferroni correction. As can be seen in Table 11, there were significant interaction effects for the equations containing the WASI Full Scale IQ scores and the RBANS Delayed Memory Index. There were also interaction effects approaching significance for equations containing the RBANS Immediate Memory and RBANS Attention Indices. These interaction effects indicated that the slopes of the regression lines for cases were different to the slopes of the regression lines for controls.

Table 11. Results of multiple negative binomial regression analyses testing interaction effects for $N = 389$, with diagnostic group and the neurocognitive variables as predictors ($x_1$ and $x_2$ respectively), and with the SPQ Cognitive-Perceptual Factor consistently used as the dependent variable ($y$).

<table>
<thead>
<tr>
<th>Predictor ($x_2$)</th>
<th>Model (Likelihood Ratio $\chi^2$)</th>
<th>Equation: $\log(y) = a + b_1x_1 + b_2x_2 + b_3(x_1 \times x_2)$</th>
<th>$p$ ($x_1$)</th>
<th>$p$ ($x_2$)</th>
<th>$p$ ($x_1 \times x_2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>$\chi^2(3) = 61.687$, $p&lt;0.001**$</td>
<td>$\log(y) = 4.578 - 2.164x_1 + 0.001x_2 - 0.031(x_1 \times x_2)$</td>
<td>0.012**</td>
<td>0.838</td>
<td>$&lt;0.001**$</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>$\chi^2(3) = 121.664$, $p&lt;0.001**$</td>
<td>$\log(y) = 2.644 - 0.241x_1 + 0.001x_2 - 0.015(x_1 \times x_2)$</td>
<td>0.689</td>
<td>0.745</td>
<td>0.018*</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>$\chi^2(3) = 114.445$, $p&lt;0.001**$</td>
<td>$\log(y) = 1.255 + 0.796x_1 + 0.006x_2 - 0.005(x_1 \times x_2)$</td>
<td>0.248</td>
<td>0.300</td>
<td>0.487</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>$\chi^2(3) = 113.846$, $p&lt;0.001**$</td>
<td>$\log(y) = 1.508 + 0.708x_1 + 0.003x_2 - 0.005(x_1 \times x_2)$</td>
<td>0.362</td>
<td>0.557</td>
<td>0.495</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>$\chi^2(3) = 127.545$, $p&lt;0.001**$</td>
<td>$\log(y) = 2.989 - 0.298x_1 - 0.002x_2 - 0.015(x_1 \times x_2)$</td>
<td>0.606</td>
<td>0.600</td>
<td>0.013*</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>$\chi^2(3) = 123.494$, $p&lt;0.001**$</td>
<td>$\log(y) = 3.279 - 1.045x_1 + 0.003x_2 - 0.024(x_1 \times x_2)$</td>
<td>0.180</td>
<td>0.467</td>
<td>0.004**</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>$\chi^2(3) = 118.740$, $p&lt;0.001**$</td>
<td>$\log(y) = 1.911 + 0.762x_1 - 0.017x_2 - 0.037(x_1 \times x_2)$</td>
<td>0.057</td>
<td>0.559</td>
<td>0.323</td>
</tr>
</tbody>
</table>

** = Significant at $\alpha \leq 0.007$.
* = $p \leq 0.05$. 
In order to test main effects of the neurocognitive variables, or in other words to assess whether the neurocognitive items contributed significantly to the variance in SPQ Cognitive-Perceptual Factor scores, interaction terms were removed from the regression equations. Table 12 shows multiple negative binomial regression analyses testing main effects for the neurocognitive measures that had previously given rise to significant interactions (WASI FSIQ, and RBANS Immediate Memory, Attention and Delayed Memory Indices). Again, diagnostic group (case or control) and the neurocognitive measures were entered as predictors, and the SPQ Cognitive-Perceptual Factor was consistently used as the dependent variable. The significance level of these regressions was set at $\alpha \leq 0.0125$ after Bonferroni correction.

The regressions reported in Table 12 yielded significant main effects for WASI Full Scale IQ, and the RBANS Attention Index. This indicated a significant relationship between both the WASI Full Scale IQ, and the RBANS Attention Index with the SPQ Cognitive-Perceptual Factor. Given significant interactions found previously, examination of Figures 25 and 29 revealed that relationships were predominantly driven by the case group, and there was likely no relationship for the control group. There were no significant main effects for either of the RBANS Memory Indices.

Table 13 shows multiple negative binomial regression analyses testing main effects for the three remaining neurocognitive measures whose equations did not contain a significant interaction effect (RBANS Construction, RBANS Language and LNS). These equations tested main effects of diagnostic group and each of the three remaining neurocognitive variables. Again, diagnostic group (case or control) and the neurocognitive measures were entered as predictors, and the SPQ Cognitive-Perceptual Factor was consistently used as the dependent variable. The significance
level of these regressions was set at $\alpha \leq 0.017$ after Bonferroni correction.

As can be seen in Table 13, there were no significant main effects for the RBANS Construction or RBANS Language Indices. However, there was a trend towards significance for a main effect of the LNS. This indicated that for both cases and controls, there was no relationship between the RBANS Construction Index and the SPQ Cognitive-Perceptual Factor, nor between the RBANS Language Index and the SPQ Cognitive-Perceptual Factor. Yet, there appeared to be a weak relationship between the LNS and SPQ Cognitive-Perceptual Factor for both groups, as indicated by a trend toward significance. However this relationship did not remain after Bonferroni correction. As a final note, there were significant main effects of diagnostic group in every equation in Tables 12 and 13. This indicated that diagnosis was a large contributor to variance in SPQ Cognitive-Perceptual Factor scores.

To aid understanding and interpretation of the above statistical analyses, scatterplots showing negative binomial regression fit lines for relationships between the seven neurocognitive measures and the SPQ Cognitive-Perceptual Factor are shown in Figures 25-31.

<table>
<thead>
<tr>
<th>Predictor (x2)</th>
<th>Model (Likelihood Ratio $\chi^2$)</th>
<th>Equation: log(y) = a + $bx_1$ + $bx_2$</th>
<th>p (x1)</th>
<th>p (x2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>$\chi^2 (2) = 123.044$, $p&lt;0.001^{**}$</td>
<td>log(y) = 2.632 + 1.138$x_1$ - 0.012$x_2$</td>
<td>&lt;0.001**</td>
<td>0.002**</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>$\chi^2 (2) = 116.104$, $p&lt;0.001^{**}$</td>
<td>log(y) = 1.805 + 1.150$x_1$ - 0.005$x_2$</td>
<td>&lt;0.001**</td>
<td>0.097</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>$\chi^2 (2) = 121.418$, $p&lt;0.001^{**}$</td>
<td>log(y) = 2.136 + 1.105$x_1$ - 0.008$x_2$</td>
<td>&lt;0.001**</td>
<td>0.004**</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>$\chi^2 (2) = 115.015$, $p&lt;0.001^{**}$</td>
<td>log(y) = 1.773 + 1.167$x_1$ - 0.005$x_2$</td>
<td>&lt;0.001**</td>
<td>0.204</td>
</tr>
</tbody>
</table>

** = Significant at $\alpha \leq 0.0125$.
* = $p \leq 0.05$. 

Table 12. Results of multiple negative binomial regression analyses testing main effects for $N = 389$, with diagnostic group and the neurocognitive variables as predictors ($x_1$ and $x_2$ respectively), and with the SPQ Cognitive-Perceptual Factor consistently used as the dependent variable (y).
**Table 13.** Results of multiple negative binomial regression analyses testing main effects for N = 389, with diagnostic group and the neurocognitive variables as predictors (x₁ and x₂ respectively), and with the SPQ Cognitive-Perceptual Factor consistently used as the dependent variable (y).

<table>
<thead>
<tr>
<th>Predictor (x₂)</th>
<th>Model (Likelihood Ratio χ²)</th>
<th>Equation: log (y) = a + bx₁ + bx₂</th>
<th>p (x₁)</th>
<th>p (x₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBANS Constructional Index</td>
<td>χ²(2) = 113.960, p&lt;0.001**</td>
<td>log (y) = 1.007 + 1.260x₁ + 0.003x₂</td>
<td>&lt;0.001**</td>
<td>0.438</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>χ²(2) = 113.381, p&lt;0.001**</td>
<td>log (y) = 1.232 + 1.232x₁ + 0.001x₂</td>
<td>&lt;0.001**</td>
<td>0.884</td>
</tr>
<tr>
<td>Letter-Number Sequencing</td>
<td>χ²(2) = 117.763, p&lt;0.001**</td>
<td>log (y) = 1.735 + 1.142x₁ - 0.039x₂</td>
<td>&lt;0.001**</td>
<td>0.035*</td>
</tr>
</tbody>
</table>

** = Significant at α ≤ 0.017.
* = p ≤ 0.05.

**Figure 25.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and WASI Full Scale IQ.
Figure 26. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Immediate Memory Index.

Figure 27. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Constructional Index.
Figure 28. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Language Index.

Figure 29. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Attention Index.
Figure 30. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the RBANS Delayed Memory Index.

Figure 31. Negative binomial fit lines and confidence intervals for relationships between the SPQ Cognitive-Perceptual Factor and the LNS.
7.2.2. The SPQ Disorganized and Interpersonal Factors

Unlike positive anomalous experiences as measured by the Cognitive-Perceptual Factor of the SPQ, the disorganized and negative facets of schizotypy and psychosis were not the main focus of the present project. However, given previous research showing a more consistent relationship between neurocognition and these constructs (e.g. Basso et al., 1998; Pantelis et al., 2001; de Gracia Dominguez, Viechtbauer, Simons, van Os, & Krabbendam, 2009; Lindsberg et al., 2009), it was decided to examine them post hoc. Tables 14 and 15 show multiple negative binomial regressions testing interaction effects via SPSS. Diagnostic group (case or control) and the neurocognitive measures were entered as predictors, and the SPQ Disorganized and Interpersonal Factors were entered as dependent variables. The significance level of these regressions was set at $\alpha \leq 0.007$ after Bonferroni correction.

As shown in Table 14, there was a significant interaction in the regression equation that included the RBANS Attention Index and SPQ Interpersonal Factor. There were also interaction effects approaching significance in the equations that contained the WASI IQ scores, and the RBANS Delayed Memory Index. In Table 15, there was an interaction effect approaching significance in the regression equation that included the RBANS Delayed Memory Index and the SPQ Disorganized Factor. For these equations, it was concluded that the slope of the regression line was different for participants with a diagnosis of schizophrenia or schizoaffective disorder as compared to controls.

In order to subsequently test main effects of the neurocognitive variables, or in other words to assess whether the neurocognitive items contributed significantly to
the variance in SPQ Cognitive-Perceptual Factor scores, interaction terms were
removed from the regression equations. These regressions are represented in Tables
16 and 17.

**Table 14.** Results of multiple negative binomial regression analyses testing interaction
effects for N = 389, with diagnostic group and the neurocognitive variables as predictors
($x_1$ and $x_2$ respectively), and with the SPQ Interpersonal Factor consistently used as the
dependent variable ($y$).

<table>
<thead>
<tr>
<th>Predictor ($x_2$)</th>
<th>Model (Likelihood Ratio $\chi^2$)</th>
<th>Equation: $\log(y) = a + b_{x_1} + b_{x_2} + b_{(x_1 \times x_2)}$</th>
<th>$p$ ($x_1$)</th>
<th>$p$ ($x_2$)</th>
<th>$p$ ($x_1 \times x_2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>$\chi^2 (3) = 100.581, p&lt;0.001**$</td>
<td>$\log(y) = 3.497 - 0.821x_1 + 0.000x_2 - 0.015(x_1 \times x_2)$</td>
<td>0.256</td>
<td>0.961</td>
<td>0.021*</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>$\chi^2 (3) = 96.837, p&lt;0.001**$</td>
<td>$\log(y) = 2.746 - 0.061x_1 + 0.000x_2 - 0.010(x_1 \times x_2)$</td>
<td>0.906</td>
<td>0.918</td>
<td>0.080</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>$\chi^2 (3) = 92.990, p&lt;0.001**$</td>
<td>$\log(y) = 2.265 + 0.094x_1 - 0.004x_2 - 0.009(x_1 \times x_2)$</td>
<td>0.870</td>
<td>0.437</td>
<td>0.165</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>$\chi^2 (3) = 95.771, p&lt;0.001**$</td>
<td>$\log(y) = 2.873 - 0.399x_1 + 0.002x_2 - 0.013(x_1 \times x_2)$</td>
<td>0.563</td>
<td>0.687</td>
<td>0.066</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>$\chi^2 (3) = 111.488, p&lt;0.001**$</td>
<td>$\log(y) = 3.468 - 0.636x_1 - 0.002x_2 - 0.015(x_1 \times x_2)$</td>
<td>0.188</td>
<td>0.527</td>
<td>0.003**</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>$\chi^2 (3) = 97.135, p&lt;0.001**$</td>
<td>$\log(y) = 3.040 - 0.519x_1 + 0.002x_2 - 0.015(x_1 \times x_2)$</td>
<td>0.413</td>
<td>0.687</td>
<td>0.029*</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>$\chi^2 (3) = 96.501, p&lt;0.001**$</td>
<td>$\log(y) = 2.312 + 0.454x_1 - 0.012x_2 - 0.036(x_1 \times x_2)$</td>
<td>0.185</td>
<td>0.621</td>
<td>0.261</td>
</tr>
</tbody>
</table>

** = Significant at $\alpha \leq 0.007$.
* = $p \leq 0.05$.

**Table 15.** Results of multiple negative binomial regression analyses testing interaction
effects for N = 389, with diagnostic group and the neurocognitive variables as predictors
($x_1$ and $x_2$ respectively), and with the SPQ Disorganized Factor consistently used as the
dependent variable ($y$).

<table>
<thead>
<tr>
<th>Predictor ($x_2$)</th>
<th>Model (Likelihood Ratio $\chi^2$)</th>
<th>Equation: $\log(y) = a + b_{x_1} + b_{x_2} + b_{(x_1 \times x_2)}$</th>
<th>$p$ ($x_1$)</th>
<th>$p$ ($x_2$)</th>
<th>$p$ ($x_1 \times x_2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>$\chi^2 (3) = 67.743, p&lt;0.001**$</td>
<td>$\log(y) = 2.255 - 0.454x_1 + 0.001x_2 - 0.012(x_1 \times x_2)$</td>
<td>0.584</td>
<td>0.852</td>
<td>0.126</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>$\chi^2 (3) = 66.302, p&lt;0.001**$</td>
<td>$\log(y) = 1.663 + 0.343x_1 - 0.001x_2 - 0.005(x_1 \times x_2)$</td>
<td>0.546</td>
<td>0.739</td>
<td>0.431</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>$\chi^2 (3) = 65.811, p&lt;0.001**$</td>
<td>$\log(y) = 1.515 + 0.276x_1 + 0.004x_2 - 0.009(x_1 \times x_2)$</td>
<td>0.968</td>
<td>0.414</td>
<td>0.219</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>$\chi^2 (3) = 65.649, p&lt;0.001**$</td>
<td>$\log(y) = 1.375 + 0.004x_1 + 0.005x_2 - 0.009(x_1 \times x_2)$</td>
<td>0.996</td>
<td>0.301</td>
<td>0.271</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>$\chi^2 (3) = 68.315, p&lt;0.001**$</td>
<td>$\log(y) = 1.918 + 0.144x_1 - 0.002x_2 - 0.006(x_1 \times x_2)$</td>
<td>0.797</td>
<td>0.594</td>
<td>0.259</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>$\chi^2 (3) = 70.925, p&lt;0.001**$</td>
<td>$\log(y) = 2.473 - 0.836x_1 + 0.003x_2 - 0.018(x_1 \times x_2)$</td>
<td>0.233</td>
<td>0.492</td>
<td>0.018*</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>$\chi^2 (3) = 65.898, p&lt;0.001**$</td>
<td>$\log(y) = 1.336 + 0.736x_1 - 0.020x_2 - 0.005(x_1 \times x_2)$</td>
<td>0.056</td>
<td>0.477</td>
<td>0.887</td>
</tr>
</tbody>
</table>

** = Significant at $\alpha \leq 0.007$.
* = $p \leq 0.05$. 
Table 16. Results of multiple negative binomial regression analyses testing main effects for \( N = 389 \), with diagnostic group and the neurocognitive variables as predictors \((x_1 \text{ and } x_2 \text{ respectively})\), and with the SPQ Interpersonal Factor consistently used as the dependent variable \((y)\).

<table>
<thead>
<tr>
<th>Predictor ((x_2))</th>
<th>Model (Likelihood Ratio (\chi^2))</th>
<th>Equation: (\log(y) = a + bx_1 + bx_2)</th>
<th>(p) ((x_1))</th>
<th>(p) ((x_2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>(\chi^2(2) = 95.254, p&lt;0.001**)</td>
<td>(\log(y) = 2.517 + 0.833x_1 - 0.007x_2)</td>
<td>&lt;0.001**</td>
<td>0.039*</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>(\chi^2(2) = 93.779, p&lt;0.001**)</td>
<td>(\log(y) = 2.210 + 0.825x_1 - 0.005x_2)</td>
<td>&lt;0.001**</td>
<td>0.093</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>(\chi^2(2) = 91.063, p&lt;0.001**)</td>
<td>(\log(y) = 1.858 + 0.883x_1 - 0.001x_2)</td>
<td>&lt;0.001**</td>
<td>0.742</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>(\chi^2(2) = 92.429, p&lt;0.001**)</td>
<td>(\log(y) = 1.476 + 0.674x_1 - 0.011x_2)</td>
<td>&lt;0.001**</td>
<td>0.226</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>(\chi^2(2) = 102.691, p&lt;0.001**)</td>
<td>(\log(y) = 2.620 + 0.773x_1 - 0.008x_2)</td>
<td>&lt;0.001**</td>
<td>0.001**</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>(\chi^2(2) = 92.325, p&lt;0.001**)</td>
<td>(\log(y) = 2.125 + 0.848x_1 - 0.004x_2)</td>
<td>&lt;0.001**</td>
<td>0.245</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>(\chi^2(2) = 95.238, p&lt;0.001**)</td>
<td>(\log(y) = 2.136 + 0.824x_1 - 0.033x_2)</td>
<td>&lt;0.001**</td>
<td>0.038*</td>
</tr>
</tbody>
</table>

** = Significant at \( \alpha \leq 0.007 \).
* = \( p \leq 0.05 \).

Table 17. Results of multiple negative binomial regression analyses testing main effects for \( N = 389 \), with diagnostic group and the neurocognitive variables as predictors \((x_1 \text{ and } x_2 \text{ respectively})\), and with the SPQ Disorganized Factor consistently used as the dependent variable \((y)\).

<table>
<thead>
<tr>
<th>Predictor ((x_2))</th>
<th>Model (Likelihood Ratio (\chi^2))</th>
<th>Equation: (\log(y) = a + bx_1 + bx_2)</th>
<th>(p) ((x_1))</th>
<th>(p) ((x_2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>(\chi^2(2) = 65.400, p&lt;0.001**)</td>
<td>(\log(y) = 1.492 + 0.803x_1 - 0.004x_2)</td>
<td>&lt;0.001**</td>
<td>0.294</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>(\chi^2(2) = 65.681, p&lt;0.001**)</td>
<td>(\log(y) = 2.746 - 0.061x_1 + 0.000x_2)</td>
<td>&lt;0.001**</td>
<td>0.239</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>(\chi^2(2) = 64.300, p&lt;0.001**)</td>
<td>(\log(y) = 1.077 + 0.839x_1 + 0.000x_2)</td>
<td>&lt;0.001**</td>
<td>0.942</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>(\chi^2(2) = 64.439, p&lt;0.001**)</td>
<td>(\log(y) = 0.896 + 0.857x_1 + 0.002x_2)</td>
<td>&lt;0.001**</td>
<td>0.703</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>(\chi^2(2) = 67.036, p&lt;0.001**)</td>
<td>(\log(y) = 1.531 + 0.765x_1 - 0.005x_2)</td>
<td>&lt;0.001**</td>
<td>0.097</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>(\chi^2(2) = 65.307, p&lt;0.001**)</td>
<td>(\log(y) = 1.405 + 0.796x_1 - 0.004x_2)</td>
<td>&lt;0.001**</td>
<td>0.317</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>(\chi^2(2) = 65.878, p&lt;0.001**)</td>
<td>(\log(y) = 1.311 + 0.788x_1 - 0.023x_2)</td>
<td>&lt;0.001**</td>
<td>0.207</td>
</tr>
</tbody>
</table>

** = Significant at \( \alpha \leq 0.007 \).
* = \( p \leq 0.05 \).
Table 16 shows a significant main effect of the RBANS Attention Index. It also shows main effects approaching significance for the WASI Full Scale IQ, and LNS. This indicated potential relationships between these measures and the SPQ Interpersonal Factor. Previously reported interactions with diagnostic group for the RBANS Attention and WASI IQ measures, in combination with Figures 32 and 36, revealed that tentative relationships between these measures and the SPQ Interpersonal Factor were driven by the case group. There was no interaction with diagnostic group for the LNS, indicating that a potential relationship between the LNS and the SPQ Interpersonal Factor most likely held for both cases and controls. There were no relationships between any of the neurocognitive variables and the SPQ Disorganized Factor (Table 17). There were also significant main effects of diagnostic group in every equation in Tables 16 and 17. This indicated that diagnosis was a large contributor to variance in both SPQ Interpersonal and Disorganized Factor scores.

To aid understanding and interpretation of the above statistical analyses, scatterplots were again generated to show negative binomial regression fit lines for relationships between the seven neurocognitive measures and the SPQ Interpersonal and Disorganized Factors are shown in Figures 32-45. A summary of within-group relationships between the SPQ factors and the neurocognitive variables is also represented in Table 18.
Figure 32. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and WASI Full Scale IQ.

Figure 33. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Immediate Memory Index.
**Figure 34.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Constructional Index.

**Figure 35.** Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Language Index. Index.
Figure 36. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Attention Index.

Figure 37. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the RBANS Delayed Memory Index.
Figure 38. Negative binomial fit lines and confidence intervals for relationships between the SPQ Interpersonal Factor and the Letter-Number Sequencing Task.

Figure 39. Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and WASI Full Scale IQ.
Figure 40. Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Immediate Memory Index.

Figure 41. Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Constructional Index.
Figure 42. Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Language Index.

Figure 43. Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Attention Index.
Figure 44. Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the RBANS Delayed Memory Index.

Figure 45. Negative binomial fit lines and confidence intervals for relationships between the SPQ Disorganized Factor and the Letter-Number Sequencing Task.
Table 18. Summary of within-group relationships between the SPQ factors and neurocognitive variables.

<table>
<thead>
<tr>
<th>Neurocognitive Variable</th>
<th>Significant Within-Group Relationship with the SPQ Cognitive-Perceptual Factor</th>
<th>Cases</th>
<th>Controls</th>
<th>Cases</th>
<th>Controls</th>
<th>Cases</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>✓</td>
<td>×</td>
<td>p&lt;0.05</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>✓</td>
<td>×</td>
<td>✓</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>p&lt;0.05</td>
<td>p&lt;0.05</td>
<td>p&lt;0.05</td>
<td>p&lt;0.05</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>
7.2.3. The AANEX

For the subset of Victorian ASRB participants who had completed the AANEX \((N = 50)\), a possible relationship was examined between the seven \(a priori\) chosen neurocognitive variables and the averaged AANEX Inventory Frequency/Intensity Ratings, as an assumedly convergent measure of positive anomalous experience.

Multiple linear regression was used to determine the best model fit of the data. Again as a reminder from Study 1, all assumptions of linear regression involving the AANEX measure were met. Analyses were completed via SPSS linear regression (‘Enter’ method). First it was necessary to determine whether there were any interaction effects. That is, whether the slope of the regression line was significantly different according to group. Table 19 shows interaction equations, with diagnostic group and neurocognitive variables entered as predictors, and with the AANEX Frequency/Intensity Ratings consistently used as dependent variables. Two equations are reported for each neurocognitive item – one with unstandardized coefficients \((b)\), and the other with standardized coefficients \((\beta)\). Collinearity diagnostics did not reveal any tolerances approaching 0 for any predictor variables included in these equations. The significance level of these regressions was set at \(\alpha \leq 0.007\) after Bonferroni correction. As can be seen in Table 19, there were no significant interaction effects. Subsequently, interaction terms were discarded from the equations, and main effects were tested without caveat.

Table 20 shows multiple linear regressions testing main effects of diagnostic group and the neurocognitive measures. Again, two equations are reported – one each for unstandardized \((b)\), and standardized coefficients \((\beta)\). Collinearity diagnostics did not reveal any tolerances approaching 0, and the significant level was set at \(\alpha \leq 0.007\). Significant main effects of diagnostic group were consistently found. This
indicated that diagnostic group was a significant contributor to the variance in AANEX Frequency/Intensity Ratings. There were no significant main effects of any of the neurocognitive variables. A main effect for the RBANS Construction Index approached significance, but did not survive Bonferroni correction. Again to aid interpretation and understanding of results, linear regression fit lines for cases and controls are shown graphically in Figures 46-52.

As a final note regarding Study 2, it was noticed that different results were found in the larger sample of participants who had completed the SPQ, compared to the subsample who had also completed the AANEX. Therefore, a post-hoc correlation was performed comparing the SPQ Cognitive-Perceptual Factor and the averaged AANEX Frequency/Intensity Ratings for \( N = 50 \) participants in the subsample. This bivariate Pearson correlation was moderate in size \( (r = 0.598) \).
### Table 19. Results of multiple linear regression analyses (‘Enter’ method) testing interaction effects for \( N = 50 \), with diagnostic group and the neurocognitive variables used as predictors \((x_1 \text{ and } x_2 \text{ respectively})\), and with the averaged AANEX Frequency/Intensity Ratings consistently used as the dependent variable \((y)\).

<table>
<thead>
<tr>
<th>Predictor ((x_2))</th>
<th>Model</th>
<th>( y = a + bx_1 + bx_2 + b (x_1 \times x_2) )</th>
<th>( y = a + \beta x_1 + \beta x_2 + \beta (x_1 \times x_2) )</th>
<th>( r^2 )</th>
<th>Adjusted ( r^2 )</th>
<th>( p ) ( (x_1) )</th>
<th>( p ) ( (x_2) )</th>
<th>( p ) ( (x_1 \times x_2) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>( F_{3,46} = 26.123, p &lt; 0.001** )</td>
<td>( y = 4.119 - 2.479x_1 - 0.003x_2 + 0.011(x_1 \times x_2) )</td>
<td>( y = -1.646x_1 - 0.42x_2 + 0.889(x_1 \times x_2) )</td>
<td>0.630</td>
<td>0.606</td>
<td>0.092</td>
<td>0.747</td>
<td>0.377</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>( F_{3,46} = 26.537, p &lt; 0.001** )</td>
<td>( y = 3.945 - 2.234x_1 - 0.001x_2 + 0.011(x_1 \times x_2) )</td>
<td>( y = -1.520x_1 - 0.247x_2 + 0.757(x_1 \times x_2) )</td>
<td>0.639</td>
<td>0.615</td>
<td>0.009**</td>
<td>0.533</td>
<td>0.200</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>( F_{3,46} = 29.138, p &lt; 0.001** )</td>
<td>( y = 4.381 - 0.116x_1 - 0.006x_2 - 0.010(x_1 \times x_2) )</td>
<td>( y = 0.079x_1 - 0.119x_2 - 0.669(x_1 \times x_2) )</td>
<td>0.660</td>
<td>0.637</td>
<td>0.906</td>
<td>0.349</td>
<td>0.343</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>( F_{3,46} = 26.101, p &lt; 0.001** )</td>
<td>( y = 5.082 - 2.022x_1 - 0.013x_2 + 0.016(x_1 \times x_2) )</td>
<td>( y = 1.920x_1 - 0.179x_2 + 1.207(x_1 \times x_2) )</td>
<td>0.635</td>
<td>0.611</td>
<td>0.052</td>
<td>0.216</td>
<td>0.235</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>( F_{3,46} = 25.098, p &lt; 0.001** )</td>
<td>( y = 3.827 - 0.614x_1 + 0.006x_2 - 0.005(x_1 \times x_2) )</td>
<td>( y = 0.418x_1 + 0.010x_2 - 0.377(x_1 \times x_2) )</td>
<td>0.626</td>
<td>0.601</td>
<td>0.457</td>
<td>0.996</td>
<td>0.525</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>( F_{3,46} = 24.651, p &lt; 0.001** )</td>
<td>( y = 3.848 - 0.898x_1 + 0.004x_2 - 0.003(x_1 \times x_2) )</td>
<td>( y = -0.611x_1 + 0.004x_2 - 0.178(x_1 \times x_2) )</td>
<td>0.622</td>
<td>0.596</td>
<td>0.405</td>
<td>0.972</td>
<td>0.178</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>( F_{3,46} = 24.012, p &lt; 0.001** )</td>
<td>( y = 3.845 - 0.769x_1 - 0.002x_2 - 0.030(x_1 \times x_2) )</td>
<td>( y = 0.526x_1 - 0.006x_2 - 0.265(x_1 \times x_2) )</td>
<td>0.621</td>
<td>0.595</td>
<td>0.221</td>
<td>0.962</td>
<td>0.576</td>
</tr>
</tbody>
</table>

\( ** = \text{Significant at } \alpha \leq 0.007. \)

\( * = p \leq 0.05. \)

### Table 20. Results of multiple linear regression analyses (‘Enter’ method) testing main effects for \( N = 50 \), with diagnostic group and the neurocognitive variables used as predictors \((x_1 \text{ and } x_2 \text{ respectively})\), and with the averaged AANEX Frequency/Intensity Ratings consistently used as the dependent variable \((y)\).

<table>
<thead>
<tr>
<th>Predictor ((x_2))</th>
<th>Model</th>
<th>( y = a + bx_1 + bx_2 )</th>
<th>( y = a + \beta x_1 + \beta x_2 )</th>
<th>( r^2 )</th>
<th>Adjusted ( r^2 )</th>
<th>( p ) ( (x_1) )</th>
<th>( p ) ( (x_2) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASI IQ Equivalent</td>
<td>( F_{2,46} = 38.954, p&lt;0.001** )</td>
<td>( y = 3.600 - 1.200x_1 + 0.002x_2 )</td>
<td>( y = 0.002x_1 + 0.033x_2 )</td>
<td>0.624</td>
<td>0.608</td>
<td>&lt;0.001**</td>
<td>0.736</td>
</tr>
<tr>
<td>RBANS Immediate Memory Index</td>
<td>( F_{2,46} = 38.382, p&lt;0.001** )</td>
<td>( y = 3.560 - 1.193x_1 + 0.003x_2 )</td>
<td>( y = 0.012x_1 + 0.070x_2 )</td>
<td>0.625</td>
<td>0.609</td>
<td>&lt;0.001**</td>
<td>0.466</td>
</tr>
<tr>
<td>RBANS Constructional Index</td>
<td>( F_{2,46} = 43.322, p&lt;0.001** )</td>
<td>( y = 4.745 - 1.040x_1 - 0.011x_2 )</td>
<td>( y = 0.070x_1 - 0.197x_2 )</td>
<td>0.653</td>
<td>0.638</td>
<td>&lt;0.001**</td>
<td>0.944*</td>
</tr>
<tr>
<td>RBANS Language Index</td>
<td>( F_{2,46} = 38.050, p&lt;0.001** )</td>
<td>( y = 4.198 - 1.130x_1 - 0.004x_2 )</td>
<td>( y = 0.769x_1 - 0.053x_2 )</td>
<td>0.623</td>
<td>0.607</td>
<td>&lt;0.001**</td>
<td>0.590</td>
</tr>
<tr>
<td>RBANS Attention Index</td>
<td>( F_{2,46} = 37.929, p&lt;0.001** )</td>
<td>( y = 3.976 - 1.129x_1 - 0.002x_2 )</td>
<td>( y = 0.768x_1 - 0.045x_2 )</td>
<td>0.623</td>
<td>0.606</td>
<td>&lt;0.001**</td>
<td>0.659</td>
</tr>
<tr>
<td>RBANS Delayed Memory Index</td>
<td>( F_{2,46} = 37.722, p&lt;0.001** )</td>
<td>( y = 3.919 - 1.149x_1 - 0.001x_2 )</td>
<td>( y = 0.781x_1 - 0.019x_2 )</td>
<td>0.621</td>
<td>0.605</td>
<td>&lt;0.001**</td>
<td>0.842</td>
</tr>
<tr>
<td>Letter-Number Sequencing Task</td>
<td>( F_{2,46} = 36.592, p&lt;0.001** )</td>
<td>( y = 3.970 - 1.116x_1 - 0.014x_2 )</td>
<td>( y = -0.763x_1 - 0.054x_2 )</td>
<td>0.618</td>
<td>0.601</td>
<td>&lt;0.001**</td>
<td>0.589</td>
</tr>
</tbody>
</table>

\( ** = \text{Significant at } \alpha \leq 0.007. \)

\( * = p \leq 0.05. \)
**Figure 46.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and WASI Full Scale IQ.

**Figure 47.** Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Immediate Memory Index.
Figure 48. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Constructional Index.

Figure 49. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Language Index.
Figure 50. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Attention Index.

Figure 51. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the RBANS Delayed Memory Index.
Figure 52. Linear fit lines and confidence intervals for relationships between the averaged AANEX Inventory Frequency/Intensity Ratings and the LNS.

7.3. Study 2 Comment – Hypothesis 1

The first hypothesis for Study 2 proposed that individuals with a psychotic disorder would demonstrate cognitive impairments compared to psychologically healthy individuals on a range of measures of neurocognitive function; Full Scale IQ, visual construction, language, attention, immediate memory, delayed memory, and working memory.

Comparisons conducted using independent t-tests showed that Victorian ASRB participants with a diagnosis of schizophrenia or schizoaffective disorder scored significantly lower than controls on all neurocognitive measures, all with large effect sizes. This is unsurprising in light of a large amount of previous research showing similar differences (Basso et al., 1998; Heinrichs & Zakzanis, 1998; Fioravanti et al., 2005; Heinrichs, 2005; Reichenberg & Harvey, 2007; Galderisi et al., 2009; Lindsberg et al., 2009; Tandon et al., 2009; Haenschel & Linden, 2011;
Simonsen et al., 2011). These findings support assertions that reduced neurocognitive abilities are a defining feature of psychotic disorders, especially for individuals with long-standing, chronic symptoms (e.g. Heinrichs, 2005; Wilk et al., 2005; Tandon et al., 2009).

It could be argued that the present findings of significant differences in neurocognition between people with and without psychosis were accounted for by age differences between the psychosis and control groups. Indeed, age has previously been shown to correlate with neurocognitive abilities (Tucker-Drob, 2011). However, a mean difference in age between the groups is unlikely to have given rise to the observed differences in neurocognition in the present study, given that results are consistent with previous research. Furthermore, the mean difference in age between the groups was only 3.83 years, which was a relatively small difference.

It is also important to note that while there were differences in neurocognition between cases and controls, these differences did not reflect intellectual disability within the case group. Aside from significant differences between the groups, all neurocognitive means fell within average and below average and ranges, and there was large overlap between groups. This indicates that while people with a psychotic disorder tended to score lower on neurocognitive measures than controls, they did not as a group exhibit cognitive dysfunction per se.

This finding could be a consequence of the deliberate ASRB policy of excluding participants with an FSIQ below 70, in order to increase the likelihood of a homogenous sample. Furthermore, involvement in the ASRB can be taxing in terms of organization and time commitment. This may have further precluded low functioning individuals from taking part. It cannot be said for certain how the distribution of scores on the neurocognitive measures may have been affected due to
these exclusions. However, it has been suggested that people with psychiatric disorders (and in particular psychotic disorders), are over-represented in populations of people with intellectual disabilities - and by definition, in people with FSIQ scores below 70 (Morgan, Leonard, Bourke, & Jablensky, 2008). It is therefore likely that the current study was biased by excluding a proportion of the population experiencing psychosis, who would have scored lower on neurocognitive measures than participants in the present study. This also would have affected the control sample to some extent – but arguably would have been more pronounced in the psychosis group.

7.4. Study 2 Comment – Hypothesis 2

The second hypothesis of Study 2 was that for both psychologically healthy individuals and for individuals with psychosis, scores on the neurocognitive variables would be related to the frequency and intensity of positive anomalous experiences across participants’ lifetimes.

Results indicated that for three of the RBANS indices – namely those assessing immediate memory, language, and delayed memory – there were no relationships with either of the positive anomalous experience symptom measures (i.e. the SPQ Cognitive-Perceptual Factor or the AANEX Inventory Frequency/Intensity Ratings). IQ and attention as measured by the WASI IQ Equivalent and RBANS Attention Index were significantly negatively associated with a measure of positive anomalous experience (the SPQ Cognitive-Perceptual Factor) for case participants only, and there did not appear to be an analogous relationship for controls. Only one measure appeared to be related to the SPQ Cognitive-Perceptual Factor for both groups, and that was the LNS working memory measure, which
approached significance after Bonferroni correction \((p = 0.035)\). Similarly, only the RBANS Constructional Index (assessing visual construction) was related to the AANEX Frequency/Intensity Ratings for both groups, also evidenced by a trend toward significance after Bonferroni correction \((p = 0.044)\).

Findings of no relationship between the SPQ Cognitive-Perceptual Factor and three of the neurocognitive measures, and of no relationship between the AANEX Frequency/Intensity Ratings and all but one of the neurocognitive measures may be explained by assertions that negative and disorganized facets of schizotypy and psychosis tend to be more related to neurocognitive deficits (as opposed to positive anomalous experiences; Basso et al., 1998; Pantelis et al., 2001; de Gracia Dominguez et al., 2009; Lindsberg et al., 2009). Yet, when the Interpersonal and Disorganized Factors of the SPQ were examined *post hoc*, no additional relationships were revealed in the present sample.

It is interesting that relationships were revealed between positive anomalous experiences and Full Scale IQ, and between positive anomalous experiences and attention for the case group only. This indicates a discontinuity between the psychologically healthy sample and the sample of participants with psychotic disorders, which was specific to symptom associations with IQ and attention. These associations then, could be viewed as particular risk factors for the development of full-blown psychosis. That is, high levels of positive schizotypal experiences coupled with reductions in IQ and attention could make it more likely that an individual meets diagnostic criteria for a psychotic disorder. Future longitudinal studies would be needed to provide further support for this notion.

There is previous research reporting similar symptom correlations with IQ in schizophrenia, as were found in the present research. Parnas et al. (2007) reported a
negative relationship between IQ and both hallucinations and negative symptoms. However, unlike the present findings of a relationship between IQ and both positive and negative symptoms, there are many other studies which report relationships only between IQ and negative symptoms (e.g. Addington, Addington, & Maticka-Tyndale, 1991; O’Leary et al., 2000; Rhinewine et al., 2005).

Similarly, the literature on symptom correlates of attention in psychosis samples appears quite mixed. In a sample of 134 people with schizophrenia, O’Leary et al. (2000) found no relationship between attention as measured by the Continuous Performance Test, and any symptoms assessed via the SAPS and SANS. Whereas in a similar sample of 62 people with schizophrenia, Basso et al. (1998) showed a relationship between attention as assessed via the Attention-Concentration subscale of the Wechsler Memory Scale-Revised, and negative symptoms assessed via the Schedules of Negative and Positive Symptoms. Each of these studies were slightly different again to the present research, which reports a relationship between the RBANS Attention Index and the SPQ Interpersonal and Cognitive-Perceptual Factors for the case group only.

Further complicating interpretations of these findings, in a psychologically healthy community sample, Chen et al. (1997) found a relationship between attention and both the Perceptual Aberration Scale (PAS; Chapman, Chapman, & Raulin, 1978) and the SPQ Interpersonal Factor; but did not find a relationship between attention and the SPQ Cognitive-Perceptual Factor. This relationship with the PAS but not the SPQ Cognitive-Perceptual Factor suggests that even though no relationship was discovered for the control group in the present research, had different measures of attention and/or positive anomalous experience been used, results may have been different.
As a consistent theme throughout the current project, this confusion is reflective of the difficulties in measuring psychological constructs, and difficulties with potentially heterogeneous samples. In relation to neurocognition and psychosis in particular, another good example of how differing research outcomes can occur comes from an investigation by Parnas et al. (2007). They compared premorbid intelligence for people with schizophrenia, as diagnosed using four different classification systems. Patterns of premorbid intelligence in this study varied according to the classification systems that were used for diagnosis. This very clearly illustrates that research findings do change according to how constructs and samples are measured and defined.

Aside from relationships between positive anomalous experiences and IQ and attention particular to the case group, there were two neurocognitive variables that were tentatively associated with positive anomalous experiences in both the case and the control groups. These were the only associations that supported the second hypothesis of Study 2. Specifically, there was a trend toward significance for a negative relationship between the LNS and the SPQ Cognitive-Perceptual Factor, in the absence of an interaction effect with diagnostic group. In other words, there appeared to be a relationship between a measure of working memory and a measure of positive anomalous experience for both cases and controls, however this did not survive Bonferroni correction. There also appeared to be negative relationship between the RBANS Constructional Index and the AANEX Frequency/Intensity Ratings in the absence of an interaction effect. This could be interpreted as showing a relationship between visual construction abilities and positive anomalous experiences for both cases and controls, however again it did not remain significant after Bonferroni correction.
The LNS result is notable because although it was tentative, examination of the literature reveals that working memory deficits are a particularly robust finding in people with schizophrenia, schizoaffective disorder, first episode psychosis, bipolar disorder, and those defined as clinically at risk of developing psychosis (Park, Puschel, Sauter, Rentsch, & Hell, 1999; Joyce et al., 2002; Glahn et al., 2003; Silver, Feldman, Bilker, & Gur, 2003; Wood et al., 2003; Lee & Park, 2005; McGrath, Chappie, & Wright, 2008). As well as between-group differences, and consistent with the present findings, working memory has also previously been inversely associated with both positive and negative symptoms of schizophrenia (Park et al., 1999; McGrath et al., 2008).

However, again there are also studies that report relationships between working memory and negative symptoms only (Pantelis et al., 2001; Rund et al., 2004). Reflecting aforementioned differences in outcomes according to measurement instruments used, Cameron et al. (2002) used a range of different measures of working memory (such as the Wisconsin Card Sorting Test, Excluded Letter Fluency, and Trail Making Test) to look at associations with the PANSS in 52 people with schizophrenia. They found different relationships with negative and disorganized symptoms according to each measure, and no relationships with positive symptoms for any measure that they employed.

Also consistent with the present research, a negative relationship has been previously reported between working memory and positive anomalous experiences associated with schizotypy in a psychologically healthy sample (Schmidt-Hansen & Honey, 2009). Yet, to the best of the author’s knowledge, this is the first time relationships have been assessed between working memory and positive anomalous experiences using the same measures, across a sample containing people with
psychosis and psychologically healthy controls.

Similar to Study 1, this provisional finding of a similar relationship between positive anomalous experiences and working memory across clinical and non-clinical groups together, further supports a fully dimensional model of positive anomalous experiences. Again, the fully dimensional model asserts that positive anomalous experiences occur dimensionally throughout community and clinical populations. This continuum would range from anomalous experiences in healthy people through to the positive symptoms characteristic of psychotic disorders such as schizophrenia and schizoaffective disorder. The results of Study 2 indicate that working memory abilities appear to be related to positive anomalous experiences regardless of diagnostic status, whereas reductions in IQ and attention are specifically associated with full-blown psychotic symptoms.

The apparent relationship between the RBANS Constructional Index and AANEX Frequency/Intensity Ratings also did not survive Bonferroni correction. It is a somewhat unexpected finding, and should be taken with more caution than the other results reported for Study 2. Reductions in the RBANS Constructional Index have previously been reported more consistently in dementing illnesses such as Alzheimer’s disease (Randolph, Tierney, Mohr, & Chase, 1998), as opposed to psychotic illnesses such as schizophrenia (Wilk et al., 2004). Yet, there has been previous associations between schizotypy and visuospatial and visual construction abilities (Tsakanikos & Reed, 2003; Gooding & Braun, 2004). Given no apparent analogous finding in the psychosis literature, future replication of the present results showing a relationship between positive symptoms and visual construction would be useful.

As a final observation, there were differences in findings between the two
measures of positive anomalous experience. For example, a relationship was revealed between the LNS and the SPQ Cognitive Perceptual Factor, but not the AANEX Frequency/Intensity Ratings. Another relationship was revealed between the RBANS Constructional Index and the AANEX Frequency/Intensity Ratings, but not the SPQ Cognitive-Perceptual Factor. These differences could be the result of one or all of the following possibilities:

- There may have been a reduction in power in the subset of participants who had completed the AANEX Inventory, as compared to the larger sample who had completed the SPQ.
- There may have been subtle gender and age differences between the larger sample and subsample.
- There may have been measurement error inherent to either or all of the SPQ, AANEX, and neurocognitive measures (e.g. self report bias, interviewer bias, design error etc.).
- The SPQ Cognitive-Perceptual Factor and AANEX Inventory may have been measuring slightly different latent phenomena. (Indeed, a post-hoc correlation indicated a modest correlation between the two measures, suggesting they may have measured different aspects of anomalous experience).

Briefly, these possibilities suggest that research replicating the present results using large representative samples would be desirable, especially for the AANEX. They also suggest a broader need for further research into the convergent and divergent validity of measures of positive anomalous experiences. Differences in
findings between the SPQ and AANEX measures are discussed in more detail in Chapter 9.
Chapter 8: Study 3 Results and Comment - An Investigation of the Relationship between White Matter Connectivity and Positive Anomalous Experiences

The aim of the third study was to examine the relationship between brain structural connectivity and positive anomalous experiences, across both psychologically healthy and psychosis groups. This chapter describes the statistical analyses and results pertaining to Study 3. The findings are then discussed in relation to the original hypotheses, as well as in relation to previous research.

8.1. Study 3 Demographic data

Relevant data for Study 3 were drawn from Victorian ASRB participants who had completed Diagnostic Interview for Psychoses (DIP), the diffusion weighted MRI and the Schizotypal Personality Questionnaire (SPQ). Of the 177 participants whose neuroimaging data were analyzed, four had not completed the SPQ in full and they were excluded from subsequent statistical analyses. This left a total of $N = 173$ participants; $n = 93$ with a diagnosis of schizophrenia or schizoaffective disorder, and $n = 80$ psychologically healthy controls. Demographic data for these participants is represented in Table 21.
Table 21. Demographic data for N = 173 participants who had completed the MRI and, SPQ measures.

<table>
<thead>
<tr>
<th></th>
<th>Case</th>
<th>Control</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>n = 62</td>
<td>n = 39</td>
<td>n = 101</td>
</tr>
<tr>
<td>Female</td>
<td>n = 31</td>
<td>n = 41</td>
<td>n = 72</td>
</tr>
<tr>
<td><strong>Age at Assessment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>20-63</td>
<td>19-65</td>
<td>19-65</td>
</tr>
<tr>
<td>Mean</td>
<td>38.09</td>
<td>40.30</td>
<td>39.11</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>10.695</td>
<td>13.869</td>
<td>12.278</td>
</tr>
<tr>
<td><strong>SPQ Cognitive-Perceptual Factor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>11.98</td>
<td>3.25</td>
<td>7.94</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>8.444</td>
<td>3.954</td>
<td>8.023</td>
</tr>
</tbody>
</table>

As measured via a chi-squared test of independence, there was a significant gender difference between the groups ($\chi^2 (1) = 5.682, p = 0.017$), with more male participants in the case group than in the control group. There was no significant difference in age between the groups as assessed via an independent samples t-test ($t (147.382) = 1.161, p = 0.247$). Unsurprisingly, scores on the SPQ Cognitive-Perceptual Factor (as a measure of positive anomalous experience) were significantly higher for participants with a diagnosis of schizophrenia or schizoaffective disorder than for controls ($t (134.684) = 8.90, p < 0.001$); however there was also a substantial overlap in scores between the groups (see Figure 53).
8.2 Tract Based Spatial Statistics

The established pipeline for TBSS was employed for analysis of brain imaging data for Study 3 (fsl.fmrib.ox.ac.uk/fsl/fslwiki/TBSS/UserGuide; Smith et al., 2006). This consisted of four steps. The first step of TBSS involved removal of outliers from the diffusion tensor model, and further visual inspection of DTI data. Then in Step 2, all participants’ FA data were registered to a custom FA template (FMRIB58_FA) using nonlinear registration (as per the TBSS -T option). In Step 3, FMRIB58_FA was registered to MNI152 space using affine alignment. Subsequently, all participants’ FA images were registered to MNI52 space by combining the original nonlinear transformation with the subsequent affine transformation. This yielded a standard-space version of every participant’s FA image. Standardized images were then

Figure 53. Frequency distribution of the SPQ Cognitive-Perceptual Factor.
merged, and mean FA images were created. The mean FA image was thresholded at
0.2 and a common white matter skeleton created.

Then following the method used by Seal et al. (2008), non-parametric
between-group analyses of whole-brain FA, MD, RD and AD were completed via
Randomise, which is a permutation based statistical inference tool (Nichols &
Holmes, 2002). Within-group regressions were also completed using Randomise.
These regressions assessed relationships between whole-brain measures of FA, MD,
RD and AD, and positive anomalous experiences as measured by the Cognitive-
Perceptual Factor of the SPQ. All results were corrected for multiple comparisons
using robust clusters correction \( (t \geq 3; p < 0.1_{\text{CORRECTED WHOLE BRAIN}}) \). The identity of
areas of significance were identified with reference to the *MRI Atlas of Human White
Matter* (Oishi, Faria, van Zijlh, & Mori, 2010).

**8.3. Results of TBSS Between-Group Analyses**
The TBSS between-group analysis identified several areas of white matter where the
case group had significantly lower FA \( (p < 0.1_{\text{FWE CORRECTED}}); \) see Figures 54-56).
These regions included the fornix, genu and body of the corpus callosum (including
sections connecting both frontal and bilateral parieto-occipital areas), bilateral
inferior fronto-occipital fasciculi and inferior longitudinal fasciculi, right inferior
frontal gyrus, bilateral inferior longitudinal fasciculi, right anterior corona radiata,
right uncinate fasciculus, and white matter contained in the middle occipital and
angular gyri bilaterally. Between-group comparisons did not reveal any regions of the
brain in which the case group had significantly higher FA than the controls (all \( p > 
0.1_{\text{FWE CORRECTED}}) \).
Figure 54. Sagittal slice: Areas of the brain in which cases had significantly lower FA compared to controls. Image from FSLView (neurological orientation). MNI coordinates: $x = 14; y = 25; z = 91$.

Figure 55. Sagittal slice: Areas of the brain in which cases had significantly lower FA compared to controls. Image from FSLView (neurological orientation). MNI coordinates: $x = 14; y = 25; z = 91$. 
Figure 56. Axial slice: Areas of the brain in which cases had significantly lower FA compared to controls. Image from FSLView (neurological orientation). MNI coordinates: $x = 14; y = 25; z = 91$.

Subsequent analysis revealed that these changes in FA appeared to be driven primarily by changes in RD. Figure 57 shows overlapping areas of the brain, wherein there was significantly lower FA in the case group, and correspondingly significantly higher RD ($p < 0.1_{\text{FWE CORRECTED}}$). There were no areas where the groups differed according to MD or AD (all $p > 0.1_{\text{FWE CORRECTED}}$).
Figure 57. Areas of the brain in which there was both significantly lower FA, and correspondingly higher RD for cases as compared to controls ($p < 0.1_{\text{FWE CORRECTED}}$). Images are from FSLView (neurological orientation). Reading left to right and top to bottom; axial slices represent coordinates $z = -24, -4, 4, 24, 44, \text{ and } 64$.

8.4. Results of TBSS Within-Group Regression Analyses

Independent regression analyses were conducted for each group to establish if there were potential relationships between the SPQ Cognitive-Perceptual Factor and white matter organization for each group. Figures 58-60 show white matter voxels in which a negative relationship was identified between FA values and the SPQ Cognitive-Perceptual Factor for the control group (all $p < 0.1_{\text{FWE CORRECTED}}$). These areas included the corpus callosum, left anterior thalamic radiation, left corona radiata, as well as inferior frontal and temporal white matter in the right inferior frontal gyrus, left inferior temporal gyrus and left fusiform gyrus. For the control group, there were
no areas in which AD, MD or RD values were related to scores on the SPQ Cognitive-Perceptual Factor (all \( p > 0.1 \) FWE CORRECTED). In contrast to the control group, there were no areas in which FA, MD, AD or RD were negatively related to SPQ scores for the case group (all \( p > 0.1 \) FWE CORRECTED). There were also no positive relationships between the SPQ Cognitive-Perceptual Factor and any of the connectivity measures.

**Figure 58.** Coronal slice: Areas of the brain where there was a significant negative relationship between the SPQ Cognitive-Perceptual Factor and FA for the control group. Image obtained from FSLView (neurological orientation). MNI coordinates: \( x = 8, y = 15, z = 19 \).
**Figure 59.** Sagittal slice: Areas of the brain where there was a significant negative relationship between the SPQ Cognitive-Perceptual Factor and FA for the control group. Image obtained from FSLView (neurological orientation). MNI coordinates: 
\[ x = 8, \ y = 15, \ z = 19. \]

**Figure 60.** Axial slice: Areas of the brain where there was a significant negative relationship between the SPQ Cognitive-Perceptual Factor and FA for the control group. Image obtained from FSLView (neurological orientation). MNI coordinates: 
\[ x = 8, \ y = 15, \ z = 19. \]
8.5. Study 3 Comment – Hypothesis 1

The first hypothesis for Study 3 proposed that individuals with a psychotic disorder would show relative deficits in brain structural connectivity compared to control participants as evidenced by between-group differences in key measures of white matter diffusivity (FA, MD, RD and AD).

As the above results indicate, participants with a psychotic disorder (schizophrenia or schizoaffective disorder) had significantly lower FA in a range of brain areas assessed using TBSS. These included broad areas of the corpus callosum, bilateral inferior fronto-occipital fasciculi and inferior longitudinal fasciculi, right inferior frontal gyrus, bilateral inferior longitudinal fasciculi, right anterior corona radiata, right uncinate fasciculus, and white matter contained in the middle occipital and angular gyri bilaterally.

These results are broadly consistent with numerous previous studies showing differences in white matter structural connectivity between psychologically healthy control participants, and people with various classifications of psychosis including schizophrenia, schizoaffective disorder, bipolar disorder, high-risk, and first-episode psychosis (Ardekani, Nierenberg, Hoptman, Javitt, & Lim, 2003; Hau et al., 2006; Kubicki et al., 2007; Kyriakopoulos et al., 2008; McIntosh et al., 2008; Brambilla, Bellani, Yeh, Soares, & Tansella, 2009; Karlsgodt, Niendam, Bearden, & Cannon, 2009; Kyriakopoulos & Frangou, 2009). In terms of the location of differences in white matter connectivity within the brain, the present study is also consistent with previous research investigating schizophrenia and schizoaffective disorder (Ellison-Wright & Bullmore, 2009). That is, although affected regions can tend to vary quite dramatically between studies (Kubicki et al., 2007; Kyriakopoulos et al., 2008), the present research compliments changes previously reported in fronto-thalamic regions.
(Ellison-Wright & Bullmore, 2009), and in fronto-inter-hemispheric regions including the genu (Kubicki et al., 2007; Ellison-Wright & Bullmore, 2009), and body of the corpus callosum (Kubicki et al., 2007; Kyriakopoulos et al., 2008).

However, other previously reported findings – those of changes in diffusivity measures in the arcuate fasciculus and cingulum bundle (Kubicki et al., 2007; Kyriakopoulos et al., 2008) - were not replicated in Study 3. It is possible that this failure to replicate previous results was a result of the analysis method used. In particular, TBSS is well suited to detecting effects in large major white matter tracts such as the corpus callosum, however in smaller (thinner) tracts such as the uncinate fasciculus, differences are more difficult to detect (Smith et al., 2006).

Indeed, differences in diffusion-weighted methodologies, in combination with heterogeneous samples and confounds such as medication, are often held responsible for inconsistencies in findings in psychosis research, and in white matter research pertaining to psychosis more specifically (Johansen-Berg & Behrens, 2006; Kubicki et al., 2007; Kyriakopoulos et al., 2008). An interesting example of these potential differences in findings comes from one study which used an almost identical neuroimaging protocol as the present study, but which found different results. Seal et al. (2008) compared fourteen people with schizophrenia to fourteen healthy control participants who were matched for gender, age, premorbid IQ and education level. As is highlighted in Figure 61, Study 3 of the current project reported differences in FA between cases and controls mostly in the corpus callosum, frontal and thalamic regions. Seal et al (2008) similarly reported differences also in the internal capsule and thalamic regions. However in addition they reported differences in the external capsule which were not found in the present research, and they did not find differences in the corpus callosum which were identified in the present research.
(This lack of between-group differences in the corpus callosum were particularly notable in their study.)

**Figure 61.** Comparison of results from Seal et al., (2008) and results from the present study. Results from Seal et al. (2008) are shown above, with MNI z-axis coordinates included. Corresponding slices from the present research are represented in the lower half of the figure. Images are represented on the MNI52 template, with mean FA skeletons in green. Red areas are voxels in which FA was significantly higher for control participants as compared to case participants ($p < 0.05_{\text{FWE CORRECTED}}$).
This lack of consistency between two very similar investigations is another
good example of the difficulties in conducting research in the areas of schizotypy and
psychosis. Although the two studies were similar in their neuroimaging protocols,
aside from an obvious difference in sample size (much greater numbers in the present
study), there were also some relatively small differences in demographics of the
participants. Mean ages of the samples reported by Seal et al. (2008) were \( M = 32.9 \)
\((SD = 8.8)\) for case participants, and \( M = 31.9 \) \((SD = 7.5)\) for controls. As represented
in Table 21, the current sample was older \((M = 38.09\) for cases; \(M = 40.30\) for
controls), with greater variation in age. Also, Seal et al. (2008) report a mean WASI
Full Scale IQ of \( M = 112.62 \) for controls and \( M = 95.4 \) for cases. As was reported in
Study 2 above, data from the Victorian division of the ASRB used in the present
study has a similar mean of approximately \( M = 112.8 \) for controls, but a slightly
higher IQ of approximately \( M = 101.33 \) for cases using the same measure. A final
difference between the two studies was that Seal et al. (2008), did not include
participants with schizoaffective disorder.

It is possible that any or all of these differences could have accounted for the
variation in findings. However, it is likely that the largest contributor to the
differences in outcome between these studies was sample size. To the author’s
knowledge, the present study is the largest TBSS study in a chronic schizophrenia
sample conducted to date. Thus, with more participants than in the study conducted
by Seal et al. (2008), there was consequently greater power to detect significant
differences between the groups. This has important implications for many
neuroimaging papers, which due to the cost of scanning, tend to uniformly report
results from samples sizes of less than 50 participants. However, with recent growth
of multi-center trials and both national and international collaborations, databanks
such as the ASRB will help to ameliorate this problem in future.

Having commented on the differences between the two studies, an important similarity between the present research and that of Seal et al. (2008) was that both investigations report changes in FA and RD; but no changes in AD or MD. This is important for what these measures might mean in terms of the biology of the brain. There is controversy over what measures of diffusivity indicate in relation to the pathophysiology of white matter (Assaf & Pasternak, 2008; Friedman et al., 2008; Jones et al., In Press). Changes in diffusivity are affected by a range of processes which include myelination (or demyelination)(Filippi et al., 2001; Song et al., 2003), altered axonal coherence (Hoptman et al., 2002; Madler et al., 2008), reduced or increased axon diameter (Beaulieu, 2006; Madler et al., 2008), membrane permeability (Beaulieu, 2002; Jones et al., In Press), as well as altered fiber density (Beaulieu, 2006; Madler et al., 2008).

In relation to the present study, it is noted that RD is a measurement of diffusivity perpendicular to the hypothesized axon fibers within a given voxel. Relatively increased RD indicates less structural constraint to diffusion across and through axon fibers. It has been suggested from research using mouse models that concurrent reductions in FA and increases in RD may be due to demyelination (Song et al., 2002; 2005). However more recently, researchers have warned against excluding other candidates such as reduced axonal coherence and fiber density (not to mention crossing fibers and partial volume effects; Vos, Jones, Jeurissen, Viergever, & Leemans, 2012; Jones et al., In Press).

At the very least, it has been proposed that myelin may have a neuroprotective role in relation to the timing and severity of symptoms of psychosis (Benes, Turtle, Khan, & Farol, 1994). And in addition to reductions in FA and increases in RD,
support for this idea is provided by studies finding compromised myelin in schizophrenia using magnetic transfer imaging (Foong et al., 2000). It is also supported by findings of dysregulated genes related to myelin (Hakak et al., 2001), and by studies reporting compromised oligodendrocyte cells which form the myelin sheaths surrounding neuronal axons (Uranova et al., 2001; Davis et al., 2003). It seems then, that until technology examining microscopic white matter architecture in vivo is improved, demyelination is as good an explanation as most, as to what might be driving changes in white matter connectivity in people with psychosis.

8.6. Study 3 Comment – Hypothesis 2

The second hypothesis for Study 3 postulated that for both psychological healthy individuals and for individuals with psychosis, measures of structural connectivity (FA, MD, RD and AD) from whole-brain analysis would be related to the frequency and intensity of positive anomalous experiences across participants’ lifetimes.

Interestingly, this hypothesis was supported for the control group, but not for the group of participants with a diagnosis of schizophrenia or schizoaffective disorder (the case group). That is, for psychologically healthy participants, TBSS-derived FA values in voxels located in the corpus callosum, as well as in inferior frontal and temporal brain regions, were negatively related to scores on the SPQ Cognitive-Perceptual Factor. However for participants with a psychotic disorder, no analogous relationships were identified between the SPQ Cognitive-Perceptual Factor and any of the diffusivity measures (FA, MD, RD and AD).

Results for the control group were consistent with the author’s previous finding of a negative relationship between FA and the SPQ Cognitive-Perceptual Factor in seven frontal and temporal white matter tracts in a community sample
(Nelson et al., 2011). To the author’s knowledge, these are the only two reported investigations of relationships between schizotypy and white matter connectivity. However one further study that examined white matter and ‘psychotic personality traits’ via diffusion tensor imaging also reported similar findings (Volpe et al., 2008). Specifically, Volpe et al. (2008) reported a ‘low psychotic’ group of psychologically healthy individuals had significantly higher FA in the arcuate fasciculus and fronto-parietal fibers compared to a ‘high psychotic’ group of psychologically healthy individuals.

Yet, the current absence of a similar relationship between the SPQ Cognitive-Perceptual Factor and any connectivity measures in the case group is in contrast to these findings. It is also inconsistent with previous findings of a relationship between white matter connectivity and the positive symptoms of psychosis. For example, Szesko et al. (2008) reported a relationship between FA and positive symptoms in the inferior frontal-occipital fasciculus of people with recent onset schizophrenia. Similarly, Hubl et al. (2004) found differences in FA (lower in some areas, higher in others), for people with schizophrenia experiencing auditory hallucinations compared to those without auditory hallucinations and compared to control participants. Skelly et al. (2008) found negative relationships between positive symptoms and FA in the left uncinate fasciculus, right sagittal stratum and left superior longitudinal fasciculus. Correlations between FA and positive symptoms have also been reported in the cingulum bundle (Fujiwara et al., 2007) and corpus callosum (Brambilla et al., 2005). In essence, the present research failed to replicate these previous findings.

There are two possible explanations for this failure to replicate previous results. First, in the present study there may have been a non-linear negative relationship between the SPQ Cognitive-Perceptual Factor and FA across both
groups, which plateaued as higher SPQ scores were reached. This could have given rise to a flat regression line for the cases. An alternative explanation could have been that a true relationship was masked due to the myriad of confounds inherent to people with chronic psychosis. That is, there are many extraneous variables that may have affected the present results, which are specific to the case group. These include effects on the brain from long-term medication use, chronicity and toxicity of illness, as well as other illness-related neuroanatomical and neurochemical changes. Indeed, statistics from the ASRB have shown that participants involved in the national databank have a mean duration of illness of 15.81 years (Loughland et al., 2010). Fifty-eight percent of participants have had multiple episodes, and 38 percent experience chronic unremitting illness (Loughland et al., 2010).

It is because of such confounds that the field of research into psychotic disorders has moved from studying chronic samples, to studying participants experiencing a first-episode of psychosis and participants defined as clinically at risk of developing a psychotic disorder (Keshavan, Berger, Zipursky, Wood, & Pantelis, 2005; Kelleher, Clarke, Rawdon, Murphy, & Cannon, In Press). These participants are often medication naïve, and their brains have not been subject to the neurotoxic effects of chronic illness (Kelleher et al., In Press). This is also another reason that research into schizotypy is important – because it avoids these confounds. Similar to the study of Szesko et al. (2008), whose participants had recent onset schizophrenia, future replication of Study 3 with the inclusion of first-episode and at-risk groups would be useful in future research.

In terms of the negative relationship between positive anomalous experiences and FA for the control group; it is difficult to determine the neuroanatomical processes that are giving rise to the changes in connectivity. In a physically and
psychologically healthy control group, it is unlikely that gross neuroanatomical pathology such as demyelination or axonal damage is driving differences in FA corresponding to increases in SPQ Cognitive-Perceptual Factor scores. Rather, a more plausible explanation for the results of the current study is provided by Madler et al (2008), and by Beaulieu (2006). Both of these authors argue that reductions in FA are not necessarily due to such specific disease states as demyelination, but to axonal disorganization more generally. This is more likely in the present context given that, by definition, healthy participants should not have any specific white matter disease. It is possible, though, that this more general pathology may progress into a more serious disease state such as demyelination as an individual makes the theoretical transition from high schizotypy to florid psychosis.

The neuroimaging method chosen for Study 3 was a whole-brain technique, in which TBSS was used to define and extract four measures of diffusivity (FA, MD, AD and RD) for both within- and between-group comparison. This method conferred many advantages. It was an established, automated method that was relatively fast and operator-independent. It did not rely on any prior anatomical knowledge, and allowed comparison of results from previous studies that had used a similar method. However, as with any neuroimaging method, these advantages also came at some cost (Johansen-Berg & Behrens, 2006). As the pre-processing pipeline involved registration of brain images, it is possible that warping may have occurred. Yet the pipeline did include attempts to buffer this possibility via the setting of conservative thresholds, and through the creation of a skeleton at the center of registered white matter areas.

Another limitation that accompanies use of a DTI model (as in the present study) is that of crossing fibers. Crossing fibers refers to the phenomenon where
measures of diffusivity (particularly FA) are altered due to multiple fibers following
different directions within the same voxel. Again, the current investigation went some
way in addressing this limitation by using a variety of diffusivity measures other than
just FA. However, it is recommended that future research attempt to replicate the
findings of Study 3 with alternative models that are better able to resolve crossing
fibers. Examples might include constrained spherical deconvolution (Tournier et al.,
2008; Jeurissen, Leemans, Jones, Tournier, & Sijbers, 2011; Tournier, Calamante, &
Connelly, 2012), or q-ball imaging (Tuch, 2004; Perrin et al., 2005).

Similarly, in terms of neuroimaging and assessment of brain connectivity,
newer techniques employing network theory and graph analysis have also recently
been developed (Bullmore & Sporns, 2009; Sporns, 2011b; Behrens & Sporns, 2012).
These methods assess connectivity by deriving measurements of the nodes and edges
within a hypothesized brain network. For instance, there have been studies showing
reduced ‘small worldliness’ (or reduced efficiency) of brain networks in people with
schizophrenia, along with reductions in other measurements of network connectivity
(van den Heuval, Mandl, Stam, Kahn, & Hulshoff Pol, 2010; Fornito, Zalesky,
Pantelis, & Bullmore, 2012; Wang et al., 2012; Zhang et al., 2012). Given the
findings of relationships between structural connectivity and positive anomalous
experiences across a fully dimensional continuum, an interesting line of future
research would be to ascertain whether similar relationships are found from
neuroimaging analyses that employ network analysis and graph theory.
Chapter 9: Discussion

This final chapter reviews the main findings of each of the three studies above. Results are discussed in terms of how the studies may be linked, and how they relate back to the fully dimensional approach to schizotypy and psychosis. The chapter ends with a discussion of the limitations of the project as a whole, implications for future research, and final conclusions.

9.1. Overview of Findings

The main aim of the present project was to systematically evaluate the fully dimensional model of schizotypy and psychosis. This was achieved by assessing if relationships existed between positive anomalous experiences and a range of neuroanatomical, neurocognitive, and clinical variables believed to contribute to their frequency and severity. The robustness of these relationships was examined with respect to self-reported levels of schizotypy in healthy control participants and positive symptoms in individuals with psychosis. Specific relationships were investigated over three studies:

- Study 1 assessed relationships between positive anomalous experiences and thinking style, as measured by twelve \textit{a priori} selected items from a comprehensive structured interview (the AANEX-CAR).
- Study 2 assessed relationships between positive anomalous experiences and selected neurocognitive variables including IQ, immediate memory, visuo-spatial constructional abilities, language, attention, delayed memory and working memory.
• Study 3 assessed relationships between positive anomalous experiences and brain structural connectivity, as measured using TBSS analysis of diffusion weighted MRI data.

There were two hypotheses for each study; one corresponding to predictions of between-group differences, and the other corresponding to predictions of within-group relationships. For Study 1, it was hypothesized that individuals with a psychotic disorder would exhibit differing patterns of thinking style than psychologically healthy individuals who have positive anomalous experiences, as evidenced by significant differences on each of the thinking style variables drawn from the AANEX-CAR represented in Tables 2, 6, 7 and 8. It was also hypothesized that for both psychologically healthy individuals and for individuals with psychosis, the twelve thinking style variables would be related to the frequency and intensity of positive anomalous experiences across participants’ lifetimes.

The first hypothesis for Study 1 was supported. Differences were found between cases and controls on ten out of twelve thinking style items drawn from the AANEX-CAR. This showed that case participants thought about, and responded to their positive anomalous experiences and positive symptoms in different ways to control participants. Secondly, scores on four thinking style items were related to positive anomalous experiences as measured by the AANEX Frequency/Intensity Ratings for both cases and controls. However relationships were specific to these four thinking style items (namely immersion, external and impersonal attributions and lack of social understanding), and not the eight other items. Furthermore, only the relationship between the AANEX Frequency/Intensity Ratings and the item pertaining to immersion in experiences survived Bonferroni correction. Therefore,
inferences regarding the other three items were tentative.

For Study 2, it was predicted that individuals with a psychotic disorder would demonstrate cognitive impairments compared to psychologically healthy individuals on a wide range of measures of neurocognitive function; Full Scale IQ, visual construction, language, attention, immediate memory, delayed memory, and working memory. It was also hypothesized that for both psychologically healthy individuals and for individuals with psychosis, scores on the neurocognitive variables would be related to the frequency and intensity of positive anomalous experiences across participants’ lifetimes.

The first hypothesis of Study 2 was supported. Significant differences were found between the case and control groups on all neurocognitive measures, all with large effect sizes. People with a diagnosis of schizophrenia or schizoaffective disorder scored lower than controls on the WASI Full Scale IQ measure; on the RBANS Construction, Language, Attention, Immediate Memory, and Delayed Memory Indices; and on the LNS (which assessed working memory). Findings relating to the second hypothesis for Study 2 were less consistent. For both cases and controls, a negative relationship was found between the SPQ Cognitive-Perceptual Factor and the LNS; and between the AANEX Frequency/Ratings and the RBANS Construction Index. However neither of these relationships survived conservative Bonferroni correction for multiple comparisons. Furthermore, a significant negative relationship was identified between positive anomalous experiences as measured by the SPQ Cognitive-Perceptual Factor, and measures of IQ and attention for the case group only. No additional relationships were identified between the frequency and severity of positive anomalous experiences and language, immediate memory or delayed memory.
For Study 3, it was hypothesized that individuals with a psychotic disorder would show relative deficits in brain structural connectivity compared to control participants as evidenced by between-group differences in key measures of white matter diffusivity (FA, MD, RD and AD). It was also hypothesized that for both psychologically healthy individuals and for individuals with psychosis, measures of structural connectivity (FA, MD, RD and AD) would be related to the frequency and intensity of positive anomalous experiences across participants’ lifetimes.

The first hypothesis was supported. Expected significant differences in FA and RD were identified between people with a psychotic disorder (schizophrenia or schizoaffective disorder) and psychologically healthy control participants in diffuse areas of the brain. In addition, a significant relationship was found between the SPQ Cognitive-Perceptual Factor as a measure of positive anomalous experiences, and widespread FA for the control group, which offered partial support for the second hypothesis. However, a corresponding relationship for the case group was not found. This was most likely due to confounds affecting the brains of people with chronic psychotic disorders such as medication and neurotoxicity.

All of these results have been discussed at length, in the context of how they relate to existing research (see Study 1, 2, and 3 Comments). However they have not been thoroughly discussed in terms of how they relate to the fully dimensional model more broadly.

9.2. Implications of the Findings for the Fully Dimensional Approach to Schizotypy and Psychosis

It is acknowledged that theoretical questions concerning the underlying latent structures of schizotypy and psychosis have provided a fertile battleground for many
decades (e.g. Meehl, 1962; 1990; Lenzenweger, 1994; Claridge & Beech, 1995; Lenzenweger, 2006; Raine, 2006; Beauchaine et al., 2008; Rawlings et al., 2008a). A single study, or even three studies cannot hope to resolve them once and for all. However, the findings of the present research contribute to a growing pool of literature supporting a fully dimensional model of schizotypy and psychosis (e.g. Claridge & Beech, 1995; Claridge, 1997; McGreery & Claridge, 2002; Verdoux & van Os, 2002; Goulding, 2004; Kwapił et al., 2008; Rawlings et al., 2008a).

This model would not dispute clear differences between people with psychosis and people without psychosis. Certainly in the present research, mean scores for the cases were significantly different on nearly every measurement across the three studies. Diagnosis also contributed to a large amount of the variance in positive anomalous experiences throughout the project. Clearly, diagnosis is important, and this does fit with the fully dimensional model (there are many differences between those who fall at the ‘schizotypy’ end of the continuum as compared to the ‘psychosis’ end; Figure 1). However, substantial overlap between the groups in terms of their scores on positive anomalous experiences as demonstrated in Figures 8 and 17 and 53, also shows that categorical diagnostic categories are not the be-all and end-all. There were many control participants who scored relatively highly on the SPQ Cognitive-Perceptual Factor, and many case participants who scored relatively low. This indicates that positive anomalous experiences are not confined to a small, bounded subgroup of the general population, as the quasi-dimensional approach to schizotypy would suggest.

Furthermore, similar relationships were identified between positive anomalous experiences and many correlates for both cases and controls across the three studies – including unhelpful thinking styles in Study 1, working memory in
Study 2, and white matter integrity (for controls) in Study 3. This indicates further continuity between healthy control and psychosis groups across a spectrum of positive anomalous experiences.

As a whole, the research presented in this thesis supports a fully dimensional model wherein high schizotypy is combined with a range of other risk factors to determine whether any one individual eventually meets criteria for a psychotic disorder. Risk factors for psychosis are numerous and wide-ranging, and have been reviewed in Chapter 1. Briefly, suggestions from existing reviews include a family history of psychotic disorder, reduced brain volumes and increased ventricle size, obstetric complications, trauma, low socioeconomic status, urbanicity, migration, cannabis use, generalized cognitive impairment, and so forth (Maki et al., 2005; Read, van Os, Morrison, & Ross, 2005; Keshavan et al., 2008; Tandon, Keshavan, & Nasrallah, 2008a; Tandon et al., 2008b; van Os, 2008; van Winkel, Stefanis, & Myin-Germeys, 2008). Specific risk factors that may be indicated from the findings of the three studies contained herein include increases in unhelpful responses and appraisals of positive anomalous experiences (Study 1), relative reductions in working memory compounded by reductions in Full Scale IQ and attention (Study 2), as well as increasingly diffuse white matter changes throughout the whole-brain (Study 3).

9.3. Linking the Neuroanatomical, the Neuropsychological, and the Clinical

As well as associations between positive anomalous experiences and the above risk factors, the present research also reported a range of differences between control participants and participants with schizophrenia and schizoaffective disorder. First, they included differences between groups in terms of how individuals responded to and appraised their own positive anomalous experiences. Next were decreases in
neuropsychological functioning for people with a psychotic disorder, as evidenced by lower scores on measures of Full Scale IQ, immediate memory, visual construction, language, attention, delayed memory and working memory. Last were neuroanatomical changes in the form of compromised white matter connectivity for people with psychosis, as evidenced by decreased FA and increased RD.

Although these findings appear wide-ranging, there is some logic as to how they may be linked, and how they may come together to affect the day-to-day lives of people with schizophrenia and schizoaffective disorder. For example, there is a growing body of research associating white matter connectivity and neuropsychological functioning both in the general population, and in people with psychotic disorders, particularly schizophrenia (Brickman et al., 2006; Szesko et al., 2008; Madden, Bennett, & Song, 2009). There has also been some evidence relating neurocognitive abilities and unhelpful thinking styles in people with schizophrenia (Lysaker et al., 2005; Lysaker, Dimaggio, Buck, Carcione, & Nicolo, 2007; Lysaker et al., 2010).

Typically this research relies on correlational inferences, thus insights into causative pathways are speculative rather than directly tested. However it is reasonable to postulate that on the basis of previous research, and the research contained herein, that diffuse white matter changes in the brains of people with schizophrenia and schizoaffective disorder (as were seen in Study 3) could underlie a range of functional neurocognitive deficits as were observed in Study 2. Furthermore, these difficulties with working memory, executive functioning, language and other neurocognitive problems would also likely give rise to difficulties with critical thinking and metacognition. In other words, it is probable that neurocognitive deficits would contribute to the sorts of unhelpful responses and appraisals of positive
anomalous experiences as were reported in Study 1.

The research reported across Studies 1, 2 and 3 is consistent with the model of Garety and colleagues, represented earlier in Figure 6 (Garety et al., 2001; Garety et al., 2007). Biopsychosocial vulnerabilities - such as altered connectivity reported in Study 3 - could predispose individuals to experiencing both anomalous experiences and neurocognitive difficulties. Then in the context of stressful events and accompanying emotional changes later in life, these vulnerabilities may lead to the actual occurrence of both neurocognitive decline (as seen in in Study 2), and anomalous experiences. Difficulties with neurocognition would contribute to unhelpful appraisals and responses of anomalous experiences (consistent with Study 3), leading to further stress and emotionality. In turn, increased stress and emotionality could give rise to more severe and frequent anomalous experiences. Thus, a vicious cycle would occur, eventually leading to development and maintenance of a full-blown psychotic disorder.

9.4. Measurement of Schizotypy- and Psychosis-Related Phenomena

Importantly for the purposes of the current project, it was assumed that the SPQ Cognitive-Perceptual Factor and the AANEX/Frequency Intensity Ratings were measuring the same construct – namely that of positive anomalous experiences. Throughout the present research though, and when interpreting evidence from the literature, lack of agreement between different indices of positive anomalous experience formed the basis of a sustained sense of frustration and confusion. Specifically in relation to the current project, the two measures of positive anomalous experience were not strongly correlated, and as briefly discussed in relation to Study 2, there were four potential reasons for this:
1) Due to a smaller sample size, there would have been a reduction in power in the subset of participants who had completed the AANEX interview \((N = 50)\) compared to \(N = 396\) who had completed the SPQ. This may have resulted in Type II error.

2) Subtle gender and age differences between the larger sample and subsample could also have explained the slight differences in findings between the two measures.

3) It is possible that the findings arose from measurement error associated with the SPQ, the AANEX, or both.

4) The two measures may have been tapping into separate latent constructs.

In relation to the first two possibilities (those involving potential sampling error); unfortunately due to the design and resources available to the present project, these limitations were unavoidable. Differences in demographics between the two samples were relatively subtle – especially in regards to age. Furthermore in many studies, particularly those investigating schizotypy with measures such as the SPQ, differences in gender and age have not tended to affect results (Reynolds, Raine, Mellingen, Venables, & Mednick, 2000; Volemma, Sitskoorn, Appels, & Kahn, 2002; Fossati, Raine, Carretta, Leonardi, & Maffei, 2003). Therefore, it is unlikely that differences in gender and age between the subsample and larger sample in the present research contribute strongly to the findings. However, replication of the current results with large, comparable and representative samples obviously warranted.

The third possibility refers to the potential for the SPQ and/or AANEX to
yield conflicting results due to measurement error. The SPQ is a widely used and
well-established measure of schizotypy-related phenomena (Raine, 1991; Reynolds et
al., 2000; Fossati et al., 2003). It is fast, easy to administer, and standardized.
However, it is vulnerable to self-report biases, such as social desirability bias (Moritz
et al., 1999; Shean, Bell, & Cameron, 2007).

In addition, the SPQ and its factor subscales were originally developed to be
normally distributed (Raine, 1991). In particular, The SPQ Cognitive-Perceptual
Factor was developed as a normally distributed scale, with a reported standardized
mean of approximately 12-13 in community samples (Raine, 1991). In the current
research, it was positively skewed with a substantially lower mean of 7.39 for the
total pooled sample in Study 2 ($M = 3.64$ for controls, $M = 12.39$ for cases), and 7.67
for the total pooled sample in Study 3 ($M = 3.34$ for controls, $M = 11.75$ for cases).

Given that the sample of participants who completed the SPQ in the present
research was a large community-based sample, it is unlikely that this positive skew
was due to an idiosyncrasy of the ASRB. (The ASRB includes participants with
psychosis, which should have biased the sample toward a negative skew if anything).
Rather, the distribution of the SPQ Cognitive-Perceptual Factor in the present
research is consistent with more recent studies, which tend to uniformly report
positively skewed sample distributions with means of between 4 and 9 for control
participants (Volemma et al., 2002; Fossati et al., 2003; Ma et al., 2007; Chan et al.,
2010; Fridberg, Vollmer, O'Donnell, & Skosnik, 2011), and between 7 and 14 for
clinical psychosis samples (Chan et al., 2010; Fridberg et al., 2011).

A positive skew might arise out of the dichotomous nature of the SPQ items,
where participants are required to answer either ‘yes’ or ‘no’ to each item. With no
options in-between, participants may err on the side of ‘social desirability’ caution,
and tend to circle ‘no’ when they are unsure. This dichotomous nature of the SPQ items likely hides population variability in anomalous experiences – for example people may be more likely to endorse an experience when they have dimensional qualifiers such as ‘always,’ ‘sometimes’, and ‘never’, compared to when they can only answer ‘yes’ or ‘no’.¹

The positively skewed sample distribution of the SPQ Cognitive-Perceptual Factor in the present research introduces the importance of being vigilant against potential misuse of the SPQ and other similar measures. For example, error can be created when statistical techniques assuming normality are used for positively skewed sample distributions, such as those which appear to arise out of the SPQ. Also, there is a tendency in the literature for studies to statistically impose artificial categorical boundaries on what are otherwise dimensional scales. Specifically, median splits and similar techniques are used to dichotomize, or trichotomize samples that have been administered measures such as the SPQ. These techniques are used to extract, for example, 'high schizotypy' and 'low schizotypy' groups to be compared in subsequent statistical analyses. However, they result in a substantial loss of statistical power and can therefore lead to mixed and contradictory findings (MacCallum, Zhang, Preacher, & Rucker, 2002).

In the present research, these statistical faux pas have been explicitly avoided through checking statistical assumptions, and preserving dimensionality via the use of regression analyses. Inclusion of the interview-based AANEX also allowed wide variability across the continuum, reduced self-report bias, potentially avoided floor variability,

¹ There has been a more recently developed version of the SPQ (Wuthrich & Bates, 2005), which uses Likert scales rather than dichotomous ‘yes’ or ‘no’ answers. It does not seem to have been widely taken up by researchers yet – but it is gaining popularity (e.g. Chmielewski & Watson, 2008; Cohen et al., 2011; Abbott & Byrne, 2012).
and ceiling effects, and enabled comparison of ‘apples with apples’ when looking at similarities and differences between schizotypy and psychosis. Yet despite this, the AANEX is also not immune to measurement error. It is a relatively new measure that has not yet been widely implemented. Therefore, in terms of its development, standardization and generalizability, there is still work to be done.

Finally, as per the fourth possibility above, it may be that the SPQ Cognitive-Perceptual Factor and the AANEX Inventory were simply measuring slightly different latent phenomena. For example, it might have been that the AANEX Inventory and SPQ were assessing positive anomalous experiences over different time frames; the AANEX measuring lifetime experiences, and the SPQ measuring current experiences. These problems with measurement and measurement error highlight one of the most important implications to arise out of the present research. That is the need for further investigation into the concurrent, convergent and divergent validity of measurement tools and of subclinical and clinical psychosis-related phenomena. While there has been much research into the measurement and latent structure of schizotypy itself (Stefanis et al., 2004; Mason & Claridge, 2006; Wuthrich & Bates, 2006), and there has been recent studies beginning to look at convergent validity of ‘attenuated psychosis’ screening tools (Kline et al., 2012a; Kline et al., 2012b); to date there does not appear to have been comprehensive investigation into, for example, the convergent validity between schizotypy and psychotic-like experiences.

This is representative of widespread confusion in the literature more broadly. As was highlighted in Chapter 1, terms such as positive and negative schizotypy, schizotypal personality, ‘PLIKs’ and ‘PLEs’ (e.g. Zammit et al., 2009; Kelleher & Cannon, 2011), subclinical psychotic experiences (e.g. van Os et al., 2009),
anomalous experiences (e.g. Brett et al., 2007), cognitive-perceptual, interpersonal and disorganized personality traits (e.g. Raine, 1991; 2006), SPD-proneness ('schizotypal personality disorder proneness'; Chan et al., 2010), and non-clinical dimensions of psychosis (Skinner et al., 2011) are used interchangeably. It is not clear whether they are actually measuring the same experiences, or how they relate to one another.

There is certainly evidence that 'psychotic' traits and 'schizotypal' traits are convergent constructs (Bentall, Claridge, & Slade, 1989; Claridge, McGreery, & Mason, 1996; Stefanis et al., 2002). For instance, one investigation assessed the convergence of schizotypal traits and sub-clinical hallucinations and delusions in a community sample of 1095 participants (Claridge et al., 1996). Factor analysis from this study suggested that subclinical hallucinations and delusions do map onto the cognitive-perceptual factor of schizotypy. However, more up-to-date investigation exploring and comparing the psychometric properties of a range of measures pertaining to schizotypy, anomalous experiences and psychotic symptoms would greatly assist in further development of the field.

9.5. Limitations

Some limitations of the present research have already been discussed in the context of each study separately. However, there were some further limitations of the present research, mostly relating to use of the AANEX interview in Studies 1 and 2. One limitation that may have affected results was that interviewers (administering not only the AANEX, but all measurements) were not blinded to diagnosis. This might have lead to experimenter bias, wherein experimenters either consciously or unconsciously direct the research process towards an expected outcome. This was
particularly pertinent for the AANEX interview, which may have been relatively more vulnerable to rater subjectivity compared to the other measures. Unfortunately, there do not appear to be any examples in the literature where investigators using the AANEX were blind to diagnosis, with which to compare results of the current project. In future, it would be more valid to conduct research wherein AANEX interviewers are blinded to diagnosis. Findings from a study which does this could then be compared with the results of both the current research, and the results of Brett et al. (2007).

A related problem pertaining to the AANEX in particular was that given the human and financial resources allocated to the project, computation of inter-rater reliability was not feasible. In their development of the AANEX, Brett et al. (2007) had three clinically trained psychologists rate four of the same interviews, in order to compare ratings. This yielded a weighted kappa of 0.67 for all items on the AANEX-Inventory, and weighted kappa >0.4 for all AANEX-CAR items. Although the AANEX data in the present research was collected and scored by a rater with clinical training (MN), there were no other raters. It is proposed as a minimum for future research, that a random allocation of at least four AANEX interviews be scored by two or more raters, as per the method employed by Brett et al. (2007). This is especially true given that the AANEX is a relatively new and under-researched measure.

A final limitation of the AANEX data used for the present research was that the AANEX-CAR ratings were collected for one time point only. Participants were asked to remember back to the first time they had any given positive anomalous experience, and the AANEX-CAR was completed retrospectively for that first time period. Being first experiences, this method would have reduced the likelihood that
appraisals and responses were affected by medication use at the time. However as data were retrospective, case participants’ perceptions regarding positive anomalous experiences also would have been filtered through (often) many years of chronic illness. In a similar way, all participants’ recall would have been affected by their own perceptions and motivations. As mentioned in Study 1, the mean duration of illness for participants involved in the ASRB is estimated at $M = 15.81$ years ($SD = 10.01$; Loughland et al., 2010). Given it is likely that individuals’ appraisals and responses to positive anomalous experiences change over time (Brett et al., 2007), prospective studies utilizing the AANEX and similar measures would provide interesting results for comparison with the present research.

### 9.6. Future Research

Aside from replications of the present research using prospective designs and multiple raters, there were a number of other directions for future research that arose out of the current project. For instance, the main focus of the studies contained herein were the positive anomalous experiences of both psychologically healthy people and people with psychotic disorders. This avoided problems associated with assuming that positive, negative and disorganized experiences necessarily ‘hang together’ in community samples. However, a disadvantage was that it precluded thorough investigation into the correlates of negative and disorganized symptoms and experiences.

Although no additional findings of any consequence were discovered when negative and disorganized schizotypal traits were analyzed in Study 2, in Study 3 negative and disorganized traits may have shown different relationships with structural connectivity in different areas of the brain. It would also be useful to
discover whether the results of Study 1 hold for negative and disorganized symptoms. For example, a possible hypothesis might be that unhelpful responses to psychotic symptoms are associated with greater social withdrawal and other negative traits and by extension, greater dysfunction.

In another direction for future research, investigators could extend Bentall’s (2003) single symptom approach even further, and break results down into more specific symptoms. That is, rather than examining positive symptoms as a whole, it would be informative to examine variables associated with, for example, paranoid delusions specifically, or magical thinking, or disordered speech, and so forth. Comparing the associates of one type of experience with the associates of other experiences would also be informative. These types of investigations have already begun to yield interesting results. For instance, a tendency for individuals experiencing delusions to cognitively ‘jump to conclusions’ has been widely studied (e.g. Bentall, 2003; Moore & Sellen, 2006; Lincoln, Ziegler, Mehl, & Rief, 2010).

9.7. Conclusions
As has been comprehensively reviewed throughout this thesis, in the last five years there has been an explosion of research consistently demonstrating similarities between experiences associated with schizotypy and psychosis. Indeed, it would seem that for many findings in relation to psychotic disorders, there is a corresponding finding in relation to schizotypy - although not always of the same magnitude of effect. This is especially true for environmental and social findings such as those pertaining to cannabis use, maternal infection and trauma, but is somewhat less true for biological and molecular genetic findings – where there has been a relative paucity of research. The studies reported herein went some way to resolve this
deficiency by investigating the positive anomalous experiences associated with schizotypy and psychosis, and their relationship to neuroanatomical, neurocognitive and clinical correlates.

The results of this project are consistent with a fully dimensional model, wherein varying levels of schizotypal personality traits throughout the general population lie on a continuum with schizophrenia spectrum disorders. On this basis, it is proposed that there should be no question of whether or not the two constructs are related. A more pertinent question would be; what determines whether or not an individual makes the hypothetical transition from high schizotypy to full-blown psychosis? This transition could come about in a number of different ways. One possible mechanism might be that as an individual moves along the continuum, their symptoms become linearly more severe. For example in relation to cognitive deficits, it could be that impairments become more numerous, pervasive and severe along an increasing schizotypy and psychosis scale.

However, as a fully dimensional model of schizotypy would suggest, it is more likely that the effects of various genetic, biological and environmental risk factors combine with high schizotypy in various cumulative, nonlinear and perhaps even idiopathic ways to determine outcome. Although outside the scope of this research, valuable intersections could be made here with the burgeoning literature on ultra high-risk for psychosis groups, which identify the anomalous psychotic experiences associated with schizotypy as a risk factor for the development of full-blown psychosis, along with a number of other risk factors such as depression, reduced attention, and family history of psychosis (Yung et al., 2004).

It is proposed that the relationship between schizotypy and psychosis may be viewed as similar to the relationship between neuroticism and anxiety disorders. High
levels of neuroticism are often found in people with anxiety disorders, however high neuroticism is not sufficient in and of itself to indicate the presence of an anxiety disorder. The same can be said of schizotypy and psychosis in that high levels of schizotypy may be associated with psychosis, and high schizotypy may be associated with similar variables to psychosis, but high schizotypy does not necessarily indicate dysfunction alone. Just as neuroticism on its own is insufficient to indicate a specific anxiety disorder, the value of schizotypy is not found in its use as a screening measure for specific psychotic disorders. Rather, the value of schizotypy lies in what it can tell us about normal human experience, and the possible pathways from psychological health to psychological dysfunction.
References


Brickman, A. M., Zimmerman, M. E., Paul, R. H., Grieve, S. M., Tate, D. F., Cohen,


Davis, K. L., Stewart, D. G., Friedman, J. I., Buchsbaum, M., Harvey, P. D., Hof, P.


matter integrity and prediction of social and role functioning in subjects at ultra-high risk for psychosis. Biological Psychiatry, 66(6), 562-569.
disorder. Human Brain Mapping, 31(6), 904-916.


schizotypal traits and COMPT, PRODH and BDNF genes in a healthy Chinese population. *Psychiatry Research, 153*(1), 7-15.


McGorry, P. D., Allot, K., & Jackson, H. J. (2009). Diagnosis and the staging model of psychosis. In H. J. Jackson & P. D. McGorry (Eds.), *The Recognition and


Simonsen, C., Sundet, K., Vaskinn, A., Birkenaes, A. B., Engh, J. A., Faerden, A.,


Stefanis, N. C., Smyrnis, N., Avramopoulos, D., Evdokimidis, I., Ntzoufras, I., &


Tourrier, J. D., Yeh, C.-H., Calamante, F., Cho, K.-H., Connelly, A., & Lin, C.-P.


treatment evidence for clinical staging in psychotic disorders: From the at-risk mental state to chronic schizophrenia. *Biological Psychiatry, 70*(7), 619-625.


Appendix A

Ethics Approval Documents

7th December 2006

Dr Carmel Loughland
NISAD
C- Centre for Mental Health Studies
PO Box 833
NEWCASTLE 2300
Dear Carmel,

Re: MHREC 2006.061 The Australian Schizophrenia Research Bank (ASRB)

Your protocol was reviewed and approved by the Mental Health Research and Ethics Committee on the 06.12.06.

Enclosed please find a copy of the signed approval certificate.

On behalf of the Committee may I wish you the very best in your research and we look forward to hearing your results.

Yours Sincerely,

[Signature]

Dr. Stacey Gabriel
Manager
Mental Health Research and Ethics Committee
Dr Mark Seal  
Group Leader  
Murdoch Children’s Research Institute  
The Royal Children’s Hospital  

25 January 2011  

Dear Dr Seal,  

MH Project Number: 2010.241  

Project Title: **Cognition, Connectivity and the Positive Symptoms of Psychosis**.  
I am pleased to advise that the above project has received ethical approval.  

HREC Approval Date: 25 January 2011  

Participating Site/s:  
Murdoch Children’s Research Institute  

Approved Documents:  
- Project Protocol version 3 dated December 2010;  
- Invitation to Participants – Control Participants version 2 dated December 2010;  
- Invitation to Participants – Schizophrenia Participants version 2 dated December 2010;  
- Participant Information and Consent Form - Control Participants version 4 dated December 2010;  
- Participant Information and Consent Form - Schizophrenia Participants version 4 dated December 2010;  
- Questionnaire DASS;  
- Questionnaire Brief Core Schema Scales: beliefs about self and others; and  
- Interview: Appraisals of Anomalous Experiences (AANEX) 2007 interview.  

Site Specific Assessment:  
Please note: Please forward this HREC approval certificate to the Director of Research at your organisation together with your Research Governance-Site Specific Assessment application. You cannot commence this study until you have completed all the requirements of the Site Specific Assessment and have received written approval to conduct your research project at your organisation.  

Conditions of Ethics Approval:  
In order to comply with the National Statement on Ethical Conduct in Human Research 2007, Guidelines for Good Clinical Research Practice and Melbourne Health Research Policies and Guidelines you are required to:  
- Notify the HREC of the actual start date of the project;  

*The Melbourne Health HREC operates and is constituted in accordance with the National Statement on Ethical Conduct in Human Research 2007.*  

HREC Approval Of New Project (non SERP)
Office for Research

2 May 2011

Dr Marc Seal
Melbourne Neuropsychiatry Centre
The University of Melbourne
National Neuroscience Facility Level 2
Parkville VIC 3050

Dear Dr Seal,

RE: MIHREC Project 2010.241 - Cognition, connectivity and the positive symptoms of psychosis

Thank you for submitting the following correspondence:

A Request for Approval of Amendment form dated 29th October 2010 enclosing:

- Protocol version 4, dated March 2011
- Participant Information and Consent form (Controls) version 5, dated April 2011
- Participant Information and Consent form (Schizophrenia) version 5, dated April 2011

I am pleased to advise that the Mental Health Research Ethics Committee reviewed and approved the amendment(s) to the above named project.

Yours sincerely,

Ms Angela Gray
Manager - Human Research Ethics Committee
Appendix B

Consent Forms

Cognition, Connectivity, and the Positive Symptoms of Psychosis

Participant Information and Consent Form

Principal Researcher: Dr. Marc Seal
Associate Researchers: Ms. Margaret Nelson and Dr. Lisa Phillips
Version: 5.0 April 2011

Introduction
You are invited to take part in the project titled ‘Cognition, Connectivity and the Positive Symptoms of Psychosis’, which is affiliated with the Australian Schizophrenia Research Bank (ASRB). This is because you have previously participated in the ASRB as a control participant with no personal or family history of schizophrenia, and have given your consent to be contacted for further research involving schizophrenia.

This Participant Information and Consent Form tells you about the research project. It explains what is involved to help you decide if you want to take part.

Please read this information carefully. Ask questions about anything that you don’t understand or want to know more about. Before deciding whether or not to take part, you might want to talk about it with a relative, friend or your local health worker.

Participation in this research is voluntary. If you don’t wish to take part, you don’t have to. You can withdraw your consent at any time without affecting your treatment. Your request to withdraw will be respected and upon receipt of a written request, your stored personal information will be destroyed.

If you decide you want to take part in the research project, you may be asked to sign the consent section. By signing it you are telling us that you:

understand what you have read;
consent to take part in the research project;
consent to be involved in the procedures described;
consent to the use of your personal and health information as described.

You will be given a copy of this Participant Information and Consent Form to keep.

What is the purpose of this research project?
This project first seeks to determine how two different factors affect the development and maintenance of hallucinations and delusions. One of these is biological, and relates to poor connectivity between different parts of the brain. The other is psychological, and will consider the way an individual thinks about their own psychotic experiences. The project ultimately seeks to investigate how these two factors interact with each other and with other contributors, to increase the chances of experiencing hallucinations or delusions.

This project will use information from a small subset of participants involved in the Victorian division of the ASRB. It has been partly financed by PhD scholarship funding from the Australian Schizophrenia Research Institute, which is also responsible for the ASRB. Finally, the results of this research will be also be used for a PhD thesis, to be completed by the researcher Ms Margaret Nelson.

Participant Information & Consent Form, Version 5.0, Date: April 2011
What does participation in this research project involve?
If you agree to participate in this research, you will be invited to undergo an interview and two short questionnaires. During the interview, you will be asked about some experiences you may have had during your lifetime. These may range from very mild strange experiences that most people have - such as deja vu or seeing a ghost, to hallucinatory symptoms such as hearing voices. Depending on the number of experiences you have had, the interview is expected to last between forty-five minutes and two hours. The interview will be recorded for quality control, however you may let the researcher know if you do not wish for this to occur.

The questionnaires will be short (approximately fifteen minutes in total). The first will ask about your feelings towards yourself and others. The second will ask about your feelings over the previous week before the interview.

We will also obtain your brain scan, neuropsychological data and information about your personal history from your records stored at the ASRB for use in this study.

You will not be paid for your participation in this research, but you will be reimbursed up to $20 for travel costs.

What are the possible benefits?
We cannot guarantee or promise that you will receive any benefits from this research. However, one possible benefit may include the sense of satisfaction and enjoyment provided by the opportunity to describe your own experiences in your own words. Other benefits include an opportunity to contribute to current understandings of the nature of hallucinations and delusions.

What are the possible risks?
No serious risks are anticipated for participants involved in the project. However, some people may find that talking about their life experiences can be distressing. If you become upset or distressed as a result of your participation in the research, the principal researcher is able to arrange for counselling or other appropriate support. Any counselling or support will be provided by staff who are not members of the research team. In addition, you may prefer to suspend or end your participation in the research if distress occurs.

Do I have to take part in this research project?
Participation in any research project is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the project at a later stage. Your decision whether to take part or not, or to take part and then withdraw, will not affect your relationship with the researchers.

How will I be informed of the results of this research project?
The estimated completion date for the project is December, 2012. Upon completion, all participants will be informed of the group findings via mail. No individual results will be available for participants.

What will happen to information about me?
Any information obtained in connection with this research project that can identify you will remain confidential and will only be used for the purpose of this research project. This is with the exception that the ASRB will be informed of any changes to information you have previously provided to them (e.g. change of telephone number). Otherwise,
any identifying information will only be disclosed with your permission, except as required by law.

Data obtained for the interview and questionnaire in the current project will be assigned a participant number, and will be stored separately from any identifying information (e.g. your name and contact details). It will not be stored with the data you have previously provided to the ASRB, and will not be accessible by other researchers involved in the ASRB. All data collected will be securely stored electronically, and only accessible by members of the research team. It will be securely kept for nine years, then destroyed.

Can I access research information kept about me?

In accordance with relevant Australian and/or Victorian privacy and other relevant laws, you have the right to access the information collected and stored by the researchers about you. Please contact one of the researchers named at the end of this document if you would like access to your information.

In addition, in accordance with regulatory guidelines, the information collected in this research project will be kept for at least nine years. You must be aware that the information collected about you may not be able to be identified once the identifying information has been removed. This will occur within one month of the data being collected. Access to information about you after this point will not be possible.

Is this research project approved?

The ethical aspects of this research project have been approved by the Melbourne Health Human Research Ethics Committee.

The project will be carried out according to the Nation Statement on Ethical Conduct in Human Research (2007) produced by the National and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies.

For further information

If you want any further information concerning this project you can contact the principal researcher, Dr. Marc Seal on (03) 9345 4310, Dr. Lisa Phillips on (03) 9326 4774, or Ms. Margaret Nelson on (03) 8344 4009.

For complaints:

If you have any complaints about any aspect of the project then you may contact:

Name: Dr Sarah Rickard
Position: Manager, Mental Health Research and Ethics Committee
Telephone: (03) 9342 8530
PARTICIPANT CONSENT FORM

I, .............................................................................. Date of Birth .........................
(print name here)

of .................................................................................................................................
(print address here)

Telephone: (h) ................................. (w) ................................. (m) .................................

Email address: ...........................................................................................................

Please cross out any of the following that do not apply to you, or that you do not give consent for:

1. I have been diagnosed with schizophrenia / I am a control person without a personal or family history of schizophrenia (please cross out the one that does NOT apply), and I have previously participated in the ASRB.

2. I agree to participate as a volunteer on the project titled 'Cognition, Connectivity and the Positive Symptoms of Psychosis' as described in the participant information statement set out above.

3. I acknowledge that I have read the participant information statement, which explains why I have been selected, the aims of the project, and the nature and possible risks of the investigation, and the statement has been explained to me to my satisfaction.

4. I have been given the opportunity to ask any questions relating to any possible physical and emotional harm I might suffer as a result of my participation and I have received satisfactory answers.

5. I understand that I can withdraw from the project at any time without prejudice to my relationship with any health professional, treating organisation or ASRB personnel.

6. I agree that research data gathered from the results of the study may be published, provided that I cannot be identified.

7. I agree to the recording of my interview for the purpose of teaching, training and quality control. I understand that recording can be stopped at any time at my request.

8. I agree to the researchers accessing my records held at the ASRB to obtain information for this study.

8. I understand that the ASRB will be notified of any changes to information that I have previously provided.

9. I acknowledge receipt of a copy of this Consent Form and the Participant Information Sheet.

Signature of volunteer: ____________________________ Date: ___________

__________________________________________ _______________________

Please PRINT name
Cognition, Connectivity, and the Positive Symptoms of Psychosis

Participant Information and Consent Form

Principal Researcher: Dr. Marc Seal
Associate Researchers: Ms. Margaret Nelson and Dr. Lisa Phillips
Version: 5.0 April 2011

Introduction
You are invited to take part in the project titled ‘Cognition, Connectivity and the Positive Symptoms of Psychosis’, which is affiliated with the Australian Schizophrenia Research Bank (ASRB). This is because you have previously participated in the ASRB as a participant with a diagnosis of schizophrenia or schizophreniform disorder, and have given your consent to be contacted for further research involving schizophrenia.

This Participant Information and Consent Form tells you about the research project. It explains what is involved to help you decide if you want to take part.

Please read this information carefully. Ask questions about anything that you don’t understand or want to know more about. Before deciding whether or not to take part, you might want to talk about it with a relative, friend or your local health worker.

Participation in this research is voluntary. If you don’t wish to take part, you don’t have to. You can withdraw your consent at any time without affecting your treatment. Your request to withdraw will be respected and upon receipt of a written request, your stored personal information will be destroyed.

If you decide you want to take part in the research project, you may be asked to sign the consent section. By signing it you are telling us that you:

- understand what you have read;
- consent to take part in the research project;
- consent to be involved in the procedures described;
- consent to the use of your personal and health information as described.

You will be given a copy of this Participant Information and Consent Form to keep.

What is the purpose of this research project?
This project first seeks to determine how two different factors affect the development and maintenance of hallucinations and delusions. One of these is biological, and relates to poor connectivity between different parts of the brain. The other is psychological, and will consider the way an individual thinks about their own psychotic experiences. The project ultimately seeks to investigate how these two factors interact with each other and with other contributors, to increase the chances of experiencing hallucinations or delusions.

This project will use information from a small subset of participants involved in the Victorian division of the ASRB. It has been partly financed by PhD scholarship funding from the Australian Schizophrenia Research Institute, which is also responsible for the ASRB. Finally, the results of this research will be also be used for a PhD thesis, to be completed by the researcher Ms Margaret Nelson.
What does participation in this research project involve?
If you agree to participate in this research, you will be invited to undergo an interview and two short questionnaires. During the interview, you will be asked about some experiences you may have had during your lifetime. These may range from very mild strange experiences that most people have had - such as deja vu or seeing a ghost, to hallucinatory symptoms such as hearing voices. Depending on the number of experiences you have had, the interview is expected to last between forty-five minutes and two hours. The interview will be recorded for quality control, however you may let the researcher know if you do not wish for this to occur.

The questionnaires will be short (approximately fifteen minutes in total). The first will ask about your feelings towards yourself and others. The second will ask about your feelings over the previous week before the interview.

We will also obtain your brain scan, neuropsychological data, and information about your personal history from your records stored at the ASRB for use in this study.

You will not be paid for your participation in this research, but you will be reimbursed up to $20 for travel costs.

What are the possible benefits?
We cannot guarantee or promise that you will receive any benefits from this research. However, one possible benefit may include the sense of satisfaction and enjoyment provided by the opportunity to describe your own experiences in your own words. Other benefits include an opportunity to contribute to current understandings of the nature of hallucinations and delusions.

What are the possible risks?
No serious risks are anticipated for participants involved in the project. However, some people may find that talking about their life experiences can be distressing. If you become upset or distressed as a result of your participation in the research, the principal researcher is able to arrange for counselling or other appropriate support. Any counselling or support will be provided by staff who are not members of the research team. In addition, you may prefer to suspend or end your participation in the research if distress occurs.

Do I have to take part in this research project?
Participation in any research project is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the project at a later stage. Your decision whether to take part or not, or to take part and then withdraw, will not affect your relationship with the researchers.

How will I be informed of the results of this research project?
The estimated completion date for the project is December, 2012. Upon completion, all participants will be informed of the group findings via mail. No individual results will be available for participants.

What will happen to information about me?
Any information obtained in connection with this research project that can identify you will remain confidential and will only be used for the purpose of this research project. This is with the exception that the ASRB will be informed of any changes to information you have previously provided to them (e.g. change of telephone number). Otherwise,
any identifying information will only be disclosed with your permission, except as required by law.

Data obtained for the interview and questionnaire in the current project will be assigned a participant number, and will be stored separately from any identifying information (e.g. your name and contact details). It will not be stored with the data you have previously provided to the ASRB, and will not be accessible by other researchers involved in the ASRB. All data collected will be securely stored electronically, and only accessible by members of the research team. It will be securely kept for nine years, then destroyed.

**Can I access research information kept about me?**

In accordance with relevant Australian and/or Victorian privacy and other relevant laws, you have the right to access the information collected and stored by the researchers about you. Please contact one of the researchers named at the end of this document if you would like access to your information.

In addition, in accordance with regulatory guidelines, the information collected in this research project will be kept for at least nine years. You must be aware that the information collected about you may not be able to be identified once the identifying information has been removed. This will occur within one month of the data being collected. Access to information about you after this point will not be possible.

**Is this research project approved?**

The ethical aspects of this research project have been approved by the Melbourne Health Human Research Ethics Committee.

The project will be carried out according to the *Nation Statement on Ethical Conduct in Human Research (2007)* produced by the National and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies.

**For further information**

If you want any further information concerning this project you can contact the principal researcher, Dr. Marc Seal on (03) 9345 4310, Dr. Lisa Phillips on (03) 9326 4774, or Ms. Margaret Nelson on (03) 8344 4009.

**For complaints:**

If you have any complaints about any aspect of the project then you may contact:

Name: Dr Sarah Rickard

Position: Manager, Mental Health Research and Ethics Committee

Telephone: (03) 9342 8530
PARTICIPANT CONSENT FORM

I, __________________________ ___________________________ Date of Birth ____________________
(print name here)
of __________________________ ___________________________ __________________________
(print address here)
Telephone: (h) ________________ (w) ________________ (m) _______________________

Email address: ___________________________________________________________

Please cross out any of the following that do not apply to you, or that you do not give consent for:

1. I have been diagnosed with schizophrenia / I am a control person without a personal or
   family history of schizophrenia (please cross out the one that does NOT apply), and I
   have previously participated in the ASRB.

2. I agree to participate as a volunteer on the project titled 'Cognition, Connectivity and the
   Positive Symptoms of Psychosis' as described in the participant information statement set
   out above.

3. I acknowledge that I have read the participant information statement, which explains why I
   have been selected, the aims of the project, and the nature and possible risks of the
   investigation, and the statement has been explained to me to my satisfaction.

4. I have been given the opportunity to ask any questions relating to any possible physical and
   emotional harm I might suffer as a result of my participation and I have received satisfactory
   answers.

5. I understand that I can withdraw from the project at any time without prejudice to my
   relationship with any health professional, treating organisation or ASRB personnel.

6. I agree that research data gathered from the results of the study may be published, provided
   that I cannot be identified.

7. I agree to the recording of my interview for the purpose of teaching, training and quality
   control. I understand that recording can be stopped at any time at my request.

8. I agree to the researchers accessing my records held at the ASRB to obtain information for
   this study.

9. I acknowledge receipt of a copy of this Consent Form and the Participant Information Sheet.

Signature of volunteer: __________________________ Date: ________________

________________________________________
Please PRINT name
## Appendix C

### Items Corresponding to Each of the Nine SPQ Subscales

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Items</th>
</tr>
</thead>
</table>
| Ideas of Reference           | 1 – Do you sometimes feel that things you see on the TV or read in the newspaper have a special meaning for you?  
10 – I am aware that people notice me when I go out for a meal or to see a film  
19 – Do some people drop hints about you or say things with a double meaning?  
28 – Have you ever noticed a common event or object that seemed to be a special sign for you?  
37 – Do you sometimes see special meanings in advertisements, shop windows, or in the way things are arranged around you?  
45 – When shopping do you get the feeling that other people are taking notice of you?  
53 – When you see people talking to each other, do you often wonder if they are talking about you?  
60 – Do you sometimes feel that other people are watching you?  
63 – Do you sometimes feel that people are talking about you? |
| Excessive Social Anxiety     | 2 – I sometimes avoid going to places where there will be many people because I will get anxious  
11 – I get very nervous when I have to make polite conversation  
20 – Do you ever get nervous when someone is walking behind you?  
29 – I get anxious when meeting people for the first time  
38 – Do you often feel nervous when you are in a group of unfamiliar people?  
46 – I feel very uncomfortable in social situations involving unfamiliar people  
54 – I would feel very anxious if I had to give a speech in front of a large group of people  
71 – I feel very uneasy talking to people I do not know well |
| Odd Beliefs or Magical Thinking | 3 – Have you had experiences with the supernatural?  
12 – Do you believe in telepathy (mind-reading)?  
21 – Are you sometimes sure that other people can tell what you are thinking?  
30 – Do you believe in clairvoyance (psychic forces, fortune telling)?  
39 – Can other people feel your feelings when they are not there?  
47 – Have you had experiences with astrology, seeing the future, UFOs, ESP or a sixth sense?  
55 – Have you ever felt that you are communicating with another person telepathically (by mind-reading)? |
| Unusual Perceptual Experiences | 4 – Have you often mistaken objects or shadows for people, or noises for voices?  
13 – Have you ever had the sense that some person or force is around you, even though you cannot see anyone?  
22 – When you look at a person, or yourself in the mirror, have you ever seen the face change right before your eyes?  
31 – I often hear a voice speaking my thoughts aloud  
40 – Have you ever seen things invisible to other people?  
48 – Do everyday things seem unusually large or small?  
56 – Does your sense of smell sometimes become unusually strong?  
61 – Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?  
64 – Are your thoughts sometimes so strong that you can almost hear them? |
| Odd or Eccentric Behaviour   | 5 – Other people see me as slightly eccentric (odd)  
14 – People sometimes comment on my unusual mannerisms and habits  
23 – Sometimes other people think that I am a little strange  
32 – Some people think that I am a very bizarre person  
67 – I am an odd, unusual person  
70 – I have some eccentric (odd) habits  
74 – People sometimes stare at me because of my odd appearance |
| No Close Friends             | 6 – I have little interest in getting to know other people  
15 – I prefer to keep to myself  
24 – I am mostly quiet when with other people |
33 – I find it hard to be emotionally close to other people
41 – Do you feel that there is no-one you are really close to outside of your immediate family, or people you can confide in or talk to about personal problems?
49 – Writing letters to friends is more trouble than it is worth
57 – I tend to keep in the background on social occasions
62 - I attach little importance to having close friends
66 - Do you feel that you cannot get 'close' to people?

Odd Speech
7 – People sometimes find it hard to understand what I am saying
16 – I sometimes jump quickly from one topic to another when speaking
25 – I sometimes forget what I am trying to say
34 – I often ramble on too much when speaking
42 – Some people find me a bit vague and elusive during a conversation
50 – I sometimes use words in unusual ways
58 – Do you tend to wander off the topic when having a conversation?
69 – I find it hard to communicate clearly what I want to say to people
72 – People occasionally comment that my conversation is confusing

Constricted Affect
8 – People sometimes find me aloof and distant
17 – I am poor at expressing my true feelings by the way I talk and look
26 – I rarely laugh and smile
35 – My ‘non-verbal’ communication (smiling and nodding during a conversation) is poor
43 – I am poor at returning social courtesies and gestures
51 – I tend to avoid eye contact when conversing with others
68 – I do not have an expressive and lively way of speaking
73 – I tend to keep my feelings to myself

Suspiciousness
9 – I am sure I am being talked about behind my back
18 – Do you often feel that other people have got it in for you?
27 – Do you sometimes get concerned that friends or co-workers are not really loyal or trustworthy?
36 – I feel I have to be on my guard even with friends
44 – Do you often pick up hidden threats or put-downs from what people say or do?
52 – Have you found that it is best not to let other people know too much about you?
59 – I often feel that others have it in for me
65 – Do you often have to keep an eye out to stop people from taking advantage of you?
# Appendix D

**Subscales Corresponding to Each of the Three SPQ Factors.**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Cognitive-Perceptual</th>
<th>Interpersonal</th>
<th>Disorganized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideas of Reference</td>
<td></td>
<td>Excessive Social Anxiety</td>
<td>Odd or Eccentric Behaviour</td>
</tr>
<tr>
<td>Odd Beliefs or Magical Thinking</td>
<td></td>
<td>No Close Friends</td>
<td>Odd Speech</td>
</tr>
<tr>
<td>Unusual Perceptual Experiences</td>
<td></td>
<td>Constricted Affect</td>
<td></td>
</tr>
<tr>
<td>Suspiciousness</td>
<td></td>
<td>Suspiciousness</td>
<td></td>
</tr>
</tbody>
</table>
Appendix E

Appraisals of Anomalous Experiences (AANEX) Interview


Name:……………………………….…………  Participant No:………….

DOB: ……………

Date of Interview: ………………..

AANEX Inventory

I’ve got a list of experiences that sometimes people have, and I’d like to ask you if you’ve ever experienced any of them.

(Follow probes given in the AANEX Inventory manual, and record on this page and overleaf.)

A – Schneiderian First Rank Symptoms

1. thought transmission……………… 4. controlled actions……………… 7. ‘activity’ experiences…………
2. receptivity ………… 5. passivity (other)……………… 8. loud thoughts………………
3. thought withdrawal ………… 6. reference experiences ………… 9. voice experiences…………

B – Anomalous perception

1. depersonalization ………… 4. visual anomalies (halls.) ……… 7. somatic anomalies ………
2. derealisation (d.m.)…………… 5. auditory anomalies …………… 8. lost automatic skills ………
3. visual anomalies (global)…… 6. oversensitivity (a/v)…………… 9. language disturbance……
8b. dividing attention deficit ……… 9b. concretism………………
10. olfactory anomalies…………

C – Anomalous cognition

1. distractability……………… 1b. thought interference………… 1c. thought blockage…………
1d. captivation/ fixation………… 3. disorientation …………… 5. thought pressure………
2. time distortion …………… 4. insight experiences …………… 6. ‘mission’ experiences……

D – Anomalous affect

1. spiritual elation……………… 2. monitored……………… 3. doom/negation………………
4. mixed/unknown emotions…… 5. emotional reactivity………… 6. loss of emotions…………

E – Paranormal

1. precognition ………… 2. OBE’s …………

F – Anomalous individuation

1. ‘loss of boundary’……… 2. subjective isolation…………
For any experience endorsed:

Q Have you had this experience more than once, or was it an isolated event?
Q Do you still experience this (from time to time)?
Q How long has the experience lasted for? (Minimum and maximum duration)
Q Did this experience occur in the context of an ‘altered state’?

IF YES ⇒ Q Can you describe what this was like? What were the other features of this state?

IF NO ⇒ Q Has this occurred at the same time as any other unusual experience? Which?

Sequence of events:

Q Which of these experiences that you’ve told me about came first? What was the earliest experience? (Age/dates)
Q Are there any distinct periods of time or episodes of your life in which you had a lot of experiences?

IF YES ⇒ Q Can you tell me a bit about them, starting with the earliest?
Q’s – Dates/ages; duration of episode; which experiences?

IF NO ⇒ Q Did some of the experiences start to occur later than others?
Q’s – Dates/ages; order of experiences occurring.

Q Have there been periods of time in which you haven’t had any unusual experiences?
### AANEX Inventory Time Line Sheet

This sheet may be useful for making a record of the types of anomalies a participant has experienced, in terms of which experiences began first, the approximate dates of onset, duration, frequency etc.

<table>
<thead>
<tr>
<th>EARLIEST</th>
<th>INTERMEDIATE</th>
<th>CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp:……………………………</td>
<td>Exp:……………………………</td>
<td>Exp:……………………………</td>
</tr>
<tr>
<td>Onset:…………………………</td>
<td>Onset:…………………………</td>
<td>Onset:…………………………</td>
</tr>
<tr>
<td>Duration:……………………</td>
<td>Duration:……………………</td>
<td>Duration:……………………</td>
</tr>
<tr>
<td>Freq:…………………………</td>
<td>Freq:…………………………</td>
<td>Freq:…………………………</td>
</tr>
<tr>
<td>Offset:………………………</td>
<td>Offset:………………………</td>
<td>Offset:………………………</td>
</tr>
</tbody>
</table>

| Exp:…………………………… | Exp:…………………………… | Exp:…………………………… |
| Onset:………………………… | Onset:………………………… | Onset:………………………… |
| Duration:…………………… | Duration:…………………… | Duration:…………………… |
| Freq:………………………… | Freq:………………………… | Freq:………………………… |
| Offset:……………………… | Offset:……………………… | Offset:……………………… |

| Exp:…………………………… | Exp:…………………………… | Exp:…………………………… |
| Onset:………………………… | Onset:………………………… | Onset:………………………… |
| Duration:…………………… | Duration:…………………… | Duration:…………………… |
| Freq:………………………… | Freq:………………………… | Freq:………………………… |
| Offset:……………………… | Offset:……………………… | Offset:……………………… |

| Exp:…………………………… | Exp:…………………………… | Exp:…………………………… |
| Onset:………………………… | Onset:………………………… | Onset:………………………… |
| Duration:…………………… | Duration:…………………… | Duration:…………………… |
| Freq:………………………… | Freq:………………………… | Freq:………………………… |
| Offset:……………………… | Offset:……………………… | Offset:……………………… |

| Exp:…………………………… | Exp:…………………………… | Exp:…………………………… |
| Onset:………………………… | Onset:………………………… | Onset:………………………… |
| Duration:…………………… | Duration:…………………… | Duration:…………………… |
| Freq:………………………… | Freq:………………………… | Freq:………………………… |
| Offset:……………………… | Offset:……………………… | Offset:……………………… |
I’d like to start at the earliest experience, and ask you a bit more about what happened, how you felt about it, and what you did.

(1) FIRST EXPERIENCES:........................................................................................................

To start with, I’d like you to think back to the first time(s) you experienced or noticed this.

A) Context: situation and feelings:

Q Can you tell me what your life was like when you had [the experience]?  
Q What kind of living situation were you in?  
Q Were there any particularly difficult or exciting events happening to you at that time?  
Q How were you feeling emotionally at this time?

Situation:                  Feelings:                  
Significant change 2 1 0 Exhaustion (physical/mental) 2 1 0 
Social Isolation 2 1 0 Depression/Loss/Hopelessness 2 1 0  
Crisis/Impasse 2 1 0 Anxiety/Stress 2 1 0  
Trauma 2 1 0 Deep relaxation 2 1 0  
Drug use 2 1 0 Elation 2 1 0  
Rel/Spir. practice 2 1 0  
Cultural context 2 1 0  
From childhood 2 1 0

B) Framework of Interpretation:

Q When you had that (first) experience, what did you think had happened?  
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................

If EXPERIENCE described ⇒ What sense did you make of it? Did you think there was an explanation for it?
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................

If BELIEF described ⇒ What did you experience that led you to think that?
..............................................................................................................................................
..............................................................................................................................................

(a) Biological 2 1 0 Psychological 2 1 0 Drug related 2 1 0  
No interpretation 2 1 0 Spiritual 2 1 0 Supernatural 2 1 0  
Normalising 2 1 0 Other people 2 1 0 

(b) Valence:  
positive 5 4 neutral 3 negative 2 1  
dangerous 5 4 neutral 3 benign 2 1

(c) I/E:  
external 5 4 both/neutral 3 internal 2 1

(d) Agency:  
personal 5 4 both/neutral 3 impersonal 2 1
If information not spontaneously given ⇒

Q Did you think [the experience] was beneficial or a bad sign?
Q Did you think [the experience] was dangerous or harmless?
Q Did you think [this] was caused by changes in you, or something outside of you?

C) Emotional and behavioural response:

C) Emotional response:

Q How did you feel when this happened, at the start?

Neutral arousal  Negative  Positive
………………………………………………………………………………………….
………………………………………………………………………………………….
………………………………………………………………………………………….
………………………………………………………………………………………….
Score: __  Score: __  Score: __

Q Did you feel very surprised, puzzled, or curious?
Q Did you have any bad feelings; worries or fears?
Q Did you have any good feelings at all?
………………………………………………………………………………………….
………………………………………………………………………………………….
………………………………………………………………………………………….
………………………………………………………………………………………….
[Note feelings mentioned initially; then note responses to specific questions; allocate score between 1 and 5 for each category as detailed in Appraisals Scoring Guide]

Q You’ve told me you felt [feeling]; can I ask you to tell me how anxious you felt? Say, from 1 to 5, if 1 is ‘not at all’, and 5 is ‘as anxious as you’ve ever been’?

not at all  a little  somewhat  rather  extremely
1  2  3  4  5

Q Could you give me an idea of how excited you were when you experienced [that]? From 1 to 5, if 1 is ‘not at all excited’ and 5 is ‘as excited as you’ve ever been’?

not at all  a little  somewhat  rather  extremely
1  2  3  4  5
Cii) Initial response:

Now I’m interested in how you responded to that experience;

Q As this was first happening, what did you think?
……………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………

Q What did you do?
……………………………………………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………………………………………

a) Avoidance e.g:
Focus on ongoing activity, change environment, talk to other about other subject, relaxation
techniques, use drugs or alcohol etc.
……………………………………………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………………………………………… Score: 5

b) Cognitive Control/ Self-statement e.g:
Reinterpretation/reframing, self-reassurance, control statements (‘don’t think about that’, switching to
other thoughts etc.
……………………………………………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………………………………………… Score: 5

c) Reappraisal e.g:
Reliving or reconsidering experience, reality testing actions or discussions with other people etc.
……………………………………………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………………………………………… Score: 5

d) Rumination e.g:
Intellectualisation, mulling over experience, involuntary rumination, etc.
……………………………………………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………………………………………… Score: 5

e) ‘Immersion’ e.g:
Acting in accordance with initial interpretation of experience, including speech, behaviour or silently
resisting experience.
……………………………………………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………………………………………… Score: 5

f) Neutral response e.g:
Acceptance of anomaly, ignoring anomaly (not active avoidance), enjoying anomaly (not active
pursuit of it), sharing experience (not reappraising or reality testing.) etc.
……………………………………………………………………………………………………………………………………………………………………
…………………………………………………………………………………………………………………………………………………………………… Score: 5

N.b. Categories given as a suggestion: verbatim responses may be content analysed after data
collection to yield different scoring categories. For these categories, lists of responses are given as examples only for ease of scoring; make notes of other responses in each category as appropriate, then allocate score between 1 and 5 for each category.
1 = no responses of this kind described
2 = minimal responses of this kind described
3 = some responses of this kind described
4 = considerable responses of this kind described (but also other kinds mentioned)
5 = only responses of this kind described
D) Context and implications of appraisal

i) Self esteem:
Q What effect did this experience have on how you saw yourself? Did it make you see yourself in a better light, make you feel worse about yourself or not have any effect?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>greatly ↑</td>
<td>slightly ↑</td>
<td>neutral</td>
<td>slightly ↓</td>
<td>greatly ↓</td>
<td></td>
</tr>
</tbody>
</table>

ii) Perceived social understanding:
Q Did you feel your experience would be understood by your social group, or did you feel it would be best to keep quiet about it?

If yes, know someone who would understand
Q Do you think they had a similar experience themselves?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>def. keep</td>
<td>best to</td>
<td>unsure</td>
<td>suspect</td>
<td>def.</td>
<td></td>
</tr>
<tr>
<td>quiet</td>
<td>keep quiet</td>
<td>understand</td>
<td>understand</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

iii) Perceived controllability: Q When you first experienced [this], how much control did you have over the experience? For example, could you stop the experience when you wanted, or did you deliberately elicit it?

Y/N

1 (none) 2 (minimal) 3 (some) 4 (mostly) 5 (total control)

iv) Attempted control: Q Did you try to control it? control your reaction or what you thought about it? In what ways?

1 (not at all) 2 (a little) 3 (some) 4 (a lot) 5 (total effort)

(If necessary, go back and amend ‘Initial Response’ scores)

v) Premorbid awareness: Q Were you aware that these experiences could occur before it happened to you? Y/N

If YES ⇒ Q When it happened, did you know what was happening because of this information you had?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>no prior</td>
<td>a little/</td>
<td>a little/</td>
<td>a lot/</td>
<td>knew all about</td>
<td></td>
</tr>
<tr>
<td>awareness</td>
<td>general</td>
<td>specific</td>
<td>specific</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

vi) Tolerance of cognitive dissonance/Intellectual involvement:
Q When [this] first happened, was it inconsistent with how you’d understood the world? Did you think that it was impossible, or feel very confused, puzzled or surprised?

Y/N

If YES ⇒ Q Was it important to you to work out what was going on, or did you take it at face value?

Q Did you think about it a lot, trying to understand, or did you avoid trying to work it out?

If NO ⇒ Q Did you feel as though you had reached a new or better understanding of the world? Y/N

If YES ⇒ Q Did you think about this new understanding a lot, trying to work out the details, or did you feel it was not important?

If NO ⇒ Q Did you think a lot about why or how your experience had happened, or what it meant?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>not at all</td>
<td>a little</td>
<td>some [20-49%]</td>
<td>a lot of [50-89%]</td>
<td>crucial [90-100%]</td>
<td>need to understand</td>
</tr>
</tbody>
</table>
E) Longer term behavioural response

Q Now I have some questions about how you dealt with this...
Q Afterwards, did [this experience] have any effects on your behaviour? Y/N
If YES ⇒ in what way?
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
If NO ⇒ Q Did you 'go through the motions' as if it hadn't happened? Y/N
Q Did you try to work out if it was true?/if it had really happened? Y/N
Q Did you think a lot about [the experience]? Y/N
If NO ⇒ Q Did you try to forget about it? Y/N
Q Were you worried that it might occur again? Y/N
If NO ⇒ Q Did you hope it might occur again? Y/N
Q Did you try to prevent it happening again/induce it? Y/N
Q Did you discuss it with friends or someone else? Y/N
Q Did you seek help or information about it? Y/N
If YES ⇒ Q Who from?
........................................................................................................................................
Q Did you use strategies to control your experience or protect yourself? Y/N
If YES ⇒ Q What kind?
........................................................................................................................................
Q Were you more likely to spend time with people or to try to avoid withdrawal ⇒ Y/N
people and spend time on your own?
........................................................................................................................................

<table>
<thead>
<tr>
<th>Reality testing</th>
<th>very much</th>
<th>a little</th>
<th>not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignoring/forgetting</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Distraction</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Drugs/alcohol</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Safety behaviours (ritualistic)</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Behavioural coping methods</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Seeking repeat experience</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Sharing experience</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Help seeking (psych. services)</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Help seeking (other)</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Seeking information</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>No effect</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Acting on interpretation</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

******************************************************************************* End of Optional section******************************************************************************
Later occasions:

Q When this happened again, did you feel differently about it? Y/N
Q Have your/did your ideas change(d) about what you thought was going on? Y/N

If YES ⇒ I’d like to ask you about your response to this kind of experience when it happened later on...

If you are asking the participant about other periods of time retrospectively, repeat sections 1b to 1d, anchoring the questions to the relevant timepoint. If you are asking the participant about their current appraisals of anomalies, move to section 2.

If NO ⇒ If other experiences endorsed in the AANEX-Inventory, repeat the process for the other anomalies of interest (sections 1a to 1d/e); If not, move to section 2 below.

(2) CURRENT APPRAISALS

Experiences: Q Which of the experiences we have mentioned are you currently having?

…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

B) Framework of interpretation

Q Do you think your understanding of your experience(s) has changed over time? Y/N

IF NO ⇒ Elicit confirmation of same framework of interpretation as in section 2a)

IF YES ⇒ Q How do you make sense of your experience(s) now?

…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

(a) Biological 2 1 0 Psychological 2 1 0 Drug related 2 1 0
No interpretation 2 1 0 Spiritual 2 1 0 Supernatural 2 1 0
Normalising 2 1 0 Other people 2 1 0

(b) Valence: positive 5 4 neutral 3 negative 2 1
dangerous 5 4 neutral 3 benign 2 1

(c) I/E: external 5 4 both/neutral 3 internal 2 1
both/neutral 5 4 both/neutral 3 impersonal 2 1

If information not spontaneously given ⇒

Q Do you think [the experience] is beneficial or a bad sign?
Q Do you think [the experience] is dangerous or harmless?
Q Do you think [this] is caused by changes in you, or something outside of you?

If NO CURRENT EXPERIENCES ⇒ omit following section and continue from section ‘f’: ‘Alternative explanations’ to the end.

Timings of current experiences:

A) Context:

Q Is there anything particular about your circumstances which you feel might contribute towards or cause these experiences/this experience? (Feelings/situation)

…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

254
C) Emotional and behavioural response:

Ci) Emotional response:

Q How do you feel when this happens?

Neutral arousal | Negative | Positive
----------------|----------|----------
………………… | ………….. | …………..
………………… | ………….. | …………..
…………………… | ………….. | …………..

Score: _ 5 5

Q Do you feel very surprised, puzzled, or curious?

Q Do you have any bad feelings; worries or fears?

Q Do you have any good feelings at all?

[Note feelings mentioned initially; then note responses to specific questions; allocate score between 1 and 5 for each category as detailed in Appraisals Scoring Guide]

Q You’ve told me you feel [feeling]; can I ask you to tell me how anxious you feel? Say, from 1 to 5, if 1 is ‘not at all’, and 5 is ‘as anxious as you’ve ever been’?

not at all | a little | somewhat | rather | extremely
-----------|---------|---------|--------|---------
1 2 3 4 5

Q Could you give me an idea of how excited you are when you experience [that]? From 1 to 5, if 1 is ‘not at all excited’ and 5 is ‘as excited as you’ve ever been’?

not at all | a little | somewhat | rather | extremely
-----------|---------|---------|--------|---------
1 2 3 4 5
Cii) Behavioural response:

*Now I’m interested in how you respond to that experience;*

**Q As this happens, what do you think?**

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………
D) Context and implications of appraisal

i) Self esteem:
Q What effect does this experience have on how you see yourself? Does it make you see yourself in a better light, does it make you feel worse about yourself?

1 2 3 4 5
greatly ↑ slightly ↑ neutral slightly ↓ greatly ↓

ii) Social support/understanding
Q Do you feel your experience would be understood by your social group, or do you feel it would be best to keep quiet about it?

1 2 3 4 5
def. keep best to unsure suspect def.
quiet keep quiet understand understand

c) Perceived controllability:
Q When you experience [this], how much control do you have over the experience? For example, can you stop the experience when you wanted, or do you deliberately elicit it? Y/N

1 (none) 2 (minimal) 3 (some) 4 (mostly) 5 (total control)

d) Attempted control:
Q Do you try to control it? control your reaction or what you think about it? In what way(s)?

1 (not at all) 2 (a little) 3 (some) 4 (a lot) 5 (total effort)

…………………………………………………………………………………………..
…………………………………………………………………………………………..
…………………………………………………………………………………………..

Q Do you think about it a lot, trying to understand, or do you avoid trying to work it out?

1 2 3 4 5
not at all a little some [20-49%] a lot of [50-89%] crucial [90-100%]

N.b. If earlier occurrences of the same kind of experience have been rated previously, rate as 5, unless a different interpretation is given such that the event is experienced as a different kind of event.

v) Tolerance of cognitive dissonance/Intellectual involvement:
Q When [this] happens, is it inconsistent with how you understand the world? Do you think that it is impossible, or feel very confused, puzzled or surprised? Y/N

If YES ⇒ Q Is it important to you to work out what is going on, or do you take it at face value?

…………………………………………………………………………………………..
…………………………………………………………………………………………..
…………………………………………………………………………………………..

Q Do you think about this new understanding a lot, trying to work out the details, or do you feel it’s not important?

If NO ⇒ Q Do you think a lot about why or how your experiences happen, or what it means?

1 2 3 4 5
not at all a little some [20-49%] a lot of [50-89%] crucial [90-100%] need to understand
E) Longer term behavioural response:

Q Now I have some questions about how you deal with this…

Q Afterwards, does [this experience] have any effect on your behaviour? Y/N In what ways?

If NO ⇒ Q Do you ‘go through the motions’ as if it hadn’t happened? Y/N

Q Do you try to work out if it’s true?/if it really happened? Y/N

Q Do you think a lot about [the experience]? Y/N

If NO ⇒ Q Do you try to forget about it? Y/N

Q Are you worried that it might occur again? Y/N

If NO ⇒ Q Do you hope it might occur again? Y/N

Q Do you try to prevent it happening again/induce it? Y/N

If YES ⇒ What do you do?

Q Do you discuss it with friends or someone else? Y/N

Q Are you seeking help or information about it? Y/N

If YES ⇒ Q Who from?

Q Do you use strategies to control your experience or protect yourself? Y/N

If YES ⇒ Q What kind?

Q Are you more likely to spend time with people or to try to avoid withdrawal? Y/N

very much a little not at all

| Reality testing | 2 | 1 | 0 |
| Ignoring/forgetting | 2 | 1 | 0 |
| Distraction | 2 | 1 | 0 |
| Drugs/alcohol | 2 | 1 | 0 |
| Safety behaviours (ritualistic) | 2 | 1 | 0 |
| Behavioural coping methods | 2 | 1 | 0 |
| Withdrawal | 2 | 1 | 0 |
| Seeking repeat experience | 2 | 1 | 0 |
| Sharing experience | 2 | 1 | 0 |
| Help seeking (psych. services) | 2 | 1 | 0 |
| Help seeking (other) | 2 | 1 | 0 |
| Seeking information | 2 | 1 | 0 |
| No effect | 2 | 1 | 0 |
| Acting on interpretation | 2 | 1 | 0 |
F) Alternative interpretations:

Q I want to ask you about some other ways of explaining what you experienced, and whether you agree that they are valid explanations or not:

Probe for endorsement of other frameworks of interpretation other than that mentioned spontaneously. Clarify responses to enable rating each: ‘definitely valid’ = 2, ‘perhaps’ = 1, ‘definitely not valid’ = 0.

Psychological: Q Do you think it is possible that your experience(s) was caused by your mind, in that there are psychological reasons or explanations for it?

0 1 2

Drug-related: Q Do you think that your experience was in any way related to drug use?

0 1 2

Spiritual: Q Do you think that there may have been spiritual elements or processes involved in your experience(s)?

0 1 2

Biological: Q Do you think it is possible that your experience(s) could be the result of some illness, disorder, or medical issue?

0 1 2

Supernatural: Q Do you think it is possible that supernatural factors were involved in your experience, such as invisible or other-worldly beings, agencies or forces?

0 1 2

Normalising: Q Do you think it is possible that your experience(s) could be normal or could reflect a natural capacity of human beings?

0 1 2

Other people: Q Do you think that your experience(s) were deliberately caused by other people?

0 1 2

No interpretation: Q Do you think that your experience(s) has/have no explanation?

0 1 2

(G) Implications for self:

i) Uniqueness of experience

Q Do you feel very unusual or special to experience these things? Y/N

Q Among the people you know well, what proportion do you think have experiences like/of a similar intensity to you?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>unique</td>
<td></td>
<td>one other</td>
<td>a few</td>
<td>many</td>
<td>most of them</td>
<td>all of them</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[1-5%]</td>
<td>[6-20%]</td>
<td>[21-50%]</td>
<td>[51-95%]</td>
<td>[95-100%]</td>
</tr>
</tbody>
</table>

ii) Uniqueness of potential

Q Do you think anybody has the potential to have experiences like this, or do you think that only certain people have the potential?

Q Do you anyone would have the same experiences as you if they were in certain circumstances?

If “only some” ⇒ Q Do you think that there are only a few (particular) people who are likely to have this experience, many people, or some?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>no, I am unique</td>
<td></td>
<td>only few</td>
<td>some</td>
<td>many</td>
<td>most</td>
<td>everyone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>'special’ people</td>
<td>predisposed</td>
<td>predisposed</td>
<td>have potential</td>
<td>has potential</td>
</tr>
</tbody>
</table>
iii) Salience/Perspective shift – reality
Q Have [these experiences] altered your view of reality? Y/N
Q How meaningful is [this] for your understanding of the world? …………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
IF YES or MEANINGFUL ⇒
Q Did it just affect details, or did it really alter the whole way you understand the nature of the world?
………………………………………………………………………………………………………
1  2  3  4  5  
not at all  a little/ some details  some aspects  considerably altered  completely changed
Q Could you tell me a little about these changes? How has your perspective changed?
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
iv) Salience – Own identity/self
Q How important has this event/have these events been for your understanding of your life and your place in the world?
………………………………………………………………………………………………………
Q Did [this] change how you see yourself? Y / N
If YES !⇒ ask further question:
Q Do you feel that you shed aspects of your old self in this transformation? Y / N
1  2  3  4  5  
not at all  a little/ some details  some aspects  considerably altered  completely changed/rebirth
Q Could you tell me a little about the change in your view of yourself?
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
i) Are there any other aspects of your experience which you feel are important and which you would like to tell me about?
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
j) Has there been anything you’ve done, or anything about your situation which you feel has really helped you to cope with or integrate these experiences?
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
Appendix F

Probe Questions for Eliciting Anomalous Experiences

A1 Thought transmission:
a) Have you had the experience of your thoughts being read or picked up by other people?
b) Have you ever had the experience of people reacting to thoughts you have had, so that you wonder if they are aware of what you are thinking?

A2 Receptivity:
a) Have you had the experience of feeling emotions or thinking thoughts that were actually those of other people?
b) Have you ever thought that other people or agencies were putting thoughts in your head, or making you feel certain things?
c) Have you had the experience of picking up on other people’s thoughts?

A3 Thought withdrawal:
a) Have you ever experienced your thoughts being taken out of your mind, blocked or stopped by something or someone else?

A4 Controlled actions:
a) Have you ever experienced your bodily movements being controlled by someone or something outside of you?

A5 Passivity (other):
a) Have you ever had an experience of having your thoughts, feelings or movements influenced by other people? Through their thoughts, or gestures alone?
b) Have you ever had an experience in which you felt your body moving automatically, or felt urges to move into certain postures or make certain movements, when you didn’t seem to be controlling this?

A6 Reference experiences:
a) Have you had experiences in which things you read or heard people say seemed to reflect or resonate with your own thoughts?
b) Have you had experiences in which things in the world around you seemed to contain messages or hints, perhaps in a metaphorical or symbolic way?
c) Have you had the experience of people seeming to be communicating with you in a special way, like with double meanings or significant words or hints?
d) Have you had the experience of feeling as though events in your environment, such as the actions or comments of other people, are in reference to you, or are directed at you, even though you know that this is unlikely?

A7 Activity:
a) Have you had the experience of influencing or controlling people with your thoughts or gestures?
b) Have you had the experience of watching something happen and feeling as though you had caused it with your mind?
c) Have you had the experience of causing things to happen by thinking about it, when the effect happened some time later?

A8 Loud thoughts:
a) Have you ever experienced your own thoughts being very loud, so that you could hear them being spoken in your head?

A9 Voice experiences:
b) Have you ever had the experience of hearing things, like voices talking, or music playing, when there hasn’t been anyone around?

B1 Depersonalisation:
a) Have you had the experience of feeling alienated or at a distance from yourself, so that your actions and movements seem impersonal and automatic, or it feels as though you are listening to yourself
speaking when you talk?

**B2 Derealisation:**
a) Have you had the experience of the world seeming altered in a strange way, so that it didn’t seem as real and familiar as usual, but perhaps looked flat or artificial?
b) Have you had the experience of the world seeming different or new, so that it seemed less solid, and more perfect or ‘glowing’ somehow?

**B3 Visual anomalies (global):**
- Have you had the experience of alterations in your vision, so that for example colours look different, you are more sensitive to light, things seem to move when you look at them, or people’s faces look strange?

**B4 Visual anomalies (hallucinations):**
a) Have you had ever had the experience of seeing something that other people couldn’t see, or that you later found out was not there?
b) Have you had the experience of seeing someone’s aura, or other manifestations of energy?

**B5 Auditory anomalies:**
a) Have you had the experience of changes in your hearing, so that for example noises seem louder and more intrusive, or speech or music seem to sound different, peculiar or distorted?

**B6 Oversensitivity:**
a) Have you had the experience of feeling as though you have a ‘thinner skin’, because sounds or visual stimuli can’t be filtered out, and seem to flood or overwhelm you?

**B7 Somatic anomalies:**
a) Have you ever had experiences of unusual sensations in your body, not created by any obvious physical cause, for example of heat or cold, energy moving, or something entering or passing through your body?

**B8 Lost automatic skills:**
Have you experienced the loss of automatic skills, so that things you could normally do easily and without really thinking suddenly require all your attention and have be taken one step at a time?

**B8b Can’t divide attention:**
Have you noticed that it is more difficult than it used to be to do two things at the same time? E.g. to talk to someone and do some cooking at the same time?

**B9 Language Disturbance:** Have you experienced being in a state in which it is difficult to follow a conversation or understand what someone is saying, because the words seem to stand on their own and don’t make sense?

**B9b Concretism:**
Have you noticed yourself misunderstanding what people say because they’ve used a metaphor or an expression that you’ve taken literally?

**C1 Distractability:**
Have you had the experience of being unusually distractible, so that your attention is constantly caught by anything in your environment, and you can’t control or direct your attention purposefully at one thing?

**C1b Thought interference:**
Have you noticed that irrelevant or intrusive thoughts or images interrupt your thinking when you are trying to concentrate? Has this happened more than usual in any period of time? E.g. when trying to concentrate on a conversation or to some work or a book?

**C1c Thought blockages:**
Have you noticed ever that your thoughts seem to suddenly stop or fade out, so that you lose your train of thought much more often than usual?
C1d) Captivation/fixation:
Have you noticed ever that your attention gets caught by something you can see, and you find yourself looking at it without really wanting to? Like you get fixed at staring at something, or somehow something in your environment seems to stand out from everything else, so you’re drawn to look at it?

C2 Time distortion:
a) Have you had the experience of an alteration in the sense of time, so that past and future seem to disappear into an experience of the present moment?
b) Have you ever experienced difficulties with your memory, so that it is very difficult to remember what you have done or what has happened yesterday, or earlier in the day, or even a few minutes before?
c) Have you ever experienced difficulties with thinking about the future, so that it becomes very hard to plan out what you have to do, or envisage what might happen later on?

C3 Disorientation:
a) Have you had the experience of feeling disorientated in space, so that it is unusually difficult to get a sense of direction, or to find your way somewhere, even if you know the way quite well?

C4 Insight experiences:
a) Have you had the experience of having ‘insights’ or sudden revelations come into your mind, for example about the nature of divine or cosmic principles, or the functioning of society, or other fundamental issues?

C5 Thought pressure:
a) Have you had the experience of thoughts rushing very rapidly through your mind, so that one idea after another comes into your head and the thoughts seem to whirl around beyond your control?

C6 Mission experiences:
a) Have you had the experience of some kind of ‘mission’ or duty being revealed to you, and knowing that you have to fulfill this mission, or feeling compelled to do so?

D1 Spiritual elation:
Have you ever had an experience like a state of ‘grace’, in which you felt extremely content and peaceful, or released from all responsibilities, or very light and full of energy and love, which has been unlike your normal fluctuations of mood?

D2 Monitored:
Have you had the experience of feeling monitored or watched, or otherwise the subject of external attention, when there is no obvious cause for this?

D3 Doom:
a) Have you ever experienced feelings of doom, or impending catastrophe that you couldn’t explain?
b) or heaviness and lack of energy that might have made you feel as if you were dying, dead or dissolving, without any obvious cause?

D4 Mixed/unknown emotions:
a) Have you experienced states in which it has been difficult to distinguish what emotions you are feeling, as if they are all mixed up and impossible to identify, or all seem equally unpleasant and intense?

D5 Emotional reactivity:
a) Have you experienced states when you are much more emotionally reactive than usual, so that little things agitate you more than usual, and things like music, books, or news footage have the power to ‘move’ you intensely?

D6 Loss of emotions:
a) Have you had the experience of feeling as though your emotions have disappeared, so that you feel numb, or as if something is missing inside?
**E1 Precognition:**
a) Have you had the experience of knowing what is going to happen a fraction of a second before it happens?
b) Have you had experiences of precognition when you foresee an event that happens later?

**E2 Out of body experiences:**
a) Have you ever had an out-of-body experience, in which you were actually able to look at your body from outside?

**F1 Loss of boundary:**
a) Have you experienced being in a state in which there seemed to be no clear boundary or difference between yourself and things around you?
b) Have you had an experience of a loss of your individual identity and a sense of being part of some greater whole that extends far beyond you?

**F2 Subjective isolation:**
a) Have you experienced being in a state in which you felt cut off or isolated from things and people around you, perhaps as if there were some invisible barrier around you that prevented a normal connection?
Appendix G

Scoring Guide and Examples for Anomalous Experiences Inventory

The anomalous experiences (a.e.’s) in this inventory include psychotic, psychotic-like, prodromal, and paranormal experiences, in the areas of schneiderian ‘first-rank’ symptoms, anomalous perception, cognition, affect and individuation.

Each experience is allocated a score from 1-5 to reflect the frequency and/or intensity of the experience within an individual’s lifetime.

(a) Some of the definitions of experiences cover a continuum of intensity, or subclinical to clinical forms of the same experience: in these cases, the scoring criteria for each level are given, incorporating both the frequency and nature of the experience.
(b) For most of the experiences, however, given that the precise criteria for that item are met, the number allocated should purely reflect the frequency of the experience, not its severity.

It is very important not to allow the 1-5 scale to reflect ‘degrees of psychoticism’; the experience upon which the reports are anchored needs to remain as stable and equivalent across cases as possible, and therefore degrees of severity or certain forms of interpretation should not impact on the score for the endorsement of the experience.

There is an unavoidable degree of overlap between different experiences, especially amongst the first rank symptoms. There is no precise way to divide up what is often a multifactorial experience: for example, separating out thought transmission or thought insertion from passivity, or reference experiences. There is also no way precisely to define the varying degrees of frequency or duration that determine the scores for each experience; individuals experience and express the ‘states’ in an infinite number of variations, degrees and combinations. The scoring guide is offered as a rough anchoring: all scores are relative to a degree, and should be adjusted as best reflects the degree to which the key criteria are met with particular reference to the ‘uncertain’ and ‘severe’ notes as indicators of the poles of the rating scale. While ratings should be possible on the basis of the information given at the start of the interview, in response to the probe questions, other information given in the remainder of the appraisals interview should be used to inform the scoring as well. It may occur that individuals have had experiences which fulfill criteria but did not recognise the experience described in the probe question.

In terms of the relationship of experiences to drug use, for the most part experiences which have been solely related to drug use should not be scored. However, if experiences began during drug use, and subsequently occurred without drug use, or if the experiences are not an expected concomitant of use of the particular substance, e.g. auditory hallucinations in the context of cannabis or LSD use, they should be rated. If experiences have only occurred during drug intoxication, and never at other times, they should not be rated even if severe.
A) SFRS:
1) Thought transmission:
This includes the spectrum of telepathy from sensing mental state to thought broadcast, but only comprising experiences of the experienc’s thoughts being transmitted out. The experience of seeing people react to your thoughts and wondering if they have picked up your thoughts, should be rated 2, 3, or 4, depending on frequency, as if there was full conviction; BUT should not be rated 5, which is reserved for full conviction of thought transmission.

2) Uncertain: description of thoughts occasionally being picked up in vague or non-verbal way e.g. more like the general mental state than specific, explicit thoughts.
3) Mild: Occasional experiences of specific ideas, words or thoughts being picked up by people in vicinity; frequent experiences of others receiving general mental state.
4) Moderate: Frequent but intermittent experiences of specific thoughts being read or picked up by others.
5) Severe: Very frequent or continuous experiences of specific thoughts being read or picked up by others.

2) Receptivity:
This category includes but is broader than the clinical category of thought insertion, since any kind of experience of ‘made’ thoughts, emotions or sensations, or someone else’s subjective experience being experienced as one’s own, is included. Therefore feeling emotions that are actually those of other people, or feeling other people’s pains are included, although only the experience of actual thought insertion (either ‘own’ thoughts inserted by external agent, or external agent’s thoughts) can be scored severe (5) or moderate (4). Relative scores should be based on the degree of specificity and determination: e.g. picking up general feelings of other people or having thoughts influenced by others scores 2 or 3; having specific thoughts inserted by others or completely experiencing another person’s thoughts and feelings scores 3, 4 or 5, depending on frequency and duration. Having thoughts or feelings put into the mind through other means, e.g. television, radio or mobile phone ‘waves’, should also be scored here.

2) Uncertain: description of occasionally picking up or being sensitive to other people’s general mental state, emotions, or somatic problems; ‘creative inspiration’ cited as an example of thoughts coming from external source (unclear or incomplete passivity)
3) Mild: Specific thoughts or feelings experienced as being those of other people, or ‘made’ by external agency (rarely, or with incomplete passivity i.e. influenced but not determined).
4) Moderate: specific experience(s) (thoughts, emotions, sensations) entirely dictated by someone else’s experience, or by some external agency (more frequently; with complete passivity).
5) Severe: as above, more frequent/continuous.

3) Thought withdrawal:
This category is based on the FRS of thought withdrawal, and the key definition is: disruptive interference in thinking, from outside, causing loss of thoughts. Therefore it is crucial to the definition of this category that there is an ‘interpretation’ of
external interference, in order to distinguish ‘thought blocking’, in which the thoughts stop and the mind suddenly goes blank, but there is no attribution of external influence. In other words, the central feature is the aspect of ‘passivity of thought’ (see also ‘receptivity’ and ‘thought transmission’), not just disruption of thought.

Relative scores should be based on intensity of interference, as well as frequency and duration. ‘Incomplete passivity’ refers to experiences of disturbance or disruption of thinking processes, without the complete sense of passivity found when thoughts are ‘removed’.

2) Uncertain: unclear description of other people’s mental activity unintentionally interfering with or distracting one’s thoughts.
3) Mild: occasional experience of interference from other people’s mental activity, with incomplete passivity.
4) Moderate: recurrent experiences of interference from other people’s or agency’s mental activity; or at least one experience of a thought being withdrawn/removed from the mind or completely stopped.
5) Severe: Very frequent or continuous experiences of interference from the mental activity of other people or agencies; recurrent experiences of thoughts being withdrawn/removed/stopped.

4) Controlled actions:
The important feature of experiences to be scored under this category is that actual physical movements must have been experienced at the time to have been subject to the control of some other force, be it another person or an invisible agent. The influence of someone on an action does not count unless there was a contemporaneous experience of external control.
2) Uncertain: where there is uncertainty e.g.about whether particular actions are automatic, or controlled by something external.
3) Mild: Particular actions being controlled or guided.
4) Moderate: As above, with greater frequency/intensity
5) Severe: As above, described as happening continuously for periods of time.

5) Passivity:
Experiences to be scored under this category include experiences of being guided or controlled externally in a general sense (across action/decisions in general), or behaving automatically (i.e. without a sense of external control), except for distinct controlled actions, which should be scored above. The principle feature is of disruption of will, rather than boundary. Therefore, receiving thoughts or emotions from elsewhere should be scored as ‘receptivity’, unless the thoughts are urges or motivations to act (impulses/volitions).
Rating should be based on frequency:
2) Uncertain: when it is unclear whether the description fits the criteria
3) Mild: occasional, intermittent incidences (less than once a month)
4) Moderate: more frequent intermittent incidences ( once a month to once a week; not continuously for more than half an hour)
5) Severe: continuous, or frequent (more than once a week) intermittent lasting longer than half an hour.

6) Reference experiences:
This category involves a spectrum of experiences, ranging from occasional ‘synchronicities’ or ‘serendipity’ to delusional perception and continuous referential thinking. Delusional perception, or the perception of symbolic meanings/messages is rated as being more severe than synchronicities in which there is no symbolism. Likewise perceived self-reference of events forms a continuum from occasional, transient perception of self-reference, to continuous, universal self-referentiality. Sometimes people may experience comments or events as being strangely familiar, and as standing out, or pertaining to them in some way because of this, rather than having any clear meaning or specifically reflecting their own thoughts.

2) Uncertain: descriptions of very general or broad synchronicities but no real delusional perception or referential thinking.
3) Mild: descriptions of frequent synchronicities, including some delusional perception, symbolic meaning or significant hints; words heard or seen reflect thoughts in striking way. 4) Moderate: as above; including self-reference of events or things people say.
5) Severe: delusional perception, extended periods of reference experiences.

7) Activity experiences:
Experiences of deliberately or unintentionally causing events to occur with the mind. The subject must believe, or have believed, that the event was linked to their mental activity. The timescale of the causation can be short or immediate (i.e. watching an event happen and feeling as though it depended on or was caused by your own thoughts/intentions) or longer term (i.e. thinking about or hoping for something, and then some time later finding that the event in question has occurred). More nebulous experiences of the causal efficacy of mental events without identifiable effects should be rated here if prevalent (and also rated as A1 Thought Transmission, if appropriate).

2) Uncertain: where the subject is not sure whether they caused something
3) Mild: occasional experiences of causation, or thought occurring without conviction that there has been causation.
4) Moderate: more regular or frequent experiences
5) Severe: very frequent or continuous experiences.

8) Loud thoughts:
The key feature is that the person must have noticed a subjective increase or change in the ‘auditory’ or ‘phonological’ quality of their thoughts. It is to be assumed that there is a continuum of ‘articulatedness’ to thoughts that is distributed across the population. If the individual is clear that they have always been able to ‘hear’ their thoughts, they should be scored 2, or 3 if it is sometimes intrusive or more noticeable. If the individual has noticed an increase in the ‘phonological’ quality of their thoughts during certain time periods, this should be scored 3-5 depending on the frequency.

2) Uncertain: Where it is not clear whether the experience represents a change, or it is not clear whether the thoughts are egodystonic rather than more articulated.
3) Mild: Experience has been subjectively noticed, occasionally
4) Moderate: Experience has been noticed, frequently but not continuously.
5) Severe: has occurred continuously for a period of time.
9) Voice experiences:
Any experience of voices speaking, music playing, or other distinct sounds should be rated here.

2) Uncertain: descriptions of borderline cases e.g. imagining what people might be thinking, almost being like hearing them. Hypnogogic or hypnopompic voice experiences. Unusual sounds such as whistles, hums, clicks etc. when persistent. External sounds seeming like words being spoken (rate as 3 if frequent and noticeable).
3) Mild: any experience of voices or music in clear consciousness.
4) Moderate: as above, greater frequency.
5) Severe: as above, more continuously.

B) Anomalous perception:
As a rule of thumb for the perceptual abnormalities, it should be established whether the individual has subjectively noticed a change at any point. In other words, if someone endorses auditory anomalies, oversensitivity or language disturbance, for example, and upon further probing (‘Has this happened more than once?’; ‘How long does it last for?’ etc.) says something along the lines of ‘I’ve always been like that’, or ‘I have very sensitive hearing’, then it is likely (although not necessary) that they do not meet criteria. They should be pressed upon whether there have been any periods in which they have noticed a change.

1) Depersonalisation:
The experience to be rated here is of being detached from oneself, so that it is as if watching oneself behave, or hearing oneself talk when speaking. In order to distinguish this from normal states of daydreaming, there should be a sense that this state is not under conscious control. Individuals may also report meditation or trance experiences in response to this question: it should be established how long the experience persists for, and the degree to which it is a direct experience rather than an intellectual perspective.

2) Uncertain: if it is unclear whether the experience is subject to conscious control or not. Frequent experiences like ‘daydreaming’ which are subjectively intrusive.
3) Mild: Brief occurrences of d.p., lasting no longer than a few hours.
4) Moderate: Longer periods e.g. a day or two, or more frequent intermittent occurrences
5) Severe: Longer periods e.g. weeks; frequent longer occurrences.

2) Derealisation:
‘It looked like um…less…like, something different to what I expected…’ [No.25]
‘It’s more as if I’m in the wrong relation to the world around me, out of kilter, and everything is just more …ethereal… brighter somehow’
‘I wasn’t really that concerned about the world, and it just seemed like a bit like Disneyland really, kind of magical, it was kind of… it was without its normal mundane attributes; it just was what it was… it didn’t necessarily make any sense, but – there it was!’ [No: 17]
‘..I have had the feeling that it was in some way staged; as though it was like…a
Theatre in some way’ [No. 35]
The category of ‘derealisation’ overlaps with the category of ‘delusional mood’, defined as a sense of something strange, different or wrong with the world and events in it. However, delusional mood may not necessarily entail a change in the describable appearance of the world or events, for example the sense that things are not so ‘real’. Delusional mood without any describable changes in the appearance of the world should still be scored in this category, but only d.m. with concomitant derealisation should be scored 4 or 5, depending on frequency.

2) Uncertain: Not clear whether the experience meets criteria; not clear whether it was an intellectual attitude, or a genuine experience of delusional mood.
3) Mild: Brief or passing moments of delusional mood/derealisation
4) Moderate: Must endure for at least a day.
5) Severe: D.M. has endured for several days continuously.

3) Visual anomalies (global):
Due to the nature of this experience, sometimes it may not be clear whether the person is reporting an ‘anomalous’ or ‘ordinary’ experience: e.g. a person may report experiencing changes in their perception linked to changes in mood, or feeling ill or tired. Any experience in which the change is ‘noticed’, at the time, should be rated, irrespective of the interpretation given. The severity should be judged on the basis of frequency and duration, as well as whether there are multiple anomalies or just a single kind, out of the different aspects probed.

2) Uncertain: unclear whether the changes are subjectively striking at the time of their occurrence.
3) Mild: brief or intermittent experiences of visual anomalies, or increased sensitivity to light without other abnormalities.
4) Moderate: regular or longer periods of visual anomalies including changes other than increased sensitivity to light.
5) Severe: frequent or continuous experiences of marked visual anomalies as (4)

4) Visual anomalies (hallucinations):
2) Uncertain: if it is not clear whether the ‘vision’ is seen ‘in the mind’s eye’, e.g. with eyes closed, or if it is seen in external space.
3) Mild: if the subject describes a degree of input from his/her own imagination to ‘see’ the vision; if the vision is fleeting or insubstantial; must be in external space.
4) Moderate: must be without conscious control; must be present for more than a moment.
5) Severe: more frequent; longer duration.

5) Auditory anomalies:
Includes increased intrusiveness of sounds, distortion of sounds, sounds seeming like words, and deficits in the ability to locate or selectively attend to sound.

2) Uncertain: if the subject describes sounds being intrusive or other changes only when very tired, or physically ill.
3) Mild: sounds noticeably more intrusive or distorted; changes in tone of sounds that is linked to other perceptual features; sounds seem like words being spoken (also rate as ‘voice experiences’ – 2/3)
4) Moderate: more frequent
5) Severe: more frequent/continuous for periods

6) Oversensitivity:
This is similar to the previous categories of global visual anomalies and auditory anomalies, but the key feature is the subjective experience of having a ‘thinner skin’, i.e. the perceptual changes are such that the person feels oversensitised. People may report isolating themselves to reduce stimulation, or finding sounds, light etc. intrusive, painful or overstimulating. It is not necessary for the subject to have been overwhelmed by the sensory input, but it is necessary for there to be an element of subjectively ‘heightened’ sensation.

2) Uncertain: if it is unclear whether there was a subjectively noticed change at some period.
3) Mild: brief intermittent periods – lasting no longer than a few hours.
4) Moderate: More frequent; longer periods of time (e.g. a few days)
5) Severe: Very frequent or continuous periods.

7) Somatic anomalies:
This category rates unusual sensations in the body or head, including pressure, rotation, heat/cold, electrical sensations, vibration, reversed lateralisation (e.g. left/right feel as though they have been swapped), pain. More ‘ordinary’ sensations experienced as having been caused by external agents (somatic passivity), should be scored as 2 only and should additionally be rated as A2 (Receptivity), if appropriate.

2) Uncertain: if the sensation is of the normal range of feelings, (e.g. small itches or aches, tingles, emotional feelings) and the subject attributes it to something external or unusual
3) Mild: if the sensation is unusual in itself, e.g. pressure, heat, pain, something touching, entering or passing through the body.
4) Moderate: more frequent; longer duration
5) Severe: more frequent; continuous or extended duration

8) Lost automatic skills:
This category rates the experience of a change in the ability to carry out well-known tasks automatically and without deliberate deployment of attention. The experience may also be linked to a difficulty in dividing attention, or changes in memory.

2) Uncertain: if it is not clear whether it is anomalous e.g. only occurs in the context of extreme fatigue.
3) Mild: occasional, brief periods
4) Moderate: frequent but intermittent; longer periods
5) Severe: continuous for more than a day, on more than one occasion.

8b) Dividing attention deficit:
This category rates the experience of difficulty in dealing with demands involving more than one sense, e.g. difficulty cooking and talking at the same time, or doing any two things at once.

9) Language disturbance:
This category rates the experience of a change in the comprehension of spoken (or written) language such that it becomes difficult to grasp the meaning of a sentence, although the component words have been heard. This is not the same as finding it difficult to hear speech in a noisy environment. People may also report deliberately not attending to the intended meaning of speech, but attending to some other characteristic or underlying meaning. Unless this happens frequently and does not appear to be fully within the individual’s volition, this should not be rated in this category.

2) Uncertain: if it is not clear whether the experience is due to a lack of attention to the intended meaning of the language.
3) Mild: happens intermittently or occasionally.
4) Moderate: happens regularly or for longer periods
5) Severe: happens frequently or continuously.

9b) Concretism:
This category rates the experience of noticing oneself misunderstanding what people say because metaphors or expressions are being taken literally instead of in the way intended. This must have occurred noticeably more often than one would imagine, or alternatively as an enduring trait that has drawn comment.

2) Uncertain: if it is not clear whether the experience has been subjectively noticed or whether it is happening significantly more often than might be expected.
3) Mild: happens a little but has been subjectively noticed or happens frequently but is an enduring trait.
4) Moderate: happens regularly but not constantly and represents a change.
5) Severe: happens constantly

10) Olfactory anomalies:
This category rates the experience of unusual smells, in the absence of any clear source.
2) Uncertain: if it is not clear whether the smell was objectively present i.e. individual is more sensitive to it.
3) Mild: if it has occurred clearly on one or two isolated occasions, lasting no longer than one hour
4) Moderate: if it has occurred more frequently; for longer than one hour on a few occasions
5) Severe: if is has occurred repeatedly, or continuously for more than a day.

C Anomalous cognition:
1) Distractability:
In order to distinguish ‘ordinary’ distractability, the experience should be one of either being unable to focus or concentrate, for an extended period of time, because of increased distractability, or subjectively noticing extreme distractability because of the incapacity it causes in terms of making work harder, etc. Distractability that is secondary to other experiences, e.g. voices, should be scored 2. Being in a state in which no attempt is made to control attention should not be scored here, unless it is an extended state and cannot be avoided.

2) Uncertain: if it is not clear whether the experience is subjectively noticed at the
time of occurrence (e.g.)
3) Mild: brief, intermittent occurrences (lasting less than a day)
4) Moderate: more frequent occurrences, or rare occurrences lasting more than a day.
5) Severe: continuous or very frequent intermittent experiences.

1b) Intrusive thoughts:
This category rates the experience of cognitions that intrude upon and disturb the individual’s train of thought. They should be irrelevant to the topic of thought at the time, and not emotionally meaningful (to distinguish from rumination), and should be subjectively noticed as interfering with thinking. Rating as above.

1c) Loss of thoughts:
This category rates the experience of thoughts stopping, fading away, or the train of thought being lost. This must have been subjectively noticed, and should be reported as happening more than would be expected in some period of time. Rating as above.

1d) Visual fixation:
This category rates the experience of a domination of the visual field by a random single aspect of it: e.g. the individual finds themselves looking at something which seems to stand out from the rest of the environment, and finds it difficult to take the attention away from that thing. Rating as above.

2) Time Distortion:
The key feature of this category is a subjective alteration in the sense of time. This may be experienced as a speeding or slowing of time, either internally or externally, or a disappearance of the sense of time, or a cooccurrence of past/present/future. This may be related to the experience of the loss of the sense of the past (e.g. in memory changes), or future (e.g. no sense of forward planning), especially in its clearest forms. Care should be taken to establish whether an endorsement of this experience reflects an actual experience of an alteration in the sense of time, rather than an intellectual perspective on time.

2) Uncertain: when it is unclear whether the experience was primarily an intellectual perspective on the nature of time
3) Mild: when the experience has occurred rarely for more than an hour, or occasionally and lasted for less than an hour
4) Moderate: the experience has lasted for more than an hour and less than a day; has occurred occasionally
5) Severe: when the experience has lasted for at least one day

3) Disorientation:
This category rates spatial disorientation that represents a change from the individual’s normal sense of direction. Particularly relevant are experiences of disorientation in places that are normally well known to the individual. Experiences of disorientation when using tubes or buses should also be rated here if they share the characteristics above.

2) Uncertain: when it is unclear whether the disorientation is ‘normal’ (e.g. poor sense of direction) or whether it is ‘justified’ (e.g. place not well known).
3) Mild: occasional brief experiences of spatial disorientation
4) Moderate: regular or longer periods
5) Severe: frequent or continuous.

4) Insight Experiences:
The key feature of this category of cognitive anomaly is the sense of revelation or insight that accompanies the experience. The content of the experience is not central, although cognitions of this quality frequently concern fundamentals, such as the nature of reality, the functioning of society, the nature of the self; however ‘insight experiences’ may also occur regarding more mundane underlying principles.
E.g. of verbatim response: “I do have like quantum leaps of understanding, which I kind of – I feel that I understand, like I understand the base of how the world is functioning.” Rating should be based on the density of occurrence of thoughts with this quality: see below.

2) Uncertain: when it is not clear whether the person has experienced a sense of ‘revelation’, from their report of having insights
3) Mild: brief or intermittent incidence of insights with a sense of revelation or truth
4) Moderate: more frequent occurrences of insights, esp. periods of time with many insights
5) Severe: periods of time marked by continuous insights or revelations.

5) Thought pressure:
This category rates the experience of an increased rate of ideas or thoughts coming to the mind. There may or may not be a sense of decreased control of thoughts, but the increase in rate must be subjectively noticed at the time of the experience.

2) Uncertain: when it is not clear whether the person subjectively noticed an increased rate of thoughts at the time
3) Mild: brief, rare occurrences of increased rate and number of thoughts
4) Moderate: frequent, or more extended periods e.g. for more than one day
5) Severe: frequent or continuous periods e.g. for more than one week.

6) Mission Experiences:
The key feature of this category is a sense of compulsion or inescapable duty, which distinguishes the related but less intense experience of the feeling of vocation from the ‘mission’ experience. The experience of receiving a ‘mission’ might occur once, or repeatedly, and the content of the ‘mission’ might be a life-long vocation, or some more short term duty. However compulsions that have little or no inherent meaning and which border on obsessive-compulsive symptomatology (i.e. egodystonic) should be rated 2 at most.
2) Uncertain: when it is not clear whether the quality of compulsion is present within a sense of vocation
3) Mild: a single occurrence of the reception of a ‘mission’
4) Moderate: repeated occurrences of the reception of a ‘mission’
5) Severe: frequent ‘mission’ experiences

D – Anomalous Affect:
This area is the least specific and therefore care needs to be taken not to rate positively responses which may not represent particular abnormal states. In order to
attempt to distinguish ‘normal’ from anomalous affect, a good rule of thumb is to rule out affective experiences which are explained by or related to ordinary events or social interactions. For example, if someone endorses ‘mixed/unknown emotions’, and, in response to further probes, states that this has occurred only at relationship break-ups, or during major life changes, then this should be rated 1 or 2. If, on the other hand, the participant reports these affects as being *subjectively noticed, striking and not clearly related to major life or interpersonal events*, then they should be scored positively. Obviously, this is not a clear distinction, since major life or interpersonal events may well be implicated in abnormal affective experiences as well as ‘normal’ ones, and detailed probing and some clinical judgement will have to be applied. Particular care should be taken with the item ‘Loss of emotions’ to determine whether the onset may be related to antipsychotic medication. If this seems to be the case, it should be rated 2, or 3 at most if it is severe and not clear that it may not be related to (postpsychotic) depression.

1) **Spiritual elation:**
This category is called ‘spiritual elation’ to try to distinguish the experience from excitement, happiness, or elation with an anxious component. The key features are: a feeling of lightness, of elation that goes *beyond* excitement in response to a rewarding event, and this qualitative difference should be subjectively noticed. The experience is more specific than a general ‘mania high’: i.e. some *but not all* ‘mania high’s meet the criteria for this category. The experience need not be interpreted as ‘spiritual’ by the interviewee, though it often is. It need not be accompanied by other feelings/experiences, though frequently a sense of peace, increased compassion, a sense of unity with all creation or nature, freedom from burdens or anxiety and having a ‘fresh start’, or having been ‘cleansed’ are described.

2) Uncertain: It is not clear whether the experience is of happiness or reward, or something qualitatively different.
3) Mild: The experience is described as having lasted for no more than an hour
4) Moderate: The experience is described as having lasted for over an hour, no more than a day/ more than one occasion
5) Severe: The experience is described as lasting for more than one day / more than one occasion

2) **Monitored:**
The key feature of this experience is the sense of being monitored or watched *covertly*, or having some kind of ‘invisible audience’ to one’s actions and/or thoughts. This should be distinguished from self-reference experiences in which actual people or events are interpreted as overtly monitoring or watching the individual, though there is frequently a degree of overlap.

2) Uncertain: It is not clear whether the sense of being monitored extends beyond *overt* watching (i.e. reference experiences); subject describes the *belief* that they are watched e.g. by God, without describing the *sense, or experience* of being watched.
3) Mild: Infrequent or unintrusive sense of being watched or monitored
4) Moderate: Stronger or more frequent sense of being monitored
5) Severe: Experience is very frequent or continuous during a period of time.

3) **Doom:**
This category rates the sense of doom or impending catastrophe without a clear reason. A sense of dissolution or ‘negation’ should be rated here as well as panic or anxiety, if it is elicited by the probe describing it as a sense of ‘doom’.

2) Uncertain: It is not clear whether the experience is of ordinary anxiety in response to an event, or whether it represents a distinct anomalous experience.
3) Mild: Occasional experience of sense of doom
4) Moderate: Regular or more extended periods
5) Severe: Frequent or continuous

4) Mixed/unknown emotions:
The key feature of this experience is of a subjective change in the quality of emotions felt, such that they are unidentifiable. This could be experienced as several different emotions co-occurring so that they are indistinguishable, or as a change in the quality of emotions in general, so that they are all experienced as equally intense or unpleasant (usually). Although this experience may be associated with adverse events, it should be noticed at the time of occurrence as unusual, and not simply a natural and normal response to difficult circumstances. This experience may be endorsed by females as occurring premenstrually; in this case it should be rated 2 or 3 if severe.

2) Uncertain: It is not clear whether it represents a self-experienced anomaly, or an idiosyncratic response to circumstances e.g. is reported to occur only at times of relationship difficulties.
3) Mild: Anomaly noticed occasionally/for brief periods.
4) Moderate: Anomaly noticed regularly/for longer periods (> one day)
5) Severe: Anomaly noticed frequently or continuously (> 3 days)

5) Emotional reactivity:
The key feature of this experience is a subjectively noticed change in emotional sensitivity or responsiveness. As with the other experiences defined above, care must be taken to establish the relative ‘normality’ of experiences for the individual concerned, i.e. whether it always has occurred in certain circumstances or represents a change. Rating as above.

6) Loss of emotions:
This experience may be related to or experienced as depression. It is more specific than depressed affect, as the key feature is the total loss of feeling, numbness, or a sense of detachment or unreality of emotions. It is important to establish the likelihood that this is related to antipsychotic medication in the case of psychiatric subjects (by establishing the timing of the experience), or whether it appears to be a primary experience. It will not be possible to make a clear judgment in this sense, but score should be adjusted down if it appears likely that antipsychotics play a role.

2) Uncertain: It is not clear whether the experience is solely due to antipsychotic medication
3) Mild: The experience does not last for longer than a few hours
4) Moderate: The experience is extended for several days
5) Severe: The experience extends for several weeks.
E – Paranormal:

1) Precognition:
This category includes experiences of precognition over any timescale: e.g. instantaneous precognition, or over several weeks/years. It may or may not be related by the individual to activity experiences (if it is it should be rated in both categories). Precognitive dreams should also be rated in this category. Experiences which verge on déjà vu, e.g. when there is a sense of ‘I’ve experienced this before’ or ‘I knew this would happen’ but when the earlier precognitive event cannot be located in time, should be scored 2. Extended experiences of instantaneous precognition, similar to déjà vu, should be scored 3, 4 or 5 depending on frequency.

2) Uncertain: Individual is unsure whether their experience was of precognition or whether they made an ‘educated guess’ or prediction; description of déjà vu lasting no longer than a moment.

3) Mild: Individual has had isolated occurrences of this kind of experience; experiences of e.g. thinking of someone before meeting them in the street that day.

4) Moderate: Individual has either had multiple and noticeable occurrences of this kind of experience, or an extended period (more than a few moments) of ‘instantaneous’ precognition.

5) Severe: Individual has had extended periods of time with multiple occurrences of ‘delayed’ or ‘instantaneous’ precognition.

2) Out of Body Experiences:
This category is specific to the kind of experience in which the person can actually see their own body from the outside. ‘Astral travel’ will also fit this category,

2) Uncertain: It is unclear whether the individual was asleep/dreaming, or whether the experience was closer to depersonalisation.

3) Mild: OBE has occurred once; or several times but very briefly.

4) Moderate: OBE has occurred on several occasions.

5) Severe: OBE has occurred on multiple occasions.

F – Anomalous Individuation

1) Loss of boundary:
Only an experience of boundarylessness counts, not merely an intellectual appreciation. A description of the experience should be elicited, in order to assess whether or not this is the case. Features to look out for include: a prolonged and marked altered state in which the individual directly experiences themselves purely as a part of a greater whole; experiences in which events or actions on objects near to the person are experienced as if occurring to the person e.g. noises or impacts in the extrapersonal space are sensated as if somehow penetrating the person, or the person reports the experience of their ‘self’ extending in space beyond their physical body. Psychological or emotional loss of boundary with other people should be rated as A1, A2, A3, A5 or A6, as appropriate, though there may be some overlap with this category.

2) Uncertain: It is not clear whether the person is reporting an intellectual appreciation or a primary experience.
3) Mild: The experience has occurred rarely (once or twice) or briefly (less than one hour)
4) Moderate: The experience has occurred more frequently or for longer than an hour
5) Severe: The experience has occurred on many occasions or continuously for longer than a day.

2) Subjective Isolation:

The key criterion of this category is the subjective sense of isolation from others, and the world, not just intellectually, but tangibly. This may be described as a sense of a ‘barrier’ between the self and the world, as being in a different ‘dimension’ or ‘world’, or in terms of a loss of connection or normal relation to others/the world. This may or may not occur in relation to depersonalisation; if criteria for dp and s.i. are met, both categories should be rated. If the individual reports that this is a ‘normal’ state for them, or that they’ve always felt like this, it should be rated 2/3.

2) Uncertain: It is not clear whether the person is reporting an intellectual or primary experience.
3) Mild: The experience has occurred rarely or briefly (for no more than a day)
4) Moderate: The experience has occurred several times or once for more than a day.
5) Severe: The experience has occurred on many occasions or for periods of several days.
Appendix H

AANEX-CAR Scoring Guide

General Information

Scores should be allocated on the basis of the individual’s response to each specific question. However, these scores should be revised on the basis of other comments the individual makes in response to other questions, where they contribute additional information. In this way, the final set of scores should reflect as far as possible the multiple attitudes and inconsistencies that are found more often than not in an individual’s account:

- where there are multiple categories, all aspects of the response can be rated concurrently.
- where there is only one score for a specific question, the score appropriate to the explicit answer given can be moderated by the other relevant comments the individual has made.
- however, if the individual gives no appropriate response to, or appears to have misunderstood the probe question, the score must be omitted.

Verbatim notes can be made in the spaces provided while conducting the interview, and Y/N options can be circled for ease of administration and recall. Amendments to scores should be made during the course of scoring subsequent sections, where necessary.

A) Context: Situation and Feelings

The probe for this section is open, and any response which fulfills criteria as defined below should be rated. Specific categories should not be probed, although clarification can be sought.

2 = criteria are met
1 = criteria met but in a minor way, or it is not fully clear that they are met.
0 = criteria not mentioned at all

Situation:

Significant Change: Events that involve significant change of lifestyle: e.g. change of house/living situation; change of job; leaving school/home; starting university; meeting new social group.
Social Isolation: Events that involve leaving ordinary social milieu: e.g. foreign travel; moving alone to new city; or marked isolation i.e. living alone with no social contacts.
Crisis/Impasse: Events that involve serious disruption to, or threat to valued life structures; events giving ‘no way out’: e.g. incidents of death or loss, or serious illness, or threat of same; multiple negative events leading to loss of coping options.
Drug Use: Regular use of illicit drugs around and before the onset of the experience. Irregular or infrequent drug use should be scored 1 or 0, unless specifically implicated in the description of the experience.
From childhood…: Experiences have their onset in childhood (<12yrs)
Trauma: Events that involve damage to the individual, or significant others: e.g. attack, injury or accident to self or child/partner/1st deg. relative. Distinguished from ‘crisis/impasse’ by the availability of coping options being preserved.
Rel/Spir. practice: Regular use of religious or spiritual practices commencing around and before the onset of the experience, e.g. meditation, prayer, attending services, yoga, mantra/chanting, contemplation etc.
Cultural context: When a (possibly new) social contact or group encourages or supports endorsement of anomalous experiences.

Feelings:

The criteria for the different feelings should be self-evident. Rate 0 if not mentioned, 1 if mentioned but seems minor, 2 if mentioned as a/the dominant emotion during that period.

B) Framework of Interpretation:

Rate all categories that are relevant i.e. the categories are not mutually exclusive, and people often
have mixed views. Each category can be scored:

0 = no
1 = perhaps
2 = yes with regards to how far the individual’s interpretation/s fit the following categories:

**Biological:**
For interpretations in terms of illness, disorder, or any *material, internal* attribution of cause: e.g. ‘something wrong’; ‘my neurological system’; ‘my brain unbalancing’

**Psychological:**
For interpretations in terms of mental processes, or any *nonmaterial, internal* attribution of cause, with the exclusion of spiritual or religious processes: e.g. ‘It’s to do with me detaching from that situation’; ‘it’s just a mindfuck I got into’; ‘It’s my mind playing tricks on me’

**Drug related:**
For interpretations that cite the use of drugs as being relevant: e.g. ‘It might be to do with my having taken so many drugs over the last 7 years’; ‘I think having those experiences on drugs made me more likely to see these things’

**Spiritual:**
For interpretations in terms of *spiritual or religious processes*, where the experiences are seen as having an intrinsic spiritual value of some kind*: e.g. ‘It was an awakening experience’;

**Supernatural:**
For interpretations in terms of *non-material entities or forces*: e.g. ‘I could feel the hands of invisible beings on my back’

**Normalising:**
For interpretations in terms of the *normal, natural range of human capacities, experiences or processes*. e.g. ‘I just thought they were like episodes of ESP …you know…’cos probably in our lifetime we have quite a few of those…so it’s no big deal, everybody probably has…’

**Other people:**
For interpretations in terms of other people causing the experiences/ i.e. paranoid/conspiracy interpretations

**No interpretation:**
When no interpretation is offered at all, or the person says: ‘I didn’t know’ or ‘I wasn’t sure what it was’.

*nb: where ‘spiritual’ is defined as: transcending material reality; to do with some higher order or force; to do with the search for meaning in life or self -actualization ,

**Valence:**
These scores should be derived from the information given in response to the ‘Framework of Interpretation’ probes, and the specific probes.

**Positive/Negative:**
Does the person view the experience(s) as beneficial, or negative?
5 = strongly positive;
4 = slightly positive;
3 = balance of positive/negative or neutral;
2 = slightly negative;
1 = strongly negative

**Dangerous/Harmless:**
Does the person view the experience(s) as *potentially or actually* dangerous or harmless?
5 = definitely dangerous or harmful;
4 = slightly dangerous or harmful;
3 = neutral or balance of harm/harmlessness;
2 = almost completely harmless;
1 = completely harmless

**Internal/External:**
Does the person view the experience(s) as essentially having been caused by something internal i.e. changes within them, or something external i.e. changes outside of them? NB This will frequently be a *mixture* of internal/external factors: e.g. Voice/idea of reference may be attributed to a real external source, but the individual simultaneously believes that the *onset* of the experiences is due to some internal change.
5 = source of experience and source of change external to the self
4 = source external but some relevant internal aspects
3 = balance of internal and external factors
2 = predominantly due to internal factors but with some external source
1 = entirely due to internal factors.

Person/Impersonal:
Does the person view the experience(s) as having been caused by some person or agency, known or unknown, or by some impersonal process or factors? NB even if the attribution is internal, if the individual feels that the experience(s) was caused by personal decisions, or in other words, their own conscious agency, then this counts as a personal factor. ‘Agency’ includes visible and invisible conscious entities, e.g. spirits, God etc.

5 = source entirely personal
4 = source predominantly personal but with some impersonal aspect
3 = balance of personal (agential) and impersonal factors
2 = source predominantly impersonal but with some agential aspect
1 = source entirely impersonal

C) Emotional and behavioural response:

i) Emotional response:
All emotions described as occurring in response to the experiences should be noted verbatim under the relevant categories. Then, each category is rated from 1 to 5 as specified below.

- Care should be taken to rate emotional responses only, not intellectual positive/negative responses.
- Care should also be taken to rate only emotions that are actually responses to the experiences, rather than emotions that were occurring in general at that time.
- Where the individual describes different emotional responses to the experience(s) on different occasions, in different contexts, or when a category of experience has varying content, all the various emotional responses reported in the time period under analysis should be scored concurrently.

Neutral arousal:
This is rated on the basis of probes enquiring about surprise, puzzlement and curiosity, and indicates the degree of ‘uninterpreted’ arousal, or ‘orientation to the event’. As this interacts with the ‘interpreted arousal’ reflected by positive or negative feelings, the following should be used carefully to guide rating:
1 = no surprise, puzzlement or curiosity,
2 = some degree of any of the above (relatively low arousal/orientation)
3 = higher degree of one of the above in the absence of the others. (higher orientation)
4 = higher degree of all of the above (high orientation/arousal) plus score on neg/pos emotions, or ‘unengaged’
5 = only uninterpreted arousal and orientation reported.

Negative:
This is rated on the basis of probes enquiring about bad feelings, worries or fears pertaining to the experience, and other comments.
1 = no bad feelings
2 = small mention of any negative feeling
3 = definite degree of negative feelings
4 = high degree of negative feelings
5 = only negative feelings reported.

Positive:
This is rated on the basis of probes enquiring about ‘good feelings’ pertaining to the experience, and other comments.
1 = no good feelings
2 = small mention of any ‘good’ feeling
3 = definite degree of ‘good’ feelings
c)ii) Initial response:

This section rates the cognitive and behavioural response of the individual to the experience.

NB: Information elicited by other sections of the interview (e.g. Control) can inform the rating of this section, and therefore the original scores for the probed responses should be amended wherever necessary, as additional information is given.

The following rating categories are suggestions: however, the two categories ‘Rumination’ and ‘Neutral response’ did not achieve satisfactory inter-rater reliability scores in the validation study. You may wish to record participants’ responses verbatim, and subsequently devise your own categorisation of responses.

Information for the scoring of the suggested categories is given below:

Make verbatim notes in space provided. Tick any responses in the list that are mentioned, then allocate a score out of 5 for each of the 6 categories to reflect the main characteristics of the participant’s response:

1 = No responses of this kind mentioned
2 = Minimal degree of this kind of response
3 = Moderate degree of this kind of response
4 = Predominant kind of response
5 = Only responses of this kind mentioned. (Only one category should be scored 5, if all others are scored 1)

NB the categories are NOT mutually exclusive, and most individuals will describe responses fulfilling several of the categories to various degrees.

Avoidance: Any response which involves (i) turning the attention away from the event, and towards some other activity, e.g. talking to someone about some other subject, or concentrating on a task; or (ii) actively trying to normalise one’s experience through altering environment, arousal or neurophysiology. This is for active behavioural responses of an avoidant kind.

Self-statement/Cognitive Control: any response which involves a cognitive check, such as self-statements, trying to control thoughts, or deliberately reframing the experience in another way. This is for active cognitive responses of an avoidant kind. NB: ‘Reinterpretation/reframing’ differs from ‘Reality testing’ in that it is a purely internal cognitive adjustment rather than involving attempts to corroborate or check with external events.

Reappraisal: any response which (i) involves keeping or returning the attention on the event or within the frame of reference engendered by the event, e.g. mentioning the event to someone else, mulling over its meaning, trying to establish its veracity; and (ii) the subject’s description indicates that ‘decentering’ ability (secondary appraisal) was preserved.

Rumination: a response which (i) involves intellectual exploration of the meaning or implications of the event, either voluntarily or involuntarily; and (ii) is within the frame of reference engendered by the event as initially interpreted (lack of secondary appraisal).

Immersion: for any active response that is completely congruent with the initial interpretation or experience of the event: either in terms of speech or behaviour, some kind of mental resistance to the event or perceived cause of the event, or encouragement or pursuit of the event. Resistance in this category is distinguished from Avoidance by the attention remaining on the event, and a lack of secondary appraisal. Particularly if the participant’s experience consists of anomalous cognition, or if the immediate interpretation is accepted without subsequent question (‘lack of insight’), the participant may not be able to give a particular ‘response’ that is not a natural extension of the event itself, as they experienced it. Responses of this quality should be scored in this category.
Neutral response: any response in which the person neither avoids nor pursues, nor intellectually explores the experience, and thereby there is little disruption to thought or behaviour. This category does include responses of enjoying or sharing the experience where none of the elements above are present. In this case, it is differentiated from ‘Immersion’ by the absence of any specific interpretation or elaboration of the experience.

To aid scoring, some verbatim examples and scores are given below (n.b. rating in the context of the entire interview is easier than on the basis of excerpts as below):

“I usually just...don’t. I just go, whoa, what was that? And often, usually, if I hear a voice that isn’t there, it’s very brief and I don’t make much of it and just forget about it straightaway, oh like, that was weird, and that’s it. [what do you do?] nothing.”

IR score: Avoidance 1
cog Control 1
appraisal 2
Rumination 1
immersion 1
neutral 4

“I like it…I don’t really...look for any, erm, meaning in it. I just go, oh that’s funny! Sometimes, it depends what it is, sometimes it’s like, wow! [do anything in particular] no, I don’t think so...sometimes I tell people about it.”

IR score: Avoidance 1
cog Control 1
appraisal 1
Rumination 1
immersion 1
neutral 5

“I might think, this is good, how do I keep this going? might start thinking about it, trying to follow whatever impulse I have to do next, but the point of that is, this is good how do I keep this going? but that’s not very productive, it’s likely to make it go away.”

IR score: Avoidance 1
cog Control 1
appraisal 1
Rumination 3
immersion 3
neutral 1

“I think that I was thinking that it was… that it was just me being paranoid, and that it wasn’t actually...it wouldn’t really be happening... [do anything?] no, but I think it did take me a while to get out of thinking like that...I was trying hard, but I wasn’t...[kept on having those thoughts?] yeah yeah.”

IR score: Avoidance 1
cog Control 4
appraisal 3
Rumination 1
immersion 1
neutral 1

“Just, I feel like I...kind of like them to stop, I just want to sort it out, and kind of...I just try to ignore them I suppose really. [do anything] No. [not actively try to focus on something else?] no, I don’t know, I don’t really know what to focus on ...it’s there and some things break through it, and some things don’t, but I can’t really control what does and doesn’t, it’s just...”
“I’d think I’m useless. [why?] because I couldn’t stop the voices. [in response to A1?] it’s intrusive. [what would you do? A9, or A1?] Try and ignore them.”

“Erm well all my thoughts were completely self obsessed and narcissistic. I don’t think I thought about the world around because I was so detached I just couldn’t engage with it, all my thoughts were about me. [other responses] yes, the best things I ever did, was trying to make some kind of concrete engagement with the world, like doing the dishes or gardening or reading physics, it was about real things in the real world, and made me feel part of it again.”

“I thought: Am I going crazy? wow that’s beautiful, I was very happy. [did you do anything?] yeah, I went to knock the trees to see if they were physical. Observed what was going on.”

“I just…don’t think anything, I just think don’t be silly now, it’s not true. Or I’ll just be saying, I told you so, to myself. Like…most of the time, I think it’s just me being stupid, very stupid, or paranoid. [might check] yes, it’s ridiculous really. [are there times when you get carried along by it and don’t question it until later?] yeah, yeah, definitely. Yeah I don’t weight it up until way, until the next day, two days. [what proportion?] I carried along with it sometimes. [most of the time?] yeah, most of the time.”

D) Context and implications of appraisal:

i) Self esteem
The very direct prompt question for this factor may be threatening to some participants. In this situation, additional questions may be necessary, to elicit as sensitively as possible any positive or negative feelings which might raise or lower self esteem. Clues with regards to this factor may be picked up from incidental comments made at other points in the interview, and these can be used to aid scoring, or incorporated into prompts to corroborate the scoring.

ii) Social support/understanding

This factor should reflect the degree to which the individual had access to sympathetic other people to whom they felt they could talk about their experiences explicitly. Scoring of this factor of ‘sympathetic others’ depends on the extent to which the people understood and/or had had similar experiences themselves. It is not necessary for the majority of a social group to give support or understanding; a minimum of at least 1 individual available to the person is sufficient to constitute ‘social support’.

1) def. keep quiet the person felt that they should not mention their experiences to anyone
2) best to keep quiet the person felt it might be best not to mention their experiences, though it was not urgent as in (1)
3) unsure the person may have mentioned something about their experiences to some people, to test the response; may have been unsure whether others ‘understood’; may have felt that others would understand, but had no desire to share the experience, and never did; may not have known whether the other people to whom they spoke actually understood, etc.
4) suspect understand the person did talk to others about their experiences, suspecting that they would be sympathetic. It is not necessary for the person to think the others had had the experiences themselves, so long as they knew they would be non-judgmental and supportive, and did not have this belief disconfirmed.
5) def. understand the person knew that others would understand the experience and had had similar experiences themselves.

iii) Perceived Controllability:

This factor reflects the degree of control the individual perceived that they had over whether the experience occurred or not. E.g., whether the individual deliberately elicited the experience (5), or could stop it or affect whether or not it was more likely to happen (2-4).

iv) Attempted control:

This factor reflects the degree to which the individual attempted to control the experience, and is independent of (1). E.g. whether the individual used strategies to try to resist or stop the experience, or to control the way they responded to or interpreted the experience, and whether these responses were employed every time the experience occurred, or only some of the time. Behavioural responses intended to influence a perceived external cause should also be rated here, if they represent an attempt to prevent or induce the experience.

NB This section may provide additional information regarding the earlier section c)ii) ‘initial response’, so go back and check the scores allocated and amend if necessary.

v) Premorbid Awareness:

This factor should reflect the degree to which the individual had prior knowledge about the experience they had, moderated by the extent to which this knowledge was brought to bear on the interpretation of the experience, and the specificity of the prior awareness: e.g. the individual may have had some prior awareness of the possibility of certain experiences, but when it occurred this information was not brought to bear on the interpretation, and it was not specific to the precise form of the experience.

1 = no prior awareness
2 = a little or some awareness of the general area of experience; did not inform interpretation greatly
3 = some specific awareness of the kind of experience; did not inform interpretation greatly
4 = greater degree of specific awareness of kind of experience; did inform interpretation but not completely
5 = knew all about the specific kind of experience previously and interpreted it on this basis.

NB. If the section being scored is rating ‘later occasions’ of an experience that has been previously
enquired about in an earlier section, a rating of ‘5’ should be given where the previous experience of the phenomena is informing the interpretation at the time being scored. In this way, a rating of ‘5’ is the default unless the phenomenon is new experience, or perceived as a new experience.

vi) Intellectual Involvement:
This factor should reflect the degree to which the individual became intellectually involved in the experience, as demonstrated by rumination and a sense of the necessity of intellectual understanding of the experience. This may be linked to the degree to which the experience challenged the worldview of the person, which is why probes assessing this are included first; however, it is still found that a high degree of intellectual involvement may occur even when the experiences are consistent with worldview. Percentage of time spent thinking about the experience is also a good rough indication of determining the degree of intellectual involvement.

0% = not at all
1 – 19% = a little
20% - 49% = some
50% - 89% = a lot
90-100% = crucial need

However, account should be taken of whether the person was simply thinking about the experience a lot (replaying or ruminating on it), or actively exploring and trying to understand the experience.

E) Longer term behavioural response:
This section rates the individual’s response to the experience(s) in terms of general effects on their life and coping strategies over a longer time frame. The period of time to be enquired about is that immediately following the occurrence(s) of the experience(s), and the subsequent days/weeks for as long as the individual in question feels is relevant. All of the probes should be asked, and additional probes should be used to clarify answers and gain as much detailed information as possible. If the individual has already spontaneously given much of the information, their responses should still be checked by briefly running through the probes.

Note down the Y/N response to each probe and any verbatim information in the space available. Then rate each response category 2, 1 or 0 according to the degree to which it is fulfilled.

Reality testing attempts to test the veracity of the experience/interpretation

Ignoring/forgetting attempts to forget about or ignore the experience, where this is an active response.

Distraction attempts to distract from the experience, or prevent its occurrence by focusing attention on other activities

Drugs/alcohol increased or altered (not reduced) drug or alcohol use in response to the experience(s)

Safety cognitions mental/cognitive or symbolic/ritualistic behaviours to achieve a sense of protection or security in response to the experience(s)

Behavioural coping any behavioural coping methods not fitting categories of methods distraction or safety behaviours: e.g. physical exercises, avoiding situations in which experiences are likely to occur, or any other practical coping behaviours in which the main function is not just to distract attention away from the experience(s).

Withdrawal avoiding the company of other people in response to or anticipation of the experience(s).

Seeking repeat any active attempts to induce or encourage the experience(s) to reoccur
Sharing experience  discussing or mentioning the experience(s) to other people

Help seeking  approaches to clinical mental health services of any kind (psych)

Help seeking  approaches to any other individual or organisation for (other) help or advice regarding the experience(s) (formal or informal)

Seeking information  attempts to find information regarding the experience(s) from other sources, e.g. books, internet, other people

No effect  if no behaviours or external effects on the individual’s life can be identified (i.e. no disruption to work/function, though some internal feelings etc. may be affected)

Acts on Interpretation  behaviours initiated on the basis of the interpretation of the experience(s), e.g. decisions based on interpretation, change of lifestyle or work, ‘symptomatic’ behaviour.

G) Implications for self:

i) Uniqueness of experience:
This factor rates the social context of the individual, in the sense of the proportion of acquaintances known by the individual to share the experiences they have. NB emphasis should be placed on whether others have experiences of the same intensity, not just general kind; also whether others are aware of the experiences.

ii) Uniqueness of potential:
This factor rates the extent to which the individual feels that there is something different about him/her which predisposes them to the experience and distinguishes them from others.

iii) Salience/Perspective shift – reality
This factor rates the extent to which the experiences have impacted on the individual’s view of the world; in other words, the salience of the experience for effecting a shift of perspective. The relative impact of the experiences on the individual’s worldview should be rated between 1-5 as indicated on the scoring sheet. Verbatim accounts of the ways in which perspective has been affected should be elicited and recorded in the space provided. This information can inform the quantitative rating as well as providing rich qualitative information that can be analysed thematically if required.

iv) Salience – own identity/self
This factor rates the extent to which the experiences have impacted on the individual’s view of themselves; in other words, the salience of the experience for effecting a shift in self-image. As (iii) above, qualitative information should be elicited, to inform the quantitative rating and give additional information that can be thematically analysed.

v) Other aspects
This section is included to allow the respondent an opportunity to make comments that have not been specifically enquired about, and may provide information that can be used to amend the previous rating. Verbatim notes should be made for thematic analysis, if required.

vi) Help/coping and integration
This final section is included to elicit those factors which the individual feels have been helpful to them in coping with their experiences. Verbatim notes should be made for thematic analysis, if required.
Appendix I

Example SPSS Syntax (Study2)

GENLIN SPQ_Total by Diagnosis with IQ DiagnosisTimesIQ
/MODEL DIAGNOSIS IQ DiagnosisTimesIQ DISTRIBUTION =NEGBIN(MLE)

GENLIN SPQ_Cog_Pep by Diagnosis with IQ
/MODEL IQ Diagnosis DISTRIBUTION =NEGBIN(MLE)
/save MEANPRED(SPQ_Cog_Pep_NBIN_Diagnosis)
CIMEANPREDL(SPQ_Cog_Pep_NBINL_Diagnosis)
CIMEANPREDU(SPQ_Cog_Pep_NBINU_Diagnosis)

GGRAPH
/GRAPHDATASET NAME="graphdataset" VARIABLES=SPQ_Cog_Pep IQ
SPQ_Cog_Pep_NBIN_Diagnosis Diagnosis SPQ_Cog_Pep_NBINL_Diagnosis
SPQ_Cog_Pep_NBINU_Diagnosis
/GRAPHSPEC SOURCE=INLINE.
BEGIN GPL
SOURCE: s=userSource(id(“graphdataset”))
DATA: SPQ_Cog_Pep=col(source(s), name(“SPQ_Cog_Pep”))
DATA: IQ=col(source(s), name(“IQ”))
DATA: SPQ_Cog_Pep_NBIN_Diagnosis=col(source(s), name(“SPQ_Cog_Pep_NBIN_Diagnosis”))
DATA: SPQ_Cog_Pep_NBINL_Diagnosis=col(source(s), name(“SPQ_Cog_Pep_NBINL_Diagnosis”))
DATA: SPQ_Cog_Pep_NBINU_Diagnosis=col(source(s), name(“SPQ_Cog_Pep_NBINU_Diagnosis”))
DATA: Diagnosis=col(source(s), name(“Diagnosis”), unit.category())
ELEMENT: point(position(IQ*SPQ_Cog_Pep), color(Diagnosis))
ELEMENT: line(position(IQ*SPQ_Cog_Pep_NBIN_Diagnosis), color(Diagnosis))
ELEMENT: line(position(IQ*SPQ_Cog_Pep_NBINL_Diagnosis), color(Diagnosis))
ELEMENT: line(position(IQ*SPQ_Cog_Pep_NBINU_Diagnosis), color(Diagnosis))
END GPL.
DELETE VARIABLES SPQ_Cog_Pep_NBIN_Diagnosis.
DELETE VARIABLES SPQ_Cog_Pep_NBINL_Diagnosis.
DELETE VARIABLES SPQ_Cog_Pep_NBINU_Diagnosis.
Minerva Access is the Institutional Repository of The University of Melbourne

Author/s:
Nelson, Margaret Tasma

Title:
Evaluation of a continuum model of psychotic symptoms: evidence from neuroanatomical, neuropsychological and clinical correlates

Date:
2012

Citation:

Persistent Link:
http://hdl.handle.net/11343/38031

File Description:
Evaluation of a continuum model of psychotic symptoms: evidence from neuroanatomical, neuropsychological and clinical correlates

Terms and Conditions:
Terms and Conditions: Copyright in works deposited in Minerva Access is retained by the copyright owner. The work may not be altered without permission from the copyright owner. Readers may only download, print and save electronic copies of whole works for their own personal non-commercial use. Any use that exceeds these limits requires permission from the copyright owner. Attribution is essential when quoting or paraphrasing from these works.