The constellation of psychotic experiences in the general population:

Unravelling the significance of paranoid ideation

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Thesis submitted for the degree of

Doctor of Philosophy

I confirm that the word count of this thesis is less than 100,000 words.

March 2019

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Acknowledgements

I would like to take this opportunity to say thank you.

To my first supervisor, Professor Jamie Murphy. For your passion, your expertise, your support, and more than anything, for believing that I could do this when I didn't believe it myself.

To my second supervisor, Professor Mark Shevlin. For help and encouragement. Your door was always open if I needed anything.

To my family. For your unconditional love, unrelenting support, unstoppable care, and uncontrollable sense of humour. No matter how overwhelmed I felt, you made sure I never felt alone.

To the hardcore team of rockstar researchers that is the crew. For being the most loving, supportive, and thoughtful group of friends that a guy could ask for. This journey has been so much fun because of you. You are the coolest people I have ever met, and I hope you know how much you all mean to me.

Finally, to the kindest person I have ever met, my darling Emily. I could fill another thesis with all the ways that you have helped me over the last few years, but I really don't have that kind of time.

So instead, I'll just say this.

From early morning breakfasts to late night writing, you have been by my side.

I could not have done this without you.

Summary

How psychosis is conceptualised shapes every aspect of how it is studied. It affects the samples it is explored within, the psychometric scales used to measure it, and the statistical paradigms used to analyse it. If this conceptual foundation is not sound, it has extensive ramifications for the validity of any insights gained from subsequent research which has been built upon it. The way in which researchers have thought about psychosis has changed a number of times over the years. It is currently widely accepted that psychotic experience is distributed along a continuum in the general population (Van Os, Hanssen, Bijl, & Ravelli, 2000). Over the last two decades, many researchers have begun to investigate subclinical forms of psychosis in order to gain a better understanding of the construct as a whole and to learn how individuals transition along the psychosis continuum (de Leede-Smith & Barkus, 2013). However, the mechanisms underlying psychosis development were found to be highly complex and difficult to unravel. As a response to these levels of complexity, in more recent years some have begun to study psychosis at the symptom level. This approach involves treating each psychotic symptom as a stand-alone experience and attempting to understand its specific causes and developmental trajectories before exploring how it interacts with other psychotic symptoms (Owen, O'Donovan, Thapar, & Craddock, 2011). A hallmark of psychosis which has been a popular target of examination at the symptom level is paranoia. However, the role that paranoia plays in psychosis development, especially in its early stages, remains poorly understood.

Chapter 2 of this thesis explores the distribution of psychotic experiences in the general population. Results identify underlying subgroups of individuals who are

characterised by varying levels of psychotic experience and who appear to be at increased risk of developing psychosis. The high levels of paranoid ideation in these subgroups highlight its relevance in the general population. Chapter 3 investigates how different psychotic experiences relate to the underlying psychosis continuum. Results indicate that paranoia is closely related to this underlying continuum. Furthermore, the finding that paranoia is associated with milder levels of psychosis severity compared to other psychotic experiences indicates that it may emerge at an earlier stage of psychosis development. In chapter 4, psychotic experiences are visualised as a network of interacting events so that the nature of the relationships between them can be explored. Paranoia is found to be highly connected to all other psychotic experiences, indicating that it is a highly influential experience in relation to psychosis as a whole. Finally, in chapter 5, the temporal relationships between psychotic experiences are explored. The relationships between paranoia and other psychotic experiences are found to be reciprocal in nature, with each having the ability to predict the other's development. This highlights the complexity of the causal relationships between these experiences. For too long, we have neglected the importance of individual psychotic experiences. This thesis suggests by exploring the associated risk, course, and outcome of these experiences, psychosis research can move beyond the limitations of potentially flawed diagnoses.

Abbreviations

AIC - Akaike information criterion

ALSPAC – Avon Longitudinal Survey of Parents and Children

APMS – Adult Psychiatric Morbidity Survey

AUDIT – Alcohol Use Disorders Identification Test

BIC – Bayesian Information Criterion

BN – Bulimia Nervosa

BPMS – British Psychiatric Morbidity Survey

C2SS – Census 2000/2001 Supplementary Survey

CI – Confidence Interval

CIS-R – Revised Clinical Interview Schedule

CLC – Cross Lagged Correlations

CLPM – Cross Lagged Panel Model

CTT – Classical Test Theory

DIF – Differential Item Functioning

DSM – Diagnostic and Statistical Manual

GLASSO – Gaussian Lasso

ICC – Item Characteristic Curve

ICD - International Classification of Diseases

IRT – Item Response Theory

JTC – Jumping to Conclusions

LCA – Latent Class Analysis

LRT – Likelihood Ratio Test

NART – National Adult Reading Test

NCS – National Co-morbidity Survey

NESARC – National Epidemiological Survey of Alcohol and Related Conditions

ONS – Office of National Statistics

OR – Odds Ratio

PANSS – Positive and Negative Symptom Scale

PD – Personality Disorder

PLIKSQ – Psychosis-like Symptom Questionnaire

PMRF – Pairwise Markov Random Field

PSQ – Psychosis Screening Questionnaire

SCID- 11 – Structured clinical interview for DSM

SIAS – Social Interaction Anxiety Scale

SPD – Schizotypal Personality Disorder

SPSS - Statistical Package for Social Sciences

ssaBIC - Sample size Adjusted Bayesian criterion

TOM – Theory of Mind

UHR – Ultra High Risk

VR – Virtual Reality

Note on access to contents

Chapter 1: Overall introduction

1.1 Introduction

The purpose of this introduction is to outline how the field of psychology currently understands paranoid ideation, both as a stand-alone experience and within the context of psychotic illness. In order to do this, first, a concise account of the history of psychosis research will be provided, discussing how conceptualisations of the construct have evolved over the years and the impact that this has had on how it is studied. Current arguments outlining the utility of symptom level research will be discussed, followed by a summary of the current research findings on paranoia. This summary will focus mainly on the cognitive and social literature but will also briefly discuss findings from the fields of neurobiology and genetics. Based on the reviewed literature, the overall aims and hypotheses of the thesis will be outlined.

1.1.1. The History of Psychosis

The concept of psychosis has been present in the fields of psychiatry and psychology since the first half of the 19th Century (Read, van Os, Morrison, & Ross, 2005). Over the past 175 years, psychotic experience has received extensive research attention within the fields of psychology and psychiatry however, despite the wealth of research on the subject, a clear definition of psychosis is difficult to find in the literature. In a broad sense, it is presently characterised and identified in terms of perceptual, expressive, and behavioural symptoms such as delusions, auditory and verbal hallucinations, and disorganised thought and speech (Burgy, 2008; Bhati, 2013) but the psychological underpinnings of how these symptoms develop are still widely debated (Parnas, Nordgaard, & Varga, 2010). Numerous conceptualisations have been proposed and over the years, there has been extensive debate surrounding how psychosis should be defined and diagnosed. This debate is still ongoing and in order to appreciate what stage the current literature is at, an in-depth knowledge of the complex history of how normality has been defined must be provided.

In the mid-1800s, the development of evolutionary theory introduced the idea that human traits could be genetically transmitted (Darwin, 1859). Following this, the eugenics movement, which was informed by evolutionary theory, emerged. This movement resulted in efforts to define which human traits were normal and which were abnormal (Bentall, 2009). Eugenicists believed that these normal or desirable traits should be preserved and protected from abnormal or undesirable traits. One trait which was labelled as a hallmark of abnormality at this time was psychological distress. Individuals who experienced psychological distress were deemed to be possessing undesirable traits which should not be passed on to the next generation (Bentall, 2009). These individuals were subsequently excluded from general society, labelled as insane, and incarcerated in asylums. It is within these institutions where psychiatrists first attempted to classify insanity (Bentall, 2009). At this time, these asylums contained individuals who reported a multitude of unusual experiences. While those who were in charge of these institutions believed that abnormal experience could be easily identified, forming a classification system which could explain it proved difficult. A disease-based model of psychopathology was used to attempt to categorise these anomalous behaviours which were being observed into separate categories. These behaviours were thought to have biological and physiological causes however these had not yet been identified (Whitaker, 2002). While the term ‘Psychosis’ was first coined in the psychiatric literature by Canstatt in 1841, at that time, the term was broadly defined as referring to any disease of the brain with a psychological origin (Burgy, 2008). Therefore, following this, a number of different definitions of psychosis began to appear in the literature (Torous & Keshavan, 2014). There was a distinct lack of consensus between psychologists when it came to deciding how psychosis should be identified and categorised. Many of the different theories contradicted each other. For example, some supported the concept of unitary psychosis, suggesting that there is only one psychosis that manifests differently depending on the individual's personality (Berrios & Beer, 1994) while others suggested that different psychotic symptoms should be treated as unique and separate disease entities (Torous & Keshavan, 2014). Due to the lack of clarity in the literature at that time, subsequent psychosis research focused on categorisation and identification of observable symptoms (Torous & Keshavan, 2014). In the late 19th and early 20th century, Emeil Kraeplin set out to provide a framework for the study of psychological abnormality which he hoped would facilitate the identification of their biological/physiological underpinnings. He posited that the best way to scientifically study psychopathology would be to group symptoms which develop together and change over time in uniform ways into categorical psychological diseases (Whitaker, 2002). In an attempt to reconcile the conflicts between existing theories at the time, Kraepelin introduced a more unified model of psychosis comprising of two categories; dementia praecox (a condition comparable to schizophrenia) and manic-depressive insanity (which would later be re-named bipolar disorder) (Bhati, 2013). Bleuler also expanded the concept of schizophrenia by suggesting that there may be several forms of schizophrenia as opposed to one disease. He also provided descriptions psychotic experiences such as disordered perception and thought, and blunted or inappropriate affect (Torous &

Keshavan, 2014; Moskowitz & Heim, 2011). It was becoming apparent that there was a lack of reliability in the field of psychosis and subsequent research in the area focused on addressing these reliability issues.

At the same time, psychiatrists were beginning to realise that the types of psychological distress and unusual behaviours which were observed in asylums could also be found in the community. This finding blurred the lines between normality and abnormality even further (Murphy, 2016). Psychosis research continued to progress during the first half of the 20th century, refining its clinical definition. Jaspers introduced the phenomenological method, emphasising the need for clearly defined diagnostic categories and justification regarding treatment methods (Burgy, 2008). His focus on developing a list of objectively observable psychotic symptoms played a key role in improving the validity of the construct (Torous & Keshavan, 2014). Schneider continued Jaspers' work by proposing a list of symptoms of schizophrenia including delusions, hallucinations, thought insertion, and thought broadcasting. The clinical utility of this list of easily defined and measured symptoms made Schneider's work particularly influential (Torous & Keshavan, 2014). It's important to note that while Schneider's symptoms were widely used in research and clinical settings, they were more commonly utilised in Europe while at the time, researchers and clinicians in the United States were using a different set of symptoms. This meant that the same disorder was being defined and diagnosed in a number of different ways in different places (Torous & Keshavan, 2014).

1.1.2. Categorical views on psychosis.

It was clear that in order to improve the reliability of psychotic disorders, standardisation was required in terms of definition, diagnosis, and treatment. It's important to note that these problems surrounding reliability were not unique to psychosis but instead were a more general issue in the field of psychology at the time (Andreasen, 2006). Psychologists responded by developing a classification system of psychological disorders called the Diagnostic and Statistical Manual (DSM) (Andreasen, 2006). The DSM was modelled on another diagnostic tool called the International Classification of Diseases (ICD). The ICD was originally designed to catalogue known physical diseases and conditions however its 6th edition contained a small section dedicated to psychological disorders (Bhati, 2013). The first edition of the DSM was published in 1952 (Houts, 2000). It divided psychological disorders into two categories, those which had an organic cause, and those which were developed as a response to environmental influences. Psychosis fell under the latter category (Frances, 2013). When the second version of the DSM was published, issues were being raised surrounding the reliability and utility of the diagnostic categories which it contained. The DSM was also being criticised because it was leading to low levels of consensus between different psychiatrists regarding diagnosis (Bartlett, 2011). These issues were addressed in more recent versions of the DSM. When working on the third edition of the DSM, strict symptom checklists were developed to address these levels of disagreement between clinicians (Bartlett, 2011). Moreover, researchers developed standard semi-structured interviews to aid clinical assessment of different disorders (Bhati, 2013). Standardised assessments like these where a clinician would decide whether or not an individual had a psychotic disorder by measuring the presence and severity of psychotic symptoms substantially improved the reliability of these constructs (Whitaker & Cosgrove, 2015).

The most recent edition of the DSM is the DSM-5 which was published in 2013 (Bhati, 2013). The introduction of a standard diagnostic tool was beneficial for psychosis research in a number of ways. First, it meant that researchers and clinicians now had a standard nosology which provided much needed structure to help guide research, diagnosis, and treatment (Bhati, 2013). Also, the way in which new editions of the DSM were developed produced more refined descriptions of psychotic disorders. Any modifications made to the diagnostic features of a disorder needed to be based in evidence and this involved a comprehensive review of the literature (Bhati, 2013). Overall, the DSM provided a practical foundation on which a better understanding of psychotic disorders could be achieved.

1.1.3. Benefits of a categorical approach to psychosis.

It must not be forgotten that all of the advancement in psychosis research discussed up until this point took place within the context of a categorical, disease-based framework. It is understandable why this categorical approach dominated psychosis research for such a long time. In clinical terms, conceptualising psychosis as a number of distinct and separate psychological disorders made up of a number of psychotic symptoms facilitates decision making regarding diagnosis and treatment (Esterberg & Compton, 2009). Trull and Durrett (2005) stated that if a distinct diagnosis exists, a clinician can decide whether or not to administer treatment. Those who have the disorder require treatment and those who do not have the disorder, do not. Put simply, a categorical diagnostic system enables a more structured and standard clinical response to psychosis. Another advantage of categorical systems is that they facilitate fast and efficient communication between clinicians. Diagnostic labels allow a lot of information regarding symptoms, associated conditions, etc to be conveyed using very few words (Trull & Durrett, 2005). They have also facilitated communication between clinicians and the lay community, enabling lay persons to gain a better understanding of psychotic disorders (Esterberg & Compton, 2009). The categorical approach also has clear advantages in terms of research. For example, when examining the effectiveness of a given treatment, categorical diagnosis allows researchers to determine inclusion/exclusion criteria which are easily replicable across multiple studies (Esterberg & Compton, 2009). In general, it provides a level of standardisation which allows findings from different studies to be more easily compared. Another notable benefit of the categorical approach is that it has increased reliability in both clinical and research fields. As previously discussed, the field of psychosis research was facing significant reliability issues at one point and the introduction of a categorical model increased consensus among practitioners and consistency in research findings (Esterberg & Compton, 2009).

1.1.4. Limitations of the categorical approach to psychosis.

While the categorical approach offers clear benefits, it’s important to also consider how this approach can be restrictive. While a categorical framework may be pragmatically appealing in clinical settings, it may be inappropriate in a research context when trying to learn more about the latent nature of the psychosis construct.

The main reason that a clear conceptualisation of psychosis' form must be generated is to guide research into its epidemiology. The way in which psychosis is conceptualised shapes every aspect of how researchers study it. It affects the samples within which it is explored, the psychometric scales which are used to measure it, and the statistical paradigms which are used to analyse it. If this conceptual foundation is not sound, it has extensive ramifications for the validity of any of the insights gained from any subsequent research which has been built upon it. Conceptualising psychosis based on categorical models is appealing because it creates a clear division between those who are experiencing psychosis and those who are not. However, new findings began to come to light which suggested that the practice of defining psychosis solely in terms of clinical diagnostic categories has impeded researchers' ability to effectively study its epidemiology (Kendler, McGuire, Gruenberg, & Walsh, 1994). Psychosis research has been shaped by the categorical approach in a number of ways. The influence of this categorical approach must be understood before psychosis research can progress. To say that a psychotic disorder is categorical in nature implies that it is a discontinuous construct which exists as a dichotomy in the population. In other words, an individual is either psychotic or non-psychotic with nothing in between. If this were the case, one could assume that psychotic symptoms would only be present in clinical samples. Indeed, this assumption can be seen reflected in the psychosis research which originally focused on data collected from clinical populations. When researchers did begin to investigate non-clinical samples, it marked the beginning of a new era in psychosis research. Surveys using general population samples consistently demonstrated that psychotic symptoms, previously thought to only exist in clinical samples, could also be found in subclinical groups and not only that, but that these symptoms were present at much higher rates than the disorders themselves (Eaton, Romanoski, Anthony & Nestadt, 1991, Kendler, Gallagher, Abelson, & Kessler, 1996). The literature refers to these subclinical symptoms as psychotic experiences, psychosis proneness, or schizotypy (Dominguez, Wichers, Lieb, Wittchen, & Van Os, 2011). Based on these findings, researchers began to suggest that a deeper understanding of psychosis could be achieved by investigating these subclinical psychotic symptoms in more detail. (Venables, Wilkins, Mitchell, Raine, & Bailes, 1990).

1.1.5. Evidence for a psychosis continuum.

First of all, these results were clearly not compatible with a categorical model of psychosis. However, researchers cannot abandon an existing theoretical framework until there is another to replace it. This called for the development of a new framework to explain the nature of the psychosis construct. The findings mentioned in section 1.1.4 above seemed to suggest that clinically relevant psychosis is only a fraction of the psychosis phenotype. Some began to propose that a continuum of psychotic experience exists in the population with psychotic disorders at one end and milder, more common psychotic experiences at the other (Van Os, Hanssen, Bijl, & Ravelli, 2000). Over the last few decades, subclinical psychosis has received growing research attention. While psychotic symptoms such as hallucinations and delusions were found to be common in the general population, these experiences were often transient and non-distressing (de Leede-Smith & Barkus, 2013; Poulton et al., 2000; Hanssen, Bak, Bijl, Vollebergh, & Van Os, 2005) and subsequently, there was some debate around whether or not these experiences could be compared to clinically relevant psychosis (Kaymaz & van Os, 2010). Therefore, the first question which needed to be addressed was whether or not the psychosis construct has scientific validity. Research in this area has found substantial support for the psychosis continuum. Firstly, subclinical psychotic-like experiences and clinical symptoms have been found to share continuity in terms of psychopathology (Van Os, Linscott, Myin-Germeys, Delespaul, & Krabbendam, 2009). The dimensional structure of subclinical psychotic symptoms in the general population appears to resemble the dimensions of Schizophrenia (Lewandowski et al., 2006; Mata et al., 2003). Studies have revealed that subclinical symptoms displayed patterns of association which were similar to those found in psychotic disorders. In other words, the correlations between the different symptom dimensions of psychotic disorders (e.g. positive, negative, affective) resemble the correlations between different PLEs in the general population (Van Os, et al., 2000). Additionally, clinical and non-clinical symptoms have been found to have comparable patterns of co-morbidity with other psychological disorders such as anxiety and depression (Lewandowski et al., 2006; Van Os, et al., 2000; Van Os et al., 2009). All of these findings are indicative of psychopathological continuity between clinical and subclinical psychosis.

Subclinical psychotic-like experiences and clinical symptoms have also been found to share continuity in terms of their demographic characteristics. Research has consistently demonstrated that an individual is more likely to have schizophrenia if they are single, male, young, unemployed, or a member of an ethnic minority (Van Os et al., 2009). Subclinical psychotic experiences have also been found to be associated with these demographic characteristics. PLEs have been associated with a range of factors including urbanicity, migrant status, ethnic minority status, unemployment, single marital status, and lower education (Fearon et al., 2006; Johns, Cannon, & Singleton, 2004; Scott, Welham, & Martin, 2008; Spauwen et al., 2004; Morgan et al., 2009). These findings provide strong evidence for demographic continuity between clinical and subclinical psychosis. If psychotic symptoms exist along a continuum, one would expect that experiences at both ends of the spectrum would be caused by the same things. While the aetiology of psychotic disorder is complex with no one agent that could be reasonably described as a "cause" of psychosis (Van Os et al., 2009), a number of factors have been identified which are associated with an increased risk of psychosis development. When researchers investigated these risk factors, substantial overlap between clinical and subclinical experiences was discovered. Trauma is a prime example of one of these factors. The literature on the link between childhood trauma and psychotic disorders is well established. Numerous large epidemiological studies have reported strong associations between traumatic events in childhood and later development of psychotic disorders such as schizophrenia (Bebbington et al., 2004; Bebbington et al., 2011; Bentall, Jackson, Hulbert, & McGorry, 2008; Janssen et al., 2004; Schafer & Fisher, 2011). As the evidence for this association was steadily accumulating, researchers also began to investigate these forms of childhood victimisation in individuals reporting subclinical psychotic experiences. Childhood trauma was found to be significantly associated with schizotypal symptoms (Kelleher et al., 2008; Rössler, Ajdacic-Gross, Rodgers, Haker, & Müller, 2016). Furthermore, similar patterns were revealed when investigating clinical/subclinical symptoms and specific types of trauma. In both cases, sexual abuse has been found to be most closely associated with psychotic experience

(Bebbington et al., 2004; Lataster et al., 2006). Another risk factor which has received extensive research attention is urbanicity. The link between schizophrenia and living in an urban environment is well established (Vassos, Pedersen, Murray, Collier, & Lewis, 2012). Urbanicity has also been found to be associated with PLEs (Spauwen, Krabbendam, Lieb, Wittchen, & van Os, 2004). Interestingly, in both cases, urbanicity was found to be a stronger risk factor when experienced in adolescence (Van Os et al., 2009). Additionally, there is literature which has identified strong associations between cannabis use and the development of both psychotic disorder (Henquet, Murray, Linszen, & van Os, 2005) and PLEs (Henquet et al., 2004). Similar to the urbanicity research, cannabis use during adolescence was identified as conveying the highest risk of schizophrenia and PLE development (Van Os et al., 2009). The levels of continuity between clinical and subclinical experience in terms of causation provides substantial support for the psychosis continuum.

In order to investigate the continuum of psychotic experience, some researchers turned their attention to the heritability and familial clustering of psychotic symptoms (Kelleher & Cannon, 2010). Research comparing monozygotic and dizygotic twins has established that the development of schizophrenia does indeed involve a genetic component (Sullivan, Kendler, & Neale, 2003). Similar studies have revealed that schizotypy is also a heritable construct (Polanczyk et al., 2010). In addition to these findings, it has been reported that clinical and subclinical manifestations of psychosis cluster in families meaning that individuals were more likely to exhibit subclinical psychotic symptoms if they had a family member with schizophrenia (Kendler, McGuire, & Gruenberg, 1993). This evidence surrounding the familial clustering of psychotic experiences further supports the continuum theory. One final line of research worth mentioning in this area concerns the notion of predictive validity. As mentioned previously, the majority of individuals who experience subclinical psychotic symptoms such as hallucinations and delusions do not go on to develop a psychotic disorder (Van Os et al., 2009). However, there is a sub-group of individuals with PLEs who do go on to develop a clinically relevant disorder (Kelleher & Cannon, 2010). A number of prospective studies have reported that individuals with subclinical psychosis are at increased risk of developing a full-blown disorder. Poulton and colleagues (2000) investigated the prevalence of schizophreniform disorder in individuals who had reported PLEs 15 years previously. They found that self-reported psychotic symptoms predicted a high risk of going on to develop a clinical disorder. A study by Hanssen, Bak, Bijl, Vollebergh, and Van Os (2005) reported that 8% of individuals who experienced subclinical psychotic symptoms had developed a clinical psychotic disorder at a 2-year follow-up. Similarly, Welham and colleagues (2009) found that experiencing hallucinations at age 14 predicted an increased risk of psychotic disorder at age 21. The discovery that individuals who experience these subclinical forms of psychosis are at an increased risk of developing a clinical disorder is arguably one of the most important findings to support the existence of a psychosis continuum.

1.1.6. Utility of subclinical psychosis research.

As the evidence for a continuum of psychotic experience in the general population mounted, researchers began to discuss how a deeper understanding of psychosis in its subclinical forms could improve our understanding of psychotic disorders and ultimately lead to the development of more effective treatments and possible early interventions. In order to achieve this deeper understanding, subsequent research set out to discover why some individuals with subclinical psychotic experiences went on to develop clinically relevant disorders while others did not. In other words, how does an individual transition along the psychosis continuum? This is a question which has received extensive research attention and, despite the fact that the research is still in its early stages, several theories attempting to explain the nature of the continuum have been put forward. Studies utilising neuroimaging technologies have identified several biological factors associated with the development of a clinical disorder. Many of these studies focused on individuals who were identified as being at ultra-high risk (UHR) of developing psychosis. UHR individuals present with subclinical psychotic symptoms coupled with signs of functional decline and are at significantly increased risk of transitioning to clinical psychosis (Fusar-Poli, McGuire, & Borgwardt, 2012). While these transition rates have been declining in recent years (Hartmann et al., 2016), the use of UHR samples has been instrumental in identifying factors involved in psychosis development. In terms of brain structure, grey matter abnormalities in the limbic system, the cerebellum, and the frontal, prefrontal, temporal, medial, and insular cortices, have all been linked with transitions to clinical psychosis (Smieskova et al., 2010). Abnormal connectivity between different areas of the brain such as the temporal and prefrontal cortex was also associated with clinical outcomes (Fusar-Poli, et al., 2012). In terms of Neurochemistry, dopamine and glutamate have received considerable research attention. Striatal dopamine levels correlate with symptom severity in UHR individuals however it is unclear whether dopamine function predicts the development of psychotic disorder (Fusar-Poli, et al., 2012). Glutamate dysfunction was also found in UHR individuals. Increased glutamate levels in some areas of the brain (medial frontal cortex and anterior cingulate) and decreased levels in other areas (left thalamus) were associated with prodromal psychotic experience however once again, glutamate levels were not investigated in terms of transition to clinical psychosis (Fusar-Poli, et al., 2012). While this work in neuroimaging is promising and has brought us closer to understanding the neuroanatomical underpinnings of psychosis, when it comes to predicting who will develop psychosis, a stark lack of consistency is evident in the literature (Wood, Reniers, & Heinze, 2013).

It has been pointed out that clinically relevant symptoms differ from subclinical experiences in terms of how persistent they are, how distressing they are, and their associated levels of impairment (Van Os et al., 2009). Therefore, much of the research on psychosis development has focused on the mechanisms underlying these factors. Some researchers have suggested that these mechanisms are psychological in nature. They therefore investigated the psychological factors which may play a role in the development of clinical disorder. Much of the work in this area centres around the idea that an individual's response to those initial psychotic experiences can influence their chances of developing a clinical disorder. In particular, there has been a focus on factors such as cognitive biases and coping strategies. Individuals with subclinical symptoms appear to cope differently to those with clinical symptoms. Individuals with a need for care were more likely to use symptomatic coping. This association remained even when severity of symptoms was controlled for (Krabbendam, Myin-Germeys, Bak, & Van Os, 2005). Schmidt and colleagues (2014) found that psychosis development was associated with poor coping and low self-efficacy. A number of models have suggested that cognitive appraisals and responses to anomalous experiences play a key role in psychosis development. The authors suggest that anomalous experiences such as auditory hallucinations on their own are not enough to develop a psychotic disorder, but that these experiences become more problematic when the individual interprets them in a negative and delusional way (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001; Morrison, 2001). These theories state that if an individual interprets the anomalous experience as being benevolent and internally generated, it will likely be transient and non-distressing. However, if the experience is interpreted as being malevolent, coming from an external source, and personally relevant, the individual is more likely to experience distress, the symptoms are more likely to become persistent, and it is more likely that they will go on to develop a need for care (Krabbendam et al., 2005). In short, it implies that cognitive and attentional anomalies may be better predictors of a need for care than the presence of anomalous experience (Brett, Peters, & McGuire, 2015). Another factor which has been identified as playing a role in psychosis development is mood. Subclinical individuals who experienced depressed mood were reportedly more likely to develop a clinical disorder (Krabbendam et al., 2005). Velthorst and colleagues (2009) found that UHR individuals who later developed a clinical disorder reported higher levels of suspiciousness and social anhedonia than those who did not. Similarly, some research has suggested that transitions along the psychosis continuum may involve a social component. Powers, Kelley and Corlett (2016) found that the hallucinatory experiences of non-clinical voice hearers were similar to those reported by those with a clinical disorder however the two groups did differ in terms of how the people around them reacted to their voice-hearing. Individuals in the subclinical group were more likely to receive a positive response when they shared their experience with others while those in the clinical group reported more negative reactions. This suggests that the societal response to these initial hallucinatory experiences may influence the effect that they will have.

1.1.7. Exploring psychosis at the symptom level.

In more recent years, there has been a growing body of literature attempting to understand how one or two psychotic symptoms can develop into a full-blown psychotic disorder. This has led to significant progress being made in identifying a number of factors which appear to be playing key roles in this process. Despite this, a comprehensive model of psychosis development remains elusive. The research to date has shone light on the complexity of the underlying mechanisms involved in psychosis development. In the face of these levels of complexity, understanding how psychotic disorders develop can feel like an incredibly daunting task. At one time, concerns were being raised that psychosis research had reached a plateau and that a change in approach was required (Garety & Freeman, 2013). It was then proposed that the solution to these concerns may come in the form of symptom level psychosis research. In other words, instead of examining psychosis as one construct, individual psychotic symptoms are focused on. This means that each symptom is treated as a stand-alone experience and that the research aims to learn more about how they develop, what their specific risk factors are, and how they could be effectively treated. More importantly, researchers could ultimately gain a more detailed understanding of how psychosis develops by examining how these symptoms interact and influence one another without the confounding effects of potentially flawed diagnostic labels (Owen, O’Donovan, Thapar, & Craddock, 2011). While the evidence for the psychosis continuum is substantial, it does not necessarily mean that all psychotic experiences develop concurrently and share a common cause. Some researchers are beginning to suggest that these different experiences not only develop independently, but also have the ability to dynamically interact and impact on each other over time (Van Os & Reininghaus, 2016). Novel ideas such as this open up new and exciting avenues for psychosis research and could bring us closer to understanding how an individual develops a psychotic disorder. The current literature already contains substantial bodies of work which have examined individual psychotic symptoms in detail. The majority of symptom research to date has, understandably, focused on what could be considered the two key characteristics of psychosis; hallucinations and delusions. The literature in section 1.1.2 suggests that delusional ideation may play a more important role than hallucinations in the transition from mild subclinical experiences to more severe and clinically relevant ones. This therefore indicates that delusion formation could be a fruitful target for symptom-level investigation. As mentioned previously, delusional thought appears to play a key role in transitioning along the psychosis continuum and is associated with more negative outcomes such as developing a need for care (Baumeister, Sedgwick, Howes, & Peters, 2017; Krabbendam et al., 2005). Therefore, the remainder of this introduction will discuss the existing literature on delusions, covering theories of how they develop and the role they play in psychotic illness.

1.2.1. What are delusions?

In the literature, a delusion is most often described as an abnormal belief which is seemingly bizarre, is held with extreme conviction, and is resistant to change even when there is evidence to refute it (Bentall, Kinderman, & Kaney, 1994). Delusional beliefs demand research attention due to their ability to cause psychological distress and their involvement in numerous psychological disorders. Delusions have been associated with lower psychological wellbeing. In fact, nearly 50% of individuals with persecutory delusions were found to have wellbeing scores in the bottom 2% of the population (Freeman et al., 2014). Individuals with delusions are more likely to experience depression (Vorontsova, Garety, & Freeman, 2013), anxiety (Hartley, Barrowclough, & Haddock, 2013) and insomnia (Freeman, Pugh, Vorontsova, & Southgate, 2009). It is also one of the central symptoms of psychosis with 70% of first episode psychosis cases reporting a persecutory delusion (Freeman & Garety, 2014). While delusions are most commonly associated with psychotic disorder, they are also present in a range of other psychological conditions including OCD (O'Dwyer & Marks, 2000) bipolar disorder (Appelbaum, Robbins, & Roth, 1999), and personality disorders (Pearse et al., 2014). It is important to note that some researchers have criticised traditional definitions of delusions. Belief is a complex concept, and some have pointed out that the subjectivity associated with deciding whether or not a belief is bizarre is problematic (Freeman, 2007). Delusions are not discrete and dichotomous and therefore should not be examined as such. Rather, they are complex and multifaceted experiences which cannot be easily defined (Bell, Halligan, & Ellis, 2006). When choosing how to define delusions, one should consider how that definition will impact on research (Freeman, 2007). While recognising the complexity of delusional experience, Freeman (2007) proposed a more appropriate approach to defining these beliefs. He suggested the presence of a delusion should be assessed by considering the degree to which a belief is implausible, preoccupying, strongly held, not shared by others, distressing, and unfounded. In the psychosis literature, the main focus of delusion research has been on persecutory delusions. A persecutory delusion involves a belief that an external source is wishing or planning to harm you (Dickson, Barskey, Kinderman, King, & Taylor, 2016). While in the past, it was believed that delusions and normal beliefs were separate and qualitatively distinct phenomena, mediated by different underlying processes (Bentall et al., 1993), this is no longer believed to be true. It is now widely accepted that a continuum of paranoia exists in the population with normal beliefs and mild suspicion and mistrust at the lower end and clinically relevant persecutory delusions at the top of the spectrum of severity (Freeman, Pugh, Vorontsova, Antley, & Slater, 2010). Before examining the literature on how delusions develop, it would be beneficial to briefly discuss the evidence supporting the existence of a continuum of paranoid belief in the general population.

1.2.2. The continuum of delusional beliefs.

As mentioned before, persecutory delusions are becoming increasingly recognised as the extreme end of a spectrum of paranoid ideation (Freeman & Garety, 2014). Paranoia has been found to be exponentially distributed in the general population with many people having one or two milder paranoid thoughts and a small portion of the population having more numerous and severe experiences (Freeman et al., 2005). More recent research has reported that these forms of paranoid experience are hierarchically arranged in the general population

(Bebbington et al., 2013). In addition to these findings, evidence has begun to emerge that individuals can move along the spectrum over time. Prospective studies have found that individuals who reported subclinical paranoid ideation were more likely to develop clinically relevant delusions in the future (Hanssen et al., 2005; Kaymaz et al., 2012; Poulton et al., 2000). These findings have important implications for the study of delusion development. Taken together, it would appear that more severe forms of paranoid ideation such as persecutory delusions are built upon milder and more common subclinical experiences of suspicion and mistrust. Understandably, the majority of the existing research on paranoid ideation and psychosis has focused on persecutory delusions. However, examining these subclinical manifestations may shed light on the underlying mechanisms involved in the development of paranoia in its more severe forms. With this in mind, the remainder of this literature review will provide a summary of the current theories of how delusions develop. The theories discussed will cover cognitive and emotional factors, potential biological underpinnings, as well as possible social influences involved in the development and maintenance of paranoid ideation.

1.2.3. Cognitive theories of delusion development.

There is a rich body of literature investigating the psychological processes which underpin how persecutory delusions are developed and how they are maintained. The role of both cognitive and affective processes have been explored and discussed. In terms of cognition, researchers have focused on factors such as reasoning, attributional styles, and theory of mind. In terms of affective processes, research attention has been paid to factors like anxiety, depression, worry, and self-esteem. In terms of the cognitive factors involved in delusion development, perhaps one of the most consistently investigated factors has been the reasoning bias of jumping to conclusions (JTC). It has been proposed that the tendency to collect less data before reaching a decision contributes to the development and maintenance of delusions. When ambiguous information is rapidly appraised, with minimal evidence and little or no consideration of alternative explanations, delusions are more likely to form (Garety & Freeman, 2013). The link between delusion formation and JTC bias has received extensive research attention. This research has most commonly used an experimental paradigm called the beads task. The beads task is a probabilistic reasoning task which involves showing participants 2 jars of beads, each containing a mix of 2 different colours of beads. The mix of beads in each jar are in equal but opposite ratios. So, for example, one will contain 85 blue beads and 15 red while the other will contain 85 red beads and 15 blue. Both jars are then hidden, and single beads are drawn one by one from one of the jars. The participant is required to decide which jar the beads are being drawn from. JTC is assessed by counting the amount of beads the participant observed before making their decision (Dudley, Taylor, Wickham, & Hutton, 2015). Due to persecutory delusions' prominent role in psychotic disorder, much of the research investigating delusions and JTC bias have compared the performances of individuals with clinical psychotic disorders and healthy controls (Garety & Freeman, 2013). Indeed, multiple studies have reported strong links between JTC bias and delusions in individuals with psychosis (Lincoln, Ziegler, Mehl, & Rief, 2010; Menon, Mizrahi, & Kapur, 2008; Fine, Gardner, Craigie, & Gold, 2008). These studies found that delusional individuals consistently collected less data before reaching a decision. In more recent years, some researchers have begun to investigate JTC in individuals with subclinical paranoid ideation. Similar to the results from individuals who were actively delusional, individuals who were identified as being prone to delusion development were also found to make hastier decisions (Leer, Hartig, Goldmanis, & McCay, 2015; Warman & Martin, 2006; Garety & Freeman, 2013) however, these findings have been disputed (Ho-Wai So & Tsz-Kit Kwok, 2015). The finding that JTC bias is associated with both clinical and subclinical forms of paranoia emphasises the important role it plays in delusion development. The mechanisms underlying the JTC bias are poorly understood however, evidence is beginning to suggest that anxiety and issues with working memory may be involved (Garety & Freeman, 2013).

The evidence from studies using the beads task demonstrated that individuals with delusional ideation collect less information before reaching a decision however, it does not shed light on what type of information these individuals collect or how they process this information once they have it. In order to learn more about how delusional individuals form their beliefs, these questions warranted investigation. In terms of the types of information that delusional individuals collect, a number of data-gathering biases are worth mentioning. The first is the confirmation bias. It has been widely argued that a key aspect of delusion development involves paying selective attention to information which supports the delusional belief and discounting information which does not (Nickerson, 1998; Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002). Similarly, individuals with delusional ideation have been found to exhibit a bias against disconfirmatory evidence (Moritz & Woodword, 2006). There is also evidence to suggest that those with delusional ideation process information differently to their non-delusional counterparts. Researchers have investigated the different types of reasoning used by delusional individuals. Persecutory delusions were significantly associated with increased use of experiential reasoning strategies which involves rapid and intuitive decision-making and is driven by an individual's current affective state (Freeman, Lister, & Evans, 2012). Freeman and his colleagues also found an association between delusions and reduced use of rational reasoning which is a slower and more effortful strategy involving analytic review. Studies have also found that individuals who reported high levels of rational reasoning and low levels of experiential reasoning were more likely to have low levels of paranoid ideation (Freeman, Lister, & Evans, 2014; Freeman et al., 2012). The combination of JTC bias, biased attentional processes like the confirmation bias, and decreased rational reasoning are not only likely to lead to the formation of delusional beliefs but also to play an important role in their maintenance by making it more difficult to consider alternative explanations (Freeman & Garety, 2014).

Arguably the one cognitive process which has received the most research attention, both in the field of delusions and the field of psychosis in general, is theory of mind (ToM) (Freeman & Garrety, 2014). In short, ToM is an aspect of social cognition that describes the ability to understand the thoughts and feelings of others in order to explain or predict their behaviour (Phalen, Dimaggio, Popolo, & Lysaker, 2016). Researchers have suggested that deficits in ToM processes may be a predisposing factor in persecutory delusion development (Garety & Freeman, 2013). At face value, it would make intuitive sense that these factors would be related. Persecutory delusions often centre on the belief that an individual or group of individuals wish to harm you. An inability to accurately identify the intentions of others could increase the likelihood of these types of delusional beliefs developing. Additionally, evidence has been found to link ToM deficits and psychotic disorders (Brune, 2005). Despite this, little support has been found for a link between ToM and delusion development. Several meta-analyses conducted in recent years have concluded that although individuals with delusional ideation have also been found to exhibit ToM deficits, there is little evidence for a direct association (Ventura, Wood, & Hellemann, 2011; Garety & Freeman, 2013).

1.2.4. Affective factors in delusion development.

Earlier theories, which have attempted to explain delusion development purely in terms of cognitive processes have received criticism for ignoring the effects of affective factors such as mood and emotion (Winokur, Scharfetter, & Angst, 1985). Indeed, it is becoming increasingly argued that affect is actually one of the keys to understanding psychotic disorder in general (Freeman et al., 2012). In terms of persecutory delusion, research has focused on factors such as anxiety, depression, excessive worry, and self-esteem. There is a large body of existing research which has explored anxiety's role in the development of persecutory delusions. Anxiety is an obvious choice to investigate in relation to persecutory delusions as both experiences involve fear and the perception of threat (Freeman, 2007). The link between anxiety and persecutory delusions is well established. Anxious thoughts have repeatedly been found to be associated with persecutory delusions (Huppert & Smith, 2005; Van Os et al., 1999). In a more general sense, state paranoia has also been found to be positively correlated with levels of anxiety (Fowler et al., 2006; Freeman et al., 2012). Findings like these have led some researchers to propose that anxiety may be the source of the feelings of threat and danger that are present in persecutory delusions (Garety & Freeman, 2013). Freeman and colleagues (2012) set out to test if this was the case. To achieve this, they examined the relationships between state anxiety, state paranoia, and threat anticipation. They found that the relationship between state paranoia and threat anticipation was mediated by anxiety, thereby supporting the theory. Additionally, Subclinical paranoid thoughts have been found to be built upon common interpersonal anxieties (Freeman et al., 2005). These findings combined suggest that anxiety may play a key role in paranoia development even in its very early stages. Similar to anxiety, the effects of excessive worry on delusion formation has been explored. Catastrophic worry involves persistently thinking about a worry topic and perceiving progressively worse outcomes to that topic (Startup, Freeman, & Garety, 2007). It has been argued that worry can maintain and exacerbate delusional beliefs by calling the beliefs to mind, keeping them there, and increasing the distress that they cause (Garety & Freeman, 2013). Clinical levels of worry have been found in almost two-thirds of individuals with persecutory delusions and on top of this, worry was positively correlated with delusion distress (Startup, Freeman, & Garety, 2007). Longitudinal research has found that worry is also a significant predictor of the development of paranoid ideation (Freeman et al., 2012) indicating that it plays an important role at all stages of paranoia development.

Another affective factor which has been investigated in relation to paranoid ideation is depression. Depression has repeatedly been found to be common in individuals right across the paranoia spectrum (Garety & Freeman, 2013). In a general sense, depression is thought to play a role in delusion development by causing a pessimistic thinking style which would lead an individual to evaluate situations in a more negative way (Freeman & Garety, 2014). However, as the topic has been further explored, it has become apparent that the relationship between depression and persecutory delusions is more complex than this. In order to discuss this further, another affective process must be mentioned; self-esteem. Both depression and low self-esteem are characterised by negative thoughts about the self (Freeman & Garety, 2014) and the two factors have been found to correlate in delusion research (Chadwick, Brower, Juusti-Butler, & McGuire, 2005; Drake et al., 2004). Self-esteem plays a central role in some of the most prominent and influential theories of persecutory delusion development and has received extensive research attention. Richard Bentall proposed that persecutory delusions developed as a defence against low self-esteem (Bentall et al., 1994). Bentall's defence hypothesis went as follows. Individuals with persecutory delusions in fact have low self-esteem that they are not aware of. When such an individual encounters a negative event, they will develop a delusional explanation which blames the event on external sources, thereby keeping negative self-representations outside of conscious awareness. In short, delusions serve a defensive function by allowing individuals with implicit low self-esteem to maintain high levels of explicit self-esteem (Bentall et al., 1994). Two main approaches were taken to test Bentall's theory (Garety & Freeman, 2013). The first approach involved testing for a bias towards externalising the blame for negative events to external sources in individuals with persecutory delusions. Some evidence supporting the presence of externalising bias has been found (Langdon, Corner, McClaren, Ward, & Coltheart, 2006) however, this support has not been unanimous (Mehl et al., 2014). The second approach involved comparing levels of explicit and implicit self-esteem in individuals with persecutory delusions. This was where one of the main issues with the defence theory surfaced. There were serious methodological difficulties associated with measuring implicit self-esteem (MacKinnon, Newman-Taylor, & Stopa, 2011). Additionally, numerous studies have reported that most paranoid individuals also had low explicit self-esteem (Thewissen, Bentall, Lecomte, Van Os, & Myin-Germeys, 2008). These findings were clearly at odds with Bentall's original theory. In response to this, an updated version of the defence theory was proposed. This time, Bentall suggested that the defensive function of persecutory delusions is flawed and therefore, self-esteem in delusional individuals is unstable and will fluctuate between high and low levels (Bentall et al., 2001) although, it has been argued that once again, this model is difficult to test (Freeman, 2007). An alternative theory of delusion development which centred on self-esteem was put forward by Freeman and colleagues. Their theory suggested that instead of being a defence against low self-esteem, persecutory delusions were, in fact, a direct reflection of emotional experiences. They stated that when a delusional individual has negative views of themselves, the people around them, and the world, these negative views will be reflected in their delusional thoughts (Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002). The previously stated findings about increased levels of depression and self-esteem in paranoid individuals (Garety & Freeman, 2013; Thewissen, Bentall, Lecomte, Van Os, & Myin-Germeys, 2008) are compatible with Freeman's theory. In order to provide an explanation for the conflicting findings surrounding paranoia and self-esteem, Trower and Chadwick (1995) suggested that there were actually two distinct types of paranoia. Poor me paranoia is associated with blaming others, seeing others as bad, and seeing oneself as a victim while on the other hand, bad me paranoia is associated with a tendency to see oneself as bad and feel deserving of punishment from others. The model suggested that all paranoia begins with the perceived threat from another. In response to this, some people will develop poor me paranoia while others will develop bad me (Sigmarigna Milo, Taylor, & Bentall, 2006). Interestingly, when researchers investigated whether or not there were two distinct types of paranoia in the population, they found that many people varied over time in terms of the type of paranoia they were experiencing (Sigmarigna Milo, Taylor, & Bentall, 2006). This fluctuation of perceived deservedness of persecution is compatible with Bentall's updated model.

1.2.5. Recent theories of delusion development.

The theories of paranoia development discussed up to this point have explained the development of persecutory delusions in terms of flaws in cognitive and affective processes. In more recent times however, alternative explanations have begun to emerge which view paranoid ideation quite differently. The first of these explanations which will be discussed focuses on the role of anomalous experience. Persecutory delusions often occur within the context of psychotic disorders. Another hallmark of psychotic disorders are anomalous experiences such as auditory and visual hallucinations. Some researchers have argued that some persecutory delusions could have their origins in a response to an anomalous internal experience (Bell, Halligan, & Ellis, 2006). Within this context, it is argued that a delusional explanation is a reasonable response to an experience which defies reason. To put it simply, odd experiences lead to odd ideas (Freeman, 2007). Many individuals with schizophrenia experience a wide range of anomalous experiences. Aside from the most obvious and noticeable hallucinations like hearing voices, many have reported a range of more subtle perceptual anomalies such as certain voices in their environment seeming louder and random things in their visual field catching their eye (Freeman, 2007). When one considers what it would be like to experience the world in this way, the development of paranoid ideation does not appear to be such an illogical response.

Persecutory delusions are most commonly found within the context of severe psychological disorders such as schizophrenia. As mentioned earlier in this introduction, traumatic life events have been consistently identified as being a causative factor in the development of psychosis. Therefore, it is worthwhile to briefly discuss the meaning of persecutory delusions in relation to trauma. Trauma is another context within which paranoid ideation can be viewed not only as a reasonable response to one's environment, but also as an adaptive one. It has been proposed that negative beliefs about oneself and others can develop through social and emotional learning when living in a hostile environment (Gracie et al., 2007). We learn about the nature of the world and other people through our experiences. If an individual experiences trauma at a young age such as child abuse or neglect, they will be more likely to view the world as hostile and other people as threatening. Several researchers have discussed paranoia in the context of evolutionary psychology. They have put forward arguments that paranoid ideation may be adaptive in certain situations and some of their observations are worth mentioning in relation to the current topic of trauma. In an evolutionary sense, an ability to make rapid and efficient judgements about possible threats in one's environment is important for the survival of a species. Humans are incredibly social animals and therefore, an ability to detect social threats would be of particular importance to our ability to survive (Green & Phillips, 2004). In other words, the ability to quickly identify threats in the people around you is adaptive and useful within certain contexts. The ways in which a paranoid response may be adaptive within the context of traumatic experience will now be discussed. Error management theory is a model which attempts to understand decision making in the face of uncertainty. We live in an uncertain world and when faced with a decision, there is not always sufficient time or information to know for sure how to proceed. When we are faced with making a judgement under uncertainty, and there are different costs associated with a false positive and a false negative, it makes evolutionary sense to be biased towards whichever one is the least costly (Haselton & Funder, 2006). Consider how this applies to an individual who has previously experienced a trauma. They have learned that if they do not rapidly identify threat in their environment, they are at risk of serious physical or psychological harm. For them, not picking up on a threat is more costly than falsely identifying a threat that isn't actually there. Therefore, it would be adaptive for them to be biased towards threat detection. It has been argued before that being suspicious of the intentions of others could be adaptive in some situations and only becomes a problem when these suspicions become unfounded, excessive, or distressing (Bebbington et al., 2013). It begs the question, is it inappropriate to label paranoid ideation as a purely disordered process? Research like this demonstrates the importance of not just thinking about the nature of a delusional belief itself but also considering the environment and context within which it was shaped.

1.2.6. Social accounts of paranoia.

It is evident from the literature discussed thus far that the fields of psychology and psychiatry have been dominated by individualistic accounts of paranoia development. This, however, seems counter-intuitive as at their core, paranoia and persecutory delusions are processes focused on the detection of ill-intent in others and much of the information used to support delusional beliefs is interpersonal in origin. They are fundamentally social processes which have a strong influence on subsequent social behaviours (Cromby & Harper, 2009). Therefore, it is imperative that the social, relational, and societal foundations of paranoid ideation be discussed. When one attempts to explain paranoia from a social perspective, the focus is on understanding how our internal subjectivity interacts with the external world around us (Cromby & Harper, 2009). These theories recognise the problems associated with labelling a belief as empirically false and instead, focus on how that belief influences the way an individual feels and acts (Mckechnie & Harper, 2011). In general, paranoid ideation has been found to be significantly associated with poorer social functioning and increased social phobia (Freeman et al., 2010). As these findings suggest that paranoid individuals find social interaction more difficult than their healthy counterparts, it is understandable that they are also more likely to be socially isolated (Cromby & Harper, 2009). While the effects of social isolation have undoubtedly received insufficient research attention to date, it has been suggested that being isolated may exacerbate delusional beliefs by limiting opportunities for reality testing (Freeman, 2007). The societal context that we live in partly shapes our view of reality and therefore, can influence how we form beliefs. When discussing the influence of society on paranoid ideation, Mckechnie and Harper (2011) made an interesting point about social inequality. Poor people living in very unequal societies have reduced power over their own lives and are at increased risk of victimisation. Feeling under threat and feeling like powerful people are controlling you would be reasonable responses in this type of uncertain societal environment. In other words, the development of paranoid thought patterns would be understandable in a situation such as this. Paranoia is associated with low socio-economic status (Kendler, 1982) as well as refugee status (Westermeyer, 1989). Additionally, perceived discrimination was found to be significantly associated with delusions in immigrants with psychosis (Van den Berg et al., 2011). These findings suggest that the development of paranoid ideation could be a natural response to living in a society that makes you feel powerless. Arguably, social factors are most closely related to paranoid ideation on the interpersonal level. Interpersonal interactions have been identified as playing a key role in the development of paranoid beliefs. As mentioned previously much of the information which is used to support persecutory beliefs is interpersonal in nature. For example, facial expressions and body language are interpreted as negative and threatening, therefore confirming paranoid beliefs. It is important to remember however, that the interpersonal aspect of paranoia development may be more complex than simple threat perception. Research has also begun to investigate how paranoia affects subsequent social behaviour. A study conducted by Combs and Penn (2002) found that individuals who were high in subclinical paranoia engaged in less pro-social behaviour when around other people. This finding suggests that in addition to perceiving social situations in more negative ways, paranoid individuals also behave differently in social situations based on their paranoid thoughts. It would appear that the role played by interpersonal social relationships in paranoia development is not yet fully understood.

1.3.1. Paranoia's role in psychosis development.

Taking all of this existing research into account, it clearly demonstrates that paranoid cognition can shape how one perceives, behaves within, and interacts with the world around them. Current literature has also highlighted that low-level paranoid thoughts occur relatively frequently in the general population. It is already accepted that delusional ideation is one of the hallmarks of psychotic disorders and based on the literature discussed above, it is also plausible that paranoia could play a key role in the genesis and development of these disorders. Despite this however, the precise role that paranoia plays in the development of psychosis is still shrouded in mystery at this time. Therefore, this thesis aims to address this gap in the current literature. It is believed that a deeper understanding of how one transitions along the psychosis continuum could be achieved by exploring the nature of the relationships between paranoia and other psychotic experiences. This could lead to the development of more effective and symptom targeted treatments as well as more sophisticated early intervention strategies. The progress in subclinical psychosis research in recent years indicates that focusing on how paranoia interacts with other psychotic symptoms in the early stages of psychosis development could be particularly fruitful. Therefore, this thesis will attempt to explore the effects of paranoia at the milder end of the continuum where some may consider the genesis of psychotic experience to take place. The first obstacle to be faced in order to study paranoia's role in psychosis development is creating a practical theoretical framework around which this research can be conducted. This framework should capture the social nature of paranoid ideation and provide a plausible account of the relationships between paranoia other psychotic experiences. To address this, the author puts forward a novel theoretical model of early psychosis development with paranoid cognitions at its centre. This model will not only provide a structure to help plan and formulate research questions but will also aid the identification of complimentary analyses to test these questions.

1.3.2. The Cascade of Misinformation: A possible pathway to psychosis.

The model which the author is proposing is built around the central premise that paranoia plays a key role in the early stages of psychosis development. First and foremost, mild paranoid ideation has been found to be common in the general population. Moreover, research suggests that severe persecutory delusions, which are a hallmark of psychotic disorders, are built hierarchically on these milder paranoid thoughts (Freeman et al., 2005). While the majority of subclinical psychotic experiences are transitory and do not lead to the development of a psychotic disorder, they have also been found to be associated with increased risk of developing additional psychotic experiences as well as future transition to clinical psychosis (van Os & Linscott, 2012). Therefore, taking the fact that paranoia is present in the general population and appears to be associated with a liability towards delusion development and an increased likelihood of developing other psychotic experiences into account, the suggestion that paranoid ideation could play a key role in the genesis of psychosis development is not unreasonable. In order for this model to be practical and testable, it needed to provide an account of the underlying causal mechanisms by which paranoia could lead to the emergence of additional psychotic experiences. Aspects of the cognitive, social, and evolutionary psychosis literature were used to inform these proposed mechanisms. As previously discussed in this introduction, social theories outline how living in environments which one perceives as threatening can lead to the development of negative beliefs about the intentions of others. The evolutionary literature has suggested that when an individual lives in an environment, which they perceive to be socially threatening, it is imperative that possible interpersonal dangers are identified and responded to quickly. Therefore, the individual will adapt by developing an increased attentional sensitivity to negative information and will collect less information before interpreting ambiguous stimuli as negative. This would therefore explain the jumping to conclusions bias which is observed in paranoid individuals. The combination of a hypersensitivity to possible threats and the reduction in reality-checking of negative beliefs could then lead to the rapid development of multiple paranoid beliefs and cognitions about the intentions and actions of others. These thinking patterns could then motivate a range of behavioural changes in the paranoid individual, which reinforce their paranoid beliefs in a number of ways. An example of this would be reducing prosocial behaviours towards people who they believe are out to get them. These reductions in prosocial action on the part of the paranoid individual could result in the people around them responding in kind, thereby providing reinforcement for the paranoid beliefs. Another example is isolating oneself and withdrawing from social situations, which would make it more difficult to reality test their negative social beliefs. This combination of altered attention, perceptions, and behaviours could kick-start a cascade of misinformation where existing paranoid cognitions precipitate the rapid development of numerous additional threat-based beliefs. The current model proposes that this internal state, characterised by hypervigilance towards threat and a bias towards negative interpretations, can provide the psychological backdrop against which more severe psychotic symptoms such as hallucinatory experiences emerge. This addition of aberrant perceptual experiences like hearing voices or beginning to see faces in shadows could compound and reinforce paranoid thought patterns and in turn, precipitate the experience of other hallucinatory events. Ultimately, this results in a process of psychosis development where multiple psychotic experiences mutually interact and influence each other's development and maintenance. The current model posits that over time, this process, which was kick-started by low-level paranoid thinking and maintained by a network of interacting psychotic experiences, can result in the development of a clinical psychotic disorder such as Schizophrenia.

1.3.3. Aims and hypotheses of the thesis.

In a broad sense, the current thesis is concerned with understanding the role that paranoia plays in the development of psychosis. This introduction has highlighted the complexity of the mechanisms underlying the psychosis continuum and the limitations of how the continuum is conceptualised. The cascade model outlined in section 1.3.2 above provides a practical line of enquiry to facilitate decisions surrounding hypothesis formulation and the selection of analytic paradigms. There are a number of key gaps in the existing literature, which need to be illuminated in order to determine whether or not the pathway to psychosis development put forward in this thesis is a plausible one. The first objective of this thesis is to gain an understanding of how paranoia is distributed in the general population, how it relates to the underlying psychosis continuum, and how it relates to other psychotic experiences. To achieve this, in chapter 2, latent class analysis will be used to identify subgroups of individuals in the population with different profiles of psychotic experience. A regression analysis will then be used to explore associations between these subgroups and known risk factors for psychosis development. It is predicted that paranoia will feature prominently in classes which have an increased risk of transitioning to clinical psychosis. Following this, in chapter 3, Item response theory will be used to investigate how paranoia and other psychotic experiences relate to the underlying psychosis continuum. It is predicted that paranoia will be "less difficult" to endorse than other experiences but will be strongly linked to the underlying continuum. In chapter 4, the relationships between paranoia and the other psychotic experiences will be investigated using network analysis. This will shed light on how these experiences co-occur and interact in the general population. In particular, it is predicted that paranoia will play a central role in the networks obtained.

The second objective of this thesis will be to explore the development of paranoia and other psychotic experiences over time. To achieve this, in chapter 5, a cross lagged panel model analysis will be carried out to establish the temporal ordering of psychotic experiences. This longitudinal analysis will help establish whether or not paranoia is capable of precipitating the development of subsequent psychotic experiences. Together, these studies aim to provide an in-depth account of paranoia's role in the early stages of psychosis.

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Chapter 2: The structure of psychotic experiences in the general population: A latent class analysis

Abstract

A Latent Class Analysis (LCA) study carried out by Murphy et al., (2007) identified 4 latent classes of individuals within the general population who were characterised by heightened levels of psychotic experience. Paranoia was a heavily featured experience within these classes. Moreover, some of these classes also displayed increased likelihoods of endorsing a number of known psychosis risk factors. It was proposed that these classes may represent different stages of a psychosis continuum. The findings also indicate that paranoia could play a prominent role in psychosis development. The current study investigates the underlying structure of psychotic experiences in the general population by conducting an accurate replication of Murphy et al.'s (2007) LCA study. It then explores the associations between the resulting latent classes and known risk factors associated with psychosis using a multinomial logistic regression analysis. The sample consisted of 7403 participants from the Adult Psychiatric Morbidity Survey (APMS), the follow-up survey to the British Psychiatric Morbidity Survey (BPMS) which was used in Murphy et al.'s (2007) original analysis. LCA revealed 4 latent classes characterised by varying levels of psychotic experience. This mirrored Murphy et al.'s findings. In line with results from several previous LCAs, a subgroup of individuals was identified who displayed extremely high likelihoods of experiencing paranoia. Multinomial logistic regression analysis revealed individuals in the paranoia class were at increased risk of being diagnosed with a number of psychological disorders including generalised anxiety disorder and depression. They were also more likely to have experienced childhood trauma. These findings indicate that high levels of subclinical paranoia increase one's risk of transitioning to a clinical psychotic disorder. Across the four latent classes, as psychotic experience increased, so did the strength of associations

with psychological disorders and childhood trauma. These latent classes possibly represent a continuum of psychotic experience in the general population. The high levels of paranoia in the paranoid and diagnostic classes highlight the relevance of this experience in the general population. The identification of a psychosis class with increased likelihood of endorsing a range of psychosis risk factors could indicate that paranoid ideation plays a role in psychosis development. Taking all of this into account, the current study has strengthened the findings of the original work (Murphy et al., 2007), demonstrating that the patterns of subclinical psychotic symptom distribution appear to be consistent when their measurement is consistent and are evident within the general population. Moreover, they suggest that future research should explore paranoia's role subclinical psychosis further.

2.1. Introduction

This chapter aims to explore the distribution of subclinical psychotic experiences in the general population. This will be achieved by identifying latent subgroups of individuals with varying patterns of psychotic experience in a large community-based sample. In particular, the author is interested in whether or not a subgroup characterised by high levels of paranoid ideation will emerge. Following this, the relationships between the different subgroups and a number of risk factors associated with psychosis development will be explored.

Research has demonstrated that clinical psychotic disorder diagnoses such as schizophrenia are highly clinically heterogeneous constructs (Kendler, McGuire, Gruenberg, & Walsh, 1994). This finding is significant as it calls into question the validity of conceptualisations of psychosis which were based on these traditional psychotic diagnostic categories (McGorry, Bell, Dudgeon, & Jackson, 1998). This prompted some researchers to begin forming new concepts of psychosis which were not informed by potentially poorly validated diagnostic labels. To achieve this, dimensional research techniques were employed to explore the underlying structure of psychotic experiences across the entire population. One of the most commonly used statistical paradigms in this context is exploratory factor analysis (EFA). EFA is a statistical method which is concerned with identifying underlying relationships between large groups of variables. McGorry and colleagues explored the dimensional structure of psychotic symptoms using this technique. Analysis focused on a representative sample of 509 respondents with first episode psychosis. The findings indicated that the distribution of psychotic symptoms in the sample was best described in terms of four overarching dimensional factors (McGorry et al., 1998).

A similar factor structure was found in a CFA carried out by Claridge and colleagues. They explored the underlying structure of schizotypy in a subclinical sample containing 1095 adult respondents. They also found that their data were best represented by 4 dimensional factors: aberrant beliefs/perceptions, cognitive disorganisation, anhedonia, and asocial behaviour (Claridge et al., 1996). In recent years, more complex factor analytic techniques have been used to explore the continuum of psychosis. A study carried out by Reininghaus and colleagues, which analysed the factor structure of psychotic symptoms in a clinical sample containing 309 respondents diagnosed with first onset psychosis, found that a bifactor model consisting of one general factor and five specific factors provided a better account of the symptom distribution compared to more traditional factor analytic models (Reininghaus, Priebe, & Bentall, 2013). Following this, Shevlin and colleagues carried out a similar bifactor analysis in a general population sample. Their analysis found that similar to clinical symptoms, the distribution of psychotic experiences was also best described using a bifactor model made up of one general factor and 5 specific factors (Shevlin, McElroy, Bentall, Reininghaus, & Murphy, 2016). This provided support for the psychosis continuum by indicating that there is continuity in terms of factor structure between clinical and sub-clinical psychotic experiences. Factor analytic techniques are useful because they allow researchers to explore how different psychotic experiences group together in the population. However, there are some questions regarding the underlying structure of psychosis which factor analysis cannot answer. For example, they cannot be used to explore how individuals with similar patterns of psychotic experience may group together in the population. Identifying different profiles of psychotic experience and exploring their associations with risk factors and outcomes could shed light on the mechanisms underlying the psychosis continuum. It is possible that there are sub-groups of individuals within the general population whose profiles of subclinical symptoms confer a particularly high risk of developing a clinical disorder. In order to investigate these possibilities, more sophisticated statistical techniques must be employed. A statistical modelling technique that could be useful in this context is latent class analysis. Many researchers have used it to enhance our understanding of multiple psychological disorders. The next section of this introduction will provide a description of what latent class analysis is and how it has been employed to date in the field of psychology, specifically in relation to psychotic disorders.

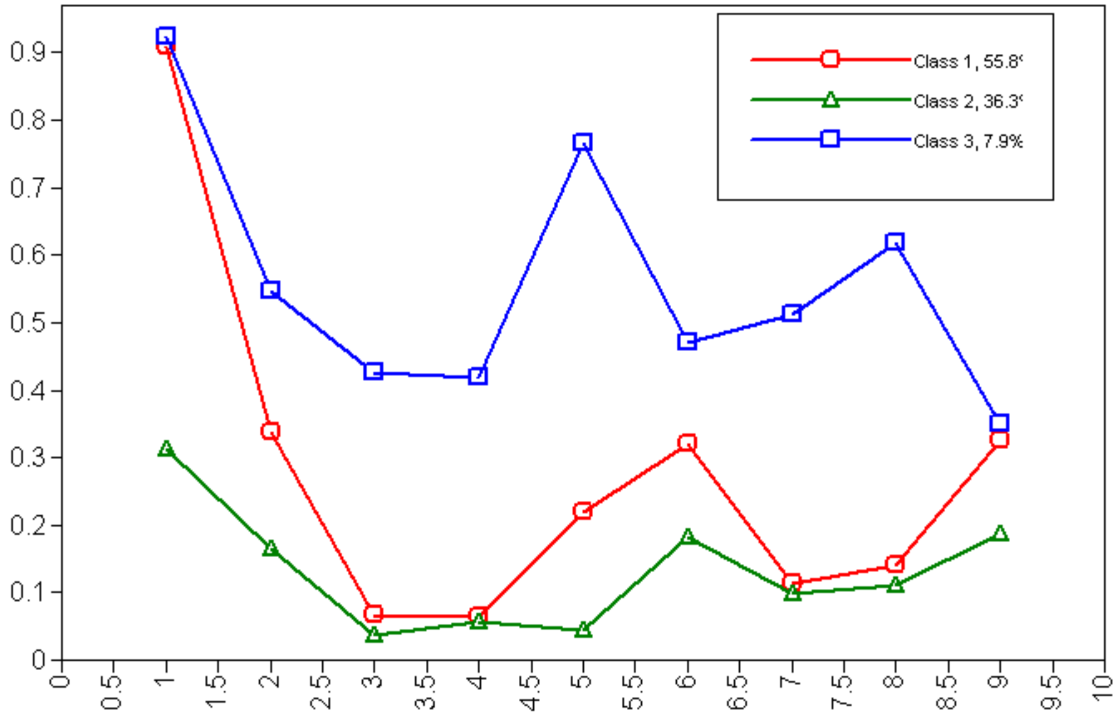
2.1.1. Latent class analysis

In order to describe what latent class analysis is, one must begin by answering the question, what is a latent class? To put it simply, a latent class is an unobserved group of individuals who all share similar response patterns to a number of observed variables (Magidson & Vermunt, 2004). Consider, for example, a sample of people who were asked two questions. 'Do you have an alcohol problem?' and 'Do you have a drug problem?'. Within this sample, there will most likely be a group of individuals who answer no to both questions, a group who say yes to the drinking problem, another group who say yes to the drug problem, and a group of individuals who say yes to both questions. Researchers may be interested in examining these groups separately to learn about specific effects of these different experiences. When researchers are only interested in two variables, there are few possible response patterns and they can be identified without the need for statistical analysis. Consider, however, if researchers wished to examine differences between individuals with different response patterns to a scale with 10 items on it. A scale containing 10 yes/no items would have 1024 unique possible response patterns. To attempt to manually assign individuals into groups in this way clearly would not be practical or useful. However, there still could be meaningful sub-groups of individuals in this data which could provide relevant insights into the nature of psychosis. This is where latent class analysis comes in. LCA is a measurement model which attempts to classify individuals into mutually exclusive groups based on their patterns of responses to a set of categorical variables. To achieve this, several models with varying numbers of latent classes are specified and estimated. These models are then compared to determine which one best fits the data. The maximum likelihood method is used to identify what amount of latent classes best account for the observed results (Rindskopf, 2009). LCA was first developed in the 1950s and has been steadily gaining popularity in the field of psychology for the last 20 years or so. The next section in this introduction will outline briefly how LCA output is interpreted.

In the first step of a latent class analysis, a number of competing latent class models are estimated and compared. In psychological research, it is common to compare five or six models in order to ensure the model with the optimum number of classes is chosen. The best fitting model is selected based on a number of model parameters. The first statistics that researchers will focus on are the goodness of fit indices. There are three of these; the Akaike Information Criterion or AIC (Akaike, 1974), the Bayesian Information Criterion or BIC (Schwartz, 1978), and the sample-size adjusted BIC (Sclove, 1987). In each case, smaller values indicate a better fitting model. All of these fit criteria identify the best fitting model by balancing how well the model fits the data with how parsimonious it is. So, for example, if a four-class model and a five-class model obtained comparable levels of model fit, these fit statistics would favour the four-class solution as it is more parsimonious. The entropy statistic is an overall measure of how accurately a given model has allocated individuals to different classes. It ranges from zero to one with higher values representing more accurate classification (Ramaswany et al., 1993). The final statistic to mention is the Lo-Mendell-Rubin adjusted likelihood ratio test. This is a statistic which allows the user to compare competing models with different numbers of classes. If a model obtains a non-significant likelihood ratio test (LRT) score, it indicates that the model with one fewer class provides better model fit (Lo et al., 2001).

Once the best fitting model has been identified, the response patterns of each of its latent classes can be represented graphically in a latent profile plot. Figure 2.1.1 below contains an example plot representing a three-class solution. Each line represents a latent class and the scale items are represented along the x axis. In this case, the scale used had 9 items in it. The probability of endorsing a given item is represented along the y axis with zero percent chance of endorsement at the bottom and a 100 percent chance of endorsement at the top. Each point along the profile plots indicates the probability that an individual in that class will endorse that item. To illustrate this point, consider item 1 on the x axis. Class 1 and class 3 both display around a 90% chance of endorsing this item. In contrast, class 2 has around a 30% chance of endorsing said item.

Figure 2.1.1. Sample 3-class latent profile plot.



2.1.2. Applications of LCA in existing literature

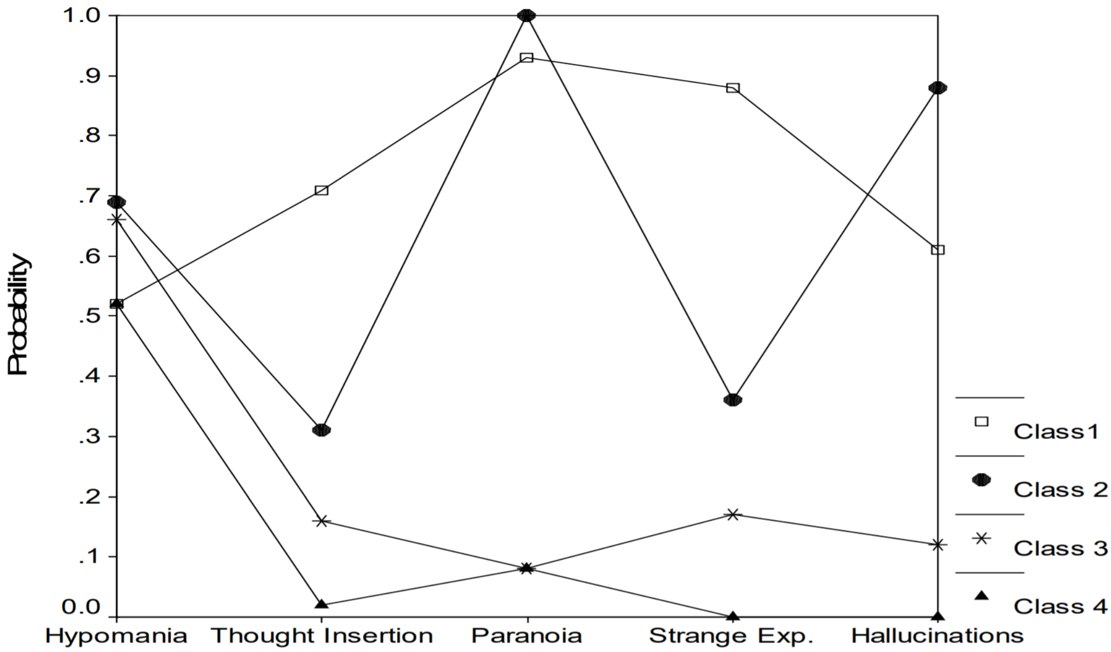
Now that a concise description of latent class analysis has been provided, the next section of this introduction will focus on how LCA has been applied in the study of psychotic disorders to date. Psychosis researchers have been utilising LCA as far back as the 1990s. A study conducted by Castle, Sham, Wessely, and Murray (1994) conducted an LCA on a sample of 447 first contact patients with a broad schizophrenia diagnosis. They identified two distinct sub-types of schizophrenia. The first they described as a 'neurodevelopmental' class. Individuals in this class were more likely to have earlier onset of disorder, exhibit poor social adjustment and restricted affect. Individuals in this class were also more likely to be male. The second was described as a 'paranoid' class and was characterised by later onset coupled with the experience of persecutory delusions. This class contained roughly equal numbers of males and females. Another study conducted by Kendler, Karkowski, and Walsh (1998) employed LCA to explore the nosologic structure of psychotic illness. Their sample consisted of 343 individuals with schizophrenia and 942 first degree relatives taken from the Roscommon family study. They found 6 distinct classes of psychotic illness which appeared to represent separate nosological constructs. These findings appeared to suggest that a range of psychotic syndromes existed in this sample. This was an important study as it was not consistent with kraepelinian and unitary models of psychosis which were prevalent at that time (Kendler et al., 1998).

The ability to identify unobservable psychosis subgroups has led to advancements in intervention research. LCA enabled Ahn et al., (2008) to identify a number of factors associated with non-adherence to antipsychotic medication. They conducted an LCA on a sample of 36,195 patients with schizophrenia and identified an adherent class, a partially adherent class, and a non-adherent class. The non-adherent group was associated with factors such as minority ethnicity, prior hospitalizations, and being female (Ahn et al., 2008). Information such as this is crucial in improving patients' pathways to recovery.

In recent years, as more and more researchers began to recognise that psychotic experiences exist along a continuum of severity in the population, LCA became an invaluable tool in this line of research. A study conducted by Gale, Wells, McGee, and Browne in 2011 used LCA to describe the underlying structure of subclinical psychotic experiences. The authors made use of a large household-based survey called the New Zealand Mental Health Survey. Their analysis identified three latent classes in the sample; a normal class, a hallucination class, and a psychotic class (Gale, Wells, McGee, & Browne, 2011). Gale et al.'s study is not the only one to use LCA to explore the underlying symptom structure of psychosis. Shevlin, Murphy, Dorahy, and Adamson (2007) explored the distribution of positive psychosis like symptoms in the National Comorbidity Survey (NCS). Similar to Gale et al.'s (2011) analysis, they identified a normal class, a hallucinatory class and a psychosis class. Unlike Gale's study however, they also identified an intermediate class within the population within which paranoia featured prominently. (Shevlin et al., 2007).

A study conducted by Murphy, Shevlin, and Adamson, (2007) stood out as being particularly relevant to the current thesis. Similar to the aforementioned studies, the authors were interested in exploring the underlying structure of psychosis symptoms in a large scale, population-based sample. Their sample was made up of data from the British Psychiatric Morbidity Survey (BPMS). The BPMS is the second in a series of surveys carried out by the Office of National Statistics. The surveys were designed to be representative of the general population living in England, Scotland and Wales. In total, 8,580 respondents were included in their analysis. The authors used LCA to search for distinct subgroups of individuals based on their responses to the five probe items of the Psychosis Screening Questionnaire (PSQ). Four latent classes were identified. The first was a normative group characterised by extremely low probabilities of experiencing any psychotic experiences. The second was an intermediate group characterised by psychotic symptom levels which were elevated compared to the normal group but still relatively low. The third class was a diagnostic psychosis class. It was characterised by extremely high probabilities of endorsing the PSQ probe items. The most interesting finding within the context of the current thesis was the nature of the fourth class. This final group was characterised by an extremely high probability of experiencing paranoia. This group was therefore named the paranoid class. The latent profile plot obtained from this analysis is displayed in figure 2.1.2 below. The latent classes which were obtained appeared to represent a continuum of psychosis proneness or severity within the sample. The intermediate, paranoid, and diagnostic classes were differentiated from the baseline level by varying levels of increased likelihood of endorsing psychotic experience. These four classes could be interpreted as representing different stages along the psychosis continuum. The symptom profiles within these groups highlighted paranoia as an experience which may play an important role in transitions along this continuum. Paranoid experiences featured prominently in both the paranoid and diagnostic classes. This explanation of the observed patterns was supported by results from a multinomial logistic regression which they ran to explore the associations between class membership and the experience of four childhood traumas; witnessing violence in the home, sexual abuse, running away from home, and being bullied. The trauma variables were most strongly associated with the psychosis group, followed by the paranoia group, and then the intermediate group (Murphy et al., 2007). Taken together, these findings indicate that experiencing paranoid ideation conveys a heightened risk of psychosis progression in the general population.

Figure 2.1.2. Profile plot for Murphy et al.'s latent class analysis



(Murphy et al., 2007)

One of the issues facing researchers who are using LCA to explore the underlying structure of psychotic symptoms is the apparent lack of consensus across different studies regarding the number and nature of psychosis classes present in the population. The three aforementioned studies that attempted to model the latent class structure of psychosis produced three different solutions. It is unclear why this lack of consensus exists. It may be down to factors such as measures and methodology. Different studies define psychosis in different ways and use different scales to measure it. Additionally, the characteristics of the samples used in these studies may play a role. However, if a new study was able to replicate the findings of one of these existing analyses, it would provide much more robust insights into the underlying mechanisms of psychosis. It would also be an important validation of the use of LCA to study psychotic symptom structure. Such a study would require two large epidemiological datasets that are comparable in terms of the populations they sampled, the measures they used, and the methodology they employed. Based on these criteria, Murphy et al.'s (2007) LCA study would appear to be the ideal candidate for replication. As previously mentioned, the sample used in Murphy et al.'s study (BPMS) was part of a series of surveys carried out by the ONS in the UK. The follow-up to the BPMS, called the Adult Psychiatric Morbidity Survey (APMS), was conducted in 2007 and is perfectly suited for a replication study such as this. Not only did the two surveys sample the same population, but they were also administered in the same way and used identical psychosis scales. In short, these surveys afford a unique opportunity to attempt to replicate the findings of two latent class analyses across two comparable, large-scale, community-based datasets. To the author's knowledge, a replication study such as the one being described has not yet been attempted in the field of psychosis research.

2.1.3. Study Aims.

The main aim of the current analysis is to conduct an accurate replication of Murphy et al.'s (2007) latent class analysis of positive psychosis symptoms. To do this, a latent class analysis will be conducted on the five probe items in the Psychiatric Morbidity Survey from the APMS dataset. Following this, a multinomial logistic regression will be carried out to examine the relationships between class membership and childhood trauma experiences. As the analysis will be so closely comparable to Murphy et al.'s original study in terms of the measures and methodology used, and if the patterns of psychotic experiences are consistent in the general population, then it is expected that the findings of this study will largely mirror those of the original 2007 work. Therefore, it is predicted that a four-class solution will be identified as the best fitting model. Furthermore, it is predicted that a class will emerge which is characterised by extremely high probability of experiencing paranoid ideation.

2.2. Method

2.2.1. Sample

The current study examined data from the third National Survey of Psychiatric Morbidity in Great Britain (also known as the Adult Psychiatric Morbidity Survey). The survey was conducted by the National Centre for Social Research in collaboration with the University of Leicester in 2007 as a follow-up to the BPMS, which was conducted in 2000 (a detailed description of the BPMS can be found in chapter 3). Their aim was to assess the prevalence of a range of both diagnosed and undiagnosed psychiatric disorders in the general population in England.

Data were collected from 7,403 respondents aged 16 and above living in private residences in England. The sample was 56.8% female, 21.7% of respondents were aged between 16 and 34, 34.4% between 35 and 54, 31.2% between 55 and 74, and 12.8% were aged over 75. In terms of ethnicity, the sample was predominately white (92.6%) with small numbers of black (2.6%), south Asian (2.7%) and mixed race (2.2%) respondents. A stratified multi-stage random probability sampling strategy was used for recruitment where households were selected at random using their small user Postcode Address File. One adult aged 16 or over was then selected for interview from each household. The survey was conducted in the respondent's home by trained interviewers. The questionnaire consisted of two interview stages. The stage two interview was administered to a subsample of respondents who displayed heightened probabilities of having psychological disorders based on their responses to screening questions. The current study focused solely on responses to the first stage of the survey. Each stage of the survey was administered using computer assisted personal interviewing. In order to produce a sample that was representative of the general household population, weighting variables were applied based on household size, household level, age, sex, and region.

2.2.2. Measures

As was the case in the BPMS, the stage 1 interview in the APMS used the Psychosis Screening Questionnaire (PSQ; Bebbington & Nayani, 1995) to assess whether or not respondents had experienced any psychotic symptoms within the last year. The PSQ consists of 5 probe questions followed by 5 secondary questions about mania, thought insertion, paranoia, strange experiences, and hallucinations. If a respondent endorsed the probe question, they would then be asked the secondary question. All questions use a binary (yes/no) response format. In order to compare results to Murphy et al.'s (2007) study, the 5 probe questions were selected for the current LCA analysis. These 5 questions are displayed in Table 2.1.1 below.

Table 2.1.1. PSQ Probe Questions

Mania	Have there been times when you felt very happy indeed without a break for days on end?
Thought	Have you ever felt that your thoughts were directly interfered with or controlled by some outside force or person?
Paranoia	Over the past year, have there been times when you felt that people were against you?
Strange	Over the past year, have there been times when you felt that something strange was going on?
Halls	Over the past year, have there been times when you heard or saw things that other people couldn't?

In addition to the psychosis variables selected for LCA analysis, a number of co-variates of psychosis were selected for the regression analysis. As was the case with the LCA variables, the variables for the current study were selected to mirror Murphy et al.'s (2007) study. The variables selected were a mixture of demographic variables, psychological disorder variables, and childhood trauma variables. The items selected for the current analysis were as follows;

1. Respondent Sex
2. Respondent Age
3. Verbal IQ: Intelligence was estimated from respondents' scores on the National Adult Reading Test (NART; Nelson & Wilson, 1982)
4. Ethnicity: A dichotomous variable was created which coded respondents as being of white ethnic origin or non-white ethnic origin.
5. Household Composition: A dichotomous variable was created in which respondents were identified as being co-habiting or living alone.
6. Employment Status: This consisted of a 4-category variable where respondents were identified as working full time, working part time, unemployed, or economically inactive.
7. Generalised Anxiety Disorder: The Clinical Interview Schedule (CIS-R) was used to produce an ICD-10 (International classification of diseases) diagnosis of Generalised Anxiety Disorder.
8. Drug Dependence: As was the case with the BPMS, the APMS recorded whether or not respondents were dependent on any drug.

9. Alcohol Dependence: Respondents who scored above 8 on the Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, De la Fuente, & Grant, 1993) were diagnosed as having an alcohol problem.
10. Mixed Anxiety/Depressive Disorder: The Clinical Interview Schedule (CIS-R) was used to produce an ICD-10 diagnosis of Mixed Anxiety/Depressive Disorder.
11. Depressive Episode: The Clinical Interview Schedule (CIS-R) was used to produce an ICD-10 diagnosis of a depressive episode
12. Obsessive Compulsive Disorder: The Clinical Interview Schedule (CIS-R) was used to produce an ICD-10 diagnosis of Obsessive-Compulsive Disorder.
13. Violence in the Home: A section of the APMS recorded the experience of victimisation and stressful life events including violence in the home, sexual abuse, running away from home, and bullying.
14. Sexual Abuse
15. Running Away From Home
16. Bullying.

2.2.3. Statistical Analysis

Latent Class Analysis

The current analysis took place in two stages. In the first stage, Latent Class Analysis was used to determine the number and nature of psychosis subtypes in the APMS sample. The author was particularly interested in whether or not the results from this analysis would mirror Murphy et al.'s (2007) findings. Six latent class models were tested in the current analysis. A number of model fit statistical indices were used to select the optimal number of latent classes. These fit indices were as follows:

Likelihood ratio chi-square (LRx^2), Akaike information criterion (AIC; Akaike, 1987), Bayesian information criterion (BIC; Schwartz, 1978), sample size adjusted BIC (SSABIC; Sclove, 1987), entropy measures (Ramaswamy, DeSarbo, Reibstein, & Robinson, 1993), and the Lo-Mendell-Rubin's adjusted likelihood ratio test (LRT; Lo, Mendell, & Rubin, 2001).

If a model obtains a non-significant likelihood ratio chi-square score, it indicates that it has an acceptable level of model fit. The AIC, BIC, and SSBIC are measures of goodness of fit where lower scores indicate a better fitting model. Entropy scores can range from 0 to 1 with higher scores indicating a better fitting model. Lo-Mendell-Rubin's LRT is another way to compare competing models with different numbers of latent classes. If a model obtains a non-significant LRT score ($p>0.05$), this suggests the model with one less class should be chosen. The statistical package Mplus version 7 (Muthen & Muthen, 1998-2012) was used to run the LCA analysis.

Multinomial Logistic Regression

The second stage of analysis involved using a multinomial logistic regression to explore the relationships between class membership and sex, age, ethnicity, household composition, verbal IQ, employment, Generalised Anxiety Disorder, drug dependence, alcohol dependence, mixed anxiety/depression, depressive episode, Obsessive Compulsive Disorder, and four childhood traumatic experiences. Individuals were assigned to a class based on the posterior probabilities from the 4 class LCA model. The regression analysis produces odds ratios for each variable. These odds ratios represent the expected increase or decrease in the likelihood of endorsing a given variable compared to the reference group. The LCA analysis was conducted using statistical package for the social sciences (SPSS) version 24 (Armonk, 2016).

2.3. Results

2.3.1. Descriptive statistics

Table 2.1.2 below contains the endorsement rates for each of the 5 probe questions in the PSQ. The 5 questions varied highly in relation to their rates of endorsement. The hypomania item was endorsed by over half of the sample (51.5%). The lowest levels of endorsement were associated with item 5 (4.4%) which measured hallucinations. Items 2 and 4, measuring thought insertion and strange experiences respectively, were also endorsed by small percentages of the population (7.8% and 8.3% respectively). Item 3, measuring paranoia, was endorsed by a larger number of respondents (17.5%).

Table 2.1.2. Frequency of endorsement of psychosis screening items.

Screening Item	Yes N (%)
Felt very happy without a break	3816 (51.5%)
Felt thoughts were interfered with	579 (7.8%)
Felt people were against you	1299 (17.5%)
Felt something strange was going on	611 (8.3%)
Heard/saw things that others couldn’t	323 (4.4%)

2.3.2. Latent class analyses

Table 2.1.3 contains the fit indices from the six latent class analyses. The four-class solution was identified as the best fitting model. The associated likelihood ratio chi-square was non-significant, both the AIC and ssaBIC fit statistics were lower for the 4-class solution than the 2 or 3 class solutions. The entropy value (0.719) indicated acceptable levels of classification accuracy. Additionally, the non-significant Lo-Mendell-Rubin's LRT indicated that the 5-class solution was not significantly better than the 4-class solution. Unlike the AIC and ssaBIC, the BIC value for the 4-class solution was not lower than in the 3-class solution which would usually suggest that it is not the optimal solution however taking all of these results into account, the 4-class solution is still considered to be the best model.

Table 2.1.3. Fit statistics for LCA of the PSQ psychosis screening items.

Classes	Log-likelihood χ^2 (*df*), *p*	AIC	BIC	ssaBIC	Entropy	LRT, *p*
1	626.511 (24), $p < 0.05$	27866.904	27901.450	27885.561	-	-
2	115.603 (20), $p < 0.05$	25546.109	25622.110	25587.155	0.797	2289.956, $p < 0.05$
3	47.837 (14), $p < 0.05$	25479.446	25596.903	25542.880	0.699	77.218, $p < 0.05$
4	13.045 (8), $p > 0.05$	25451.283	25610.195	25537.106	0.719	39.425, $p < 0.05$
5	4.267 (2), $p > 0.05$	25453.495	25653.863	25561.708	0.740	9.608, $p > 0.05$
6	0.918	25462.046	25703.869	25592.647	0.770	3.386, $p > 0.05$

AIC Akaike information criterion, *BIC* Bayesian information criterion, *ssaBIC* sample size-adjusted BIC, *LRT* Lo-Mendell-Rubin adjusted likelihood ratio test

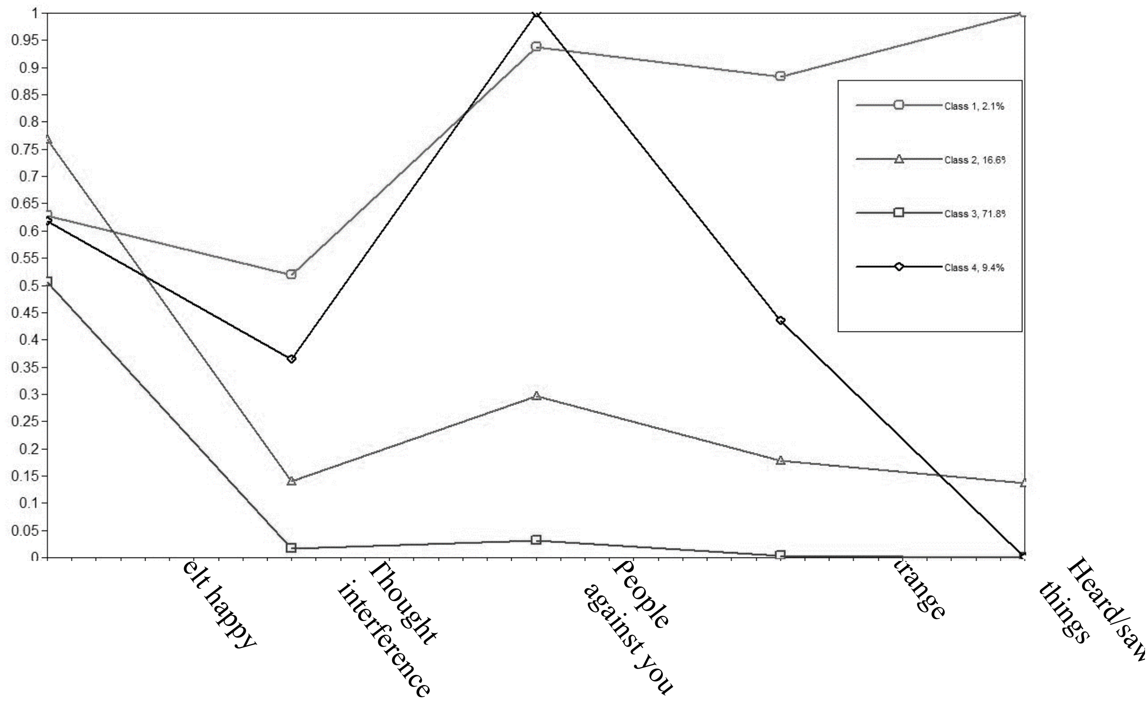
The latent class profile plot of the chosen model is shown below in figure 2.2.1. Class 3 was the largest class. It contained 77.1% (N=5706) of the sample and was characterised by almost zero probability of endorsing items 2, 3, 4, and 5 of the PSQ probe items. The probability of endorsing item 1 (hypomania) was only slightly lower than the other three latent classes. This class was labelled the baseline class.

The smallest class was class 1 which contained 2% (N=150) of the sample. The individuals in this class were characterised by some of the highest probabilities of item endorsement. Items 3, 4, and 5 had almost 100% probabilities of endorsement. The probability of endorsing item 2 was lower but was still higher than the other three classes. Item 1 had a similar probability of endorsement to the other classes. This class was labelled the diagnostic class.

Class 2 contained 10.3% (N=765) of the sample. It displayed a very similar profile to the one seen in class 3. As was the case in class 3, class 2 is characterised by low probabilities of endorsing items 2, 3, 4, and 5 and a higher probability of endorsing item 1. While the probabilities in this class are low, they are still higher than the class 3 probabilities. This class was labelled as an intermediate class.

Class 4 contained 10.5% (N=779) of the sample. Similar to class 2, it seemed to represent an intermediate group of individuals. It displayed moderate probabilities of endorsing items 1, 2, and 4 and a very low probability of endorsing item 5. Unlike class 2 however, it was also characterised by a 100% chance of endorsing item 3; paranoia. Thus, this class was labelled as a paranoid class.

Figure 2.2.1. Profile plot for latent class analysis of the Psychosis Screening Questionnaire



2.3.3. Regression Analysis

Following this, in the second stage of analysis, the associations between the four latent classes and demographic factors, clinical variables, and childhood traumas were estimated using a multinomial logistic regression. In this model, class membership was the dependent variable and the covariates were used as predictors. Table 2.1.4 below contains the prevalence of each covariate across the four latent psychosis classes.

Table 2.1.4. Psychiatric illness prevalence from psychosis class to baseline class

	Diagnostic Count Col%	Intermediate Count Col%	Baseline Count Col%	Paranoid Count Col%
Class Size	N=150 (2%)	N=765 (10.3%)	N=5706 (77.1%)	N=779 (10.5%)
Non-white ethnicity	16 (10.7%)	52 (6.8%)	402 (7%)	76 (9.8%)
Living alone	46 (30.7%)	200 (26.1%)	1617 (28.3%)	234 (30%)
Unemployed	12 (8%)	18 (2.4%)	99 (1.7%)	35 (4.5%)
Generalised anxiety disorder	27 (18%)	41 (5.4%)	164 (2.9%)	131 (16.8%)
Drug dependence	15 (10%)	29 (3.8%)	92 (1.6%)	61 (7.8%)
Alcohol dependence	59 (39.3%)	195 (25.5%)	1101 (19.3%)	248 (31.8%)
Mixed Anxiety/Depressive	27 (18%)	130 (17%)	337 (5.9%	182 (23.4 %)
Depressive episode	24 (16%)	29 (3.8%)	75 (1.3%)	79 (10.1%)
Obsessive Compulsive disorder	10 (6.7%)	15 (2%)	17 (0.3%)	44 (5.6%)
Violence in the home	44 (29.3%)	111 (14.5%)	367 (6.4%)	173 (22.2%)
Sexual abuse	31 (20.7%)	62 (8.1%)	189 (3.3%)	104 (13.4%)
Run away from home	27 (18%)	67 (8.8%)	149 (2.6%)	88 (11.3%)
Bullied	64 (42.7%)	223 (29.2%)	819 (14.4%)	286 (36.7%)

The likelihood ratio tests for the demographic risk factors, clinical variables, and childhood traumas are reported in table 2.1.5 below. The table shows that the latent classes were significantly associated with age, household composition, verbal IQ, employment status, Generalised anxiety disorder, drug dependence, alcohol dependence, mixed anxiety/depressive disorder, depressive episode, and obsessive-compulsive disorder. The four childhood trauma variables were also significantly associated with latent class membership.

Table 2.1.5. Likelihood ratio tests for multinomial logistic regression for demographic risk factors, clinical variables, and traumas.

Variable	-2log likelihood	Chi-square	df	Sig.
Sex	5443.444	1.040	3	.791
Age	5520.799	78.396	18	.000
Ethnicity	5444.550	2.147	3	.543
Household composition	5454.533	12.129	3	.007
Verbal IQ	5468.488	26.085	6	.000
Employment	5462.028	19.625	9	.020
Generalised anxiety disorder	5531.846	89.443	3	.000
Drug dependence	5450.742	8.339	3	.040
Alcohol dependence	5463.474	21.071	3	.000
Mixed anxiety/depressive	5666.342	223.938	3	.000
Depressive episode	5484.666	42.262	3	.000
OCD	5478.388	35.985	3	.000
Violence in the home	5468.964	26.561	3	.000
Sexual abuse	5463.729	21.325	3	.000
Run away from home	5470.090	27.686	3	.000
Bullied	5503.247	60.844	3	.000

The odds ratios associated with each covariate for each latent class compared to class 3 (Baseline) are contained in table 2.1.6. The likelihood of being in one of the lower age categories was highest in the intermediate and paranoid classes. The paranoia group obtained the highest odds ratios of the two. In terms of the household composition variable, odds ratios indicated that individuals in the paranoia group were more likely to be living alone compared to those in the baseline class. The odds ratios associated with verbal IQ demonstrated that the psychosis class had a higher likelihood of being in the lowest IQ category (70-89) compared to the baseline class. Additionally, both the psychosis and intermediate classes were more likely to be in the middle IQ category (90-109) compared to the normative class. The psychosis group obtained the highest odds ratio. For the employment variable, odds ratios indicated that the intermediate group was more likely to be employed than the baseline group. Also, individuals in the paranoia class had an increased likelihood of being in unpaid family work compared to the normative class. Finally, the likelihood of being unemployed was higher in the psychosis class compared to baseline.

Looking at the GAD variable, odds ratios indicated that individuals assigned to either the psychosis class or paranoia class were more likely to be diagnosed with the disorder than those assigned to the baseline class. Of the two, the highest odds ratio was associated with the paranoia class. The paranoia class also had an increased likelihood of drug dependence compared to baseline. Both the psychosis class and paranoia class were more likely to be dependent on alcohol with the psychosis group obtaining the highest odds ratio of the two. Odds ratios indicated that the psychosis, intermediate, and paranoia groups were more likely to experience mixed anxiety/depression, a depressive episode, and obsessive-compulsive disorder compared to the baseline group. Of the three, the paranoia class obtained the highest odds ratios for mixed anxiety/depression and obsessive-compulsive disorder while the highest odds ratio for experiencing a depressive episode was obtained by the psychosis class.

In terms of the four childhood trauma experiences, their associated odds ratios showed that they were each more likely to occur in the psychosis, intermediate, and paranoia classes compared to the baseline class. There was one exception to this. The intermediate group did not have an increased likelihood of experiencing sexual abuse compared to baseline. For each of the four childhood traumas, the highest odds ratios were associated with the psychosis group.

Table 2.1.6. Associations between classes and demographic risk factors

Variable	Diagnostic	Intermediate	Paranoid
Sex (male)	1.135 (.770-1.672)	1.044 (.880-1.238)	1.079 (.897-1.297)
Age			
16-24	2.029 (.762-5.405)	2.402 (1.538-3.751)**	5.313 (3.114-9.067)**
25-34	1.422 (.557-3.632)	1.653 (1.085-2.518)*	3.328 (1.991-5.563)**
35-44	2.007 (.818-4.926)	2.144 (1.438-3.198)**	4.454 (2.715-7.307)**
45-54	1.461 (.588-3.630)	1.684 (1.119-2.533)*	3.602 (2.189-5.929)**
55-64	.827 (.318-2.153)	1.574 (1.074-2.307)*	2.656 (1.635-4.316)**
65-74	.867 (.327-2.298)	1.460 (.998-2.136)	1.637 (.978-2.738)
Ethnicity (white)	.676 (.335-1.365)	.985 (.669-1.448)	.798 (.548-1.161)
Living alone	1.358 (.897-2.056)	1.151 (.948-1.396)	1.405 (1.148-1.719)**
Verbal IQ			
70-89	2.385 (1.456-3.907)**	1.235 (.981-1.555)	1.042 (.816-1.331)
90-109	1.650 (1.047-2.598)*	1.401 (1.167-1.682)**	1.187 (.977-1.442)
Employment			
Employed	1.153 (.728-1.826)	1.355 (1.093-1.679)*	1.147 (.920-1.430)
Unpaid family work	5.495 (.646-46.736)	1.440 (.322-6.445)	4.013 (1.290-12.490)**
Unemployed	2.572 (1.169-5.658)*	1.228 (.692-2.179)	1.638 (.989-2.713)
GAD	3.281 (1.868-5.762)**	1.442 (.965-2.154)	4.531 (3.337-6.152)**
Drug dependence	1.819 (.932-3.549)	1.351 (.855-2.136)	1.777 (1.181-2.675)*
Alcohol dependence	1.978 (1.346-2.907)**	1.101 (.907-1.338)	1.436 (1.181-1.748)**
Mixed anxiety/depressive	3.379 (2.055-5.555)**	3.213 (2.536-4.070)**	5.272 (4.186-6.638)**
Depressive episode	5.142 (2.672-9.895)**	2.193 (1.323-3.636)*	3.516 (2.302-5.369)**
Obsessive compulsive disorder	5.153 (1.831-14.502)**	4.794 (2.119-10.846)**	7.461 (3.645-15.271)**
Violence in home	2.162 (1.369-3.415)**	1.372 (1.057-1.782)*	1.792 (1.398-2.296)**
Sexual abuse	2.972 (1.794-4.922)**	1.381 (.990-1.928)	1.672 (1.223-2.286)**
Run away from home	2.573 (1.516-4.368)**	2.082 (1.490-2.907)**	1.914 (1.368-2.679)**
Bullied	2.061 (1.387-3.061)**	1.761 (1.454-2.133)**	1.842 (1.514-2.240)**

2.4. Discussion

The current study aimed to explore the underlying structure of psychotic experiences in the general population using LCA. The analysis was designed to replicate a previous LCA study carried out by Murphy et al., (2007). As predicted, 4 latent classes characterised by varying levels of psychotic experiences were found in the current study, mirroring Murphy et al.'s findings. Moreover, the nature of latent classes which were identified in the current study bore a number of similarities to Murphy et al.'s original work. In line with results from several previous LCAs, a subgroup of individuals were identified who displayed extremely high likelihoods of experiencing paranoia. The current study also ran a multinomial logistic regression to explore how the different latent classes varied in terms of a range of risk factors. Individuals in the psychosis class were found to be at increased risk of being diagnosed with a number of psychological disorders. They were also more likely to have experienced childhood trauma. The implications of these findings will now be discussed in relation to the existing literature and overall thesis aims. The associated limitations of this study and implications for future research and clinical practice will also be discussed.

2.4.1. Class Profiles

Results from the latent class analysis identified four distinct unobserved classes of individuals. These classes were labelled as follows: 1: Diagnostic Class, 2: Intermediate Class, 3: Baseline Class, 4: Paranoid Class. The four classes differed from each other in terms of their probabilities of endorsing each of the five PSQ probe questions. Importantly, the number of classes was consistent with the LCA in Murphy et al.'s (2007) study, which also identified four separate sub-groups within the BPMS sample. The next section of this discussion will compare the nature of the classes found in the current study to those found in the original 2007 work.

2.4.1.1. Class 1: Diagnostic Class

The first class contained 2% of the sample. Individuals in this class were characterised by extremely high probabilities of endorsing 3 of the 5 of the probe items and moderately high probabilities of endorsing the other two. Considering the high probabilities of item endorsement, this class appeared to be indicative of a disorder group and was labelled the diagnostic class. This is also supported by the fact that the lifetime prevalence of psychotic disorder is estimated to be around 3% (Perala, Suvisaari, & Saarni, 2007). As predicted, this class was comparable to the diagnostic/pathological class which was found in Murphy et al.'s (2007) study in terms of both size and structure. Their diagnostic/pathological class contained 1% of the sample and it also displayed high probabilities of endorsing 3 of the 5 of the probe items and moderately high probabilities of endorsing the other two.

2.4.1.2. Class 2: Intermediate Class and Class 3: Baseline Class

The second and third classes were characterised by some of the lowest probabilities of symptom endorsement. Apart from item 1 (hypomania), which displayed moderate probabilities of endorsement across all four latent classes, class 3 obtained the lowest probabilities in the analysis, having almost zero chance of endorsing items 2, 3, 4, and 5. The majority of individuals in the sample (77.1%) were assigned to class 3. This class was therefore labelled as the 'baseline' group because it appeared to represent a group of 'healthy' individuals who made up the majority of the population and possessed a close to zero percent chance of experiencing psychotic symptoms. Class 2 contained 10.3% of the sample and displayed slightly elevated probabilities of endorsement compared to the baseline class. While the probabilities were higher than the baseline class, they were still much lower than those in the disorder class. Class 2 was therefore labelled as an intermediate group. It is interesting to note that the profiles of symptom prevalence are almost identical between the baseline and intermediate classes. Furthermore, when comparing these two classes to Murphy et al.'s original study, some striking similarities are evident. The 2007 study identified a baseline and intermediate class with profiles extremely close to those observed in the current analysis. They both displayed moderate probabilities of endorsing the hypomania item and low probabilities of endorsing the other four items. Additionally, the sizes of these classes were markedly similar to those observed in this analysis. Their baseline group contained 75.9% of their sample (compared to 77.1% in the current analysis) and their intermediate group contained 7.1% (compared to 10.3%).

2.4.1.3. Class 4: Paranoid Class

The final class contained 10.9% of the APMS sample. Individuals in this class possessed moderate probabilities of endorsing items 1 (hypomania), 2 (thought interference), and 4 (strange experiences), and a zero probability of endorsing item 5 (hallucinations). The most prominent feature of this class however was that it displayed a 100% probability of endorsing item 3; paranoia. This was even higher than the paranoia levels observed in the diagnostic class. Class 4 was therefore labelled the paranoid group. As was the case with the previous classes, this class shared compelling similarities with the paranoid class identified in Murphy et al.'s (2007) original work. It also displayed a 100% chance of endorsing paranoia and a moderate probability of endorsing hypomania, thought interference, and strange experiences. The two paranoia classes differed in terms of their hallucination levels however. Murphy et al.'s paranoia class possessed a high probability of hallucinations while the paranoia group in the current analysis possessed a zero probability of hallucinations. Despite these small differences, by in large the observed latent sub-groups of individuals were consistent across both studies. The results of the LCA are therefore in line with the study predictions.

2.4.2. Associations With Trauma

In the second stage of the analysis, the four resulting subgroups were compared in terms of their associated prevalence rates of traumatic experiences. To achieve this, a multinomial logistic regression was carried out which explored whether or not the intermediate, paranoid and disorder classes were more likely to experience these traumas compared to the baseline group. The prevalence rates of the four traumatic experiences varied considerably across the four classes. The highest rates of trauma were associated with the disorder class. Bullying was the most widely reported trauma with 42.7% of individuals in the disorder group experiencing it. This was followed by violence in the home (29.3%), sexual abuse (20.7%), and finally running away from home (18%). These endorsement rates were lower but still considerable in the paranoid class. Once again, bullying was the most common experience (36.7%) while running away from home was the least common (11.3%). These numbers were lower again in the intermediate group and the baseline group reported the lowest levels of trauma. For example, 14.4% of the individuals in the baseline group reported being bullied and only 2.6% reported running away from home. These findings were consistent with the results of Murphy et al.'s (2007) analysis which also found that trauma prevalence increased from baseline to intermediate to paranoid to disorder class.

Moving on to the regression analysis, a similar pattern emerged. For the most part, the psychosis, intermediate, and paranoia classes were all significantly more likely to experience each of the four traumas compared to the baseline group. The one exception to this was the intermediate group which was no more likely to experience sexual abuse compared to the baseline. In each case, the psychosis group obtained the highest odds ratios in the analysis. Individuals belonging to this group were more than twice as likely to experience the four traumatic experiences compared to baseline. The psychosis class was most closely associated with sexual abuse (OR=2.972). After the psychosis class, the paranoid class obtained the next highest odds ratios for violence in the home (OR=1.792), sexual abuse (OR=1.672) and bullying (1.842). The intermediate class was more closely linked to running away from home than the paranoid class (OR=2.082 vs OR=1.914). Comparing these results to those reported in Murphy et al.'s (2007) study, it's important to note that the associations observed here were not as strong as those observed in the original analysis. Their regression found that those in the psychosis group were more than twice as likely to experience each of the four traumas compared to baseline. While the odds ratios observed in the current analysis did not reach these levels, they were still statistically significant and still followed the same patterns as those that were observed in the original study.

2.4.3. Within the context of the existing literature

The findings from the current study have a number of implications for existing research. they provide support for a number of other studies. First and foremost, the results from the regression analysis are in keeping with the well-established body of literature linking psychosis and childhood trauma (Bebbington et al., 2004; Bebbington et al., 2011; Bentall, Jackson, Hulbert, & McGorry, 2008; Janssen et al., 2004; Schafer & Fisher, 2011). In particular, the finding that the paranoia and psychosis classes were at increased risk of experiencing sexual abuse supported studies that have identified sexual abuse as the strongest predictor of psychosis (Bebbington et al., 2004; Lataster et al., 2006). Additionally, the current findings were in line with other studies assessing the prevalence of psychosis in the general population. The diagnostic class identified in the current study contained 2% of the overall sample. This compliments the existing research in this area, which has estimated psychosis prevalence to be between 1% and 3% (Kendler, Gallagher, & Abelson, 1996; Perala, et al., 2007). The current analysis provides support for continuum models of psychosis. The finding that distinct sub-groups of individuals exist in the general population which are characterised by varying degrees of psychotic experience ranging from no experience, to one or two experiences, to multiple psychotic experiences, is compatible with continuum-based models of psychosis (Van Os, Hanssen, Bijl, & Ravelli, 2000). Moreover, the current study found that psychotic symptoms occurred more frequently than full psychotic disorders. This is in keeping with other general population studies that have investigated the psychosis continuum (de Leede-Smith & Barkus, 2013; Poulton et al., 2000; Hanssen, Bak, Bijl, Vollebergh, & Van Os, 2005). Results from this analysis also provides support for a continuum of delusional belief. The class of individuals characterised by extremely high likelihoods of experiencing subclinical paranoia were found to be at increased risk of experiencing a number of psychiatric disorders including generalised anxiety disorder and depression. They were also more likely to have experience childhood trauma. Previous research has identified anxiety, depression and trauma as factors associated with clinically relevant persecutory delusions (Freeman, 2007; Garety & Freeman, 2013; Read, Agar, Argyle, & Aderhold, 2010). These findings therefore support the continuum of delusional belief as it indicates that there is continuity in terms of causal influence between subclinical and clinical forms of paranoia. Furthermore, the increased likelihood of childhood trauma associated with the paranoia class compliments several existing theories of delusion development. For example, more recently, researchers have begun to discuss the development of delusional ideation as an attempt to adapt to a hostile environment. These theories posit that within the context of traumatic experience, developing negative beliefs about others could help protect from danger (Gracie et al., 2007). The high frequencies of events such as bullying and witnessing violence in the home which were found in the paranoia class provide support for these theories. There is also research highlighting the role of social isolation in delusion development. This research suggests that being isolated limits opportunities to reality test unfounded beliefs about others, therefore exacerbating delusional thoughts (Cromby & Harper, 2009; Freeman, 2007). This link can be seen in the findings in chapter 2 as the paranoid class were more likely to be living alone compared to baseline.

Finally, cognitive models of psychosis development have suggested that paranoia could develop as a consequence of hallucinatory experiences (Bell, Halligan, & Ellis, 2006; Garety, Bebbington, Fowler, Freeman, & Kuipers, 2007; Freeman, 2007). The current results do not provide support for this claim. Instead, the structures of the 4 latent classes which were produced appeared to suggest that the development of multiple psychotic experiences could be preceded by a period of heightened paranoid ideation. This therefore suggests that paranoia can develop before the experience of other psychotic events instead of after them.

2.4.4. Implications for overall thesis aims

The question still remains of how the findings from this study should be interpreted. What information do they provide about the nature of psychosis? One possible explanation was put forward in the original study carried out by Murphy et al., (2007). They pointed out that coming from the continuum viewpoint, the four classes that have been identified appear to represent a progression along this continuum of severity. From this perspective, the baseline class represented the lower end of the psychosis continuum while the disorder class represented the more severe upper end of the continuum. The two middle classes, the intermediate and paranoid, while not indicative of a psychotic disorder, were none the less considered to represent groups of individuals who are at increased risk of developing clinical psychosis. This explanation is supported by the findings from the regression analysis, which reported increasing levels of childhood trauma from the baseline, to intermediate, to paranoid, to disorder group. If this is the case, and these classes are representing a pathway from healthy functioning to psychotic experience, then this has considerable implications for the cascade model put forward in the current thesis. Based on the suggestion that individuals can transition from one class to another over time, the existence of a class that is characterised by particularly high levels of paranoia would support the idea that the development of psychotic disorder is preceded by a period of heightened paranoid cognition. However, it must be kept in mind that this is only one possible explanation of the patterns observed in this data. The information contained in this dataset and used in this analysis is cross-sectional in nature and, as such, it's not possible to know if individuals would move from one class to another over time. Therefore, discussions surrounding the meaning of these four classes in terms of psychosis development are purely conjecture. For example, it is equally plausible that there is just a group of individuals in the population who are highly paranoid and will never go on to develop psychosis. Further research in this area is required to elucidate the meaning of membership to these classes over time.

2.4.5. Study Limitations

The current analysis was designed to replicate Murphy et al.'s (2007) study. Great care was taken to ensure that the statistical techniques and survey items used in this study were comparable to its predecessor. Due to this, the current study's limitations are largely consistent with the limitations of the original 2007 work. Both analyses used large-scale community-based samples compiled by the ONS (BPMS and APMS). Like its predecessor, the APMS contains a wealth of information on psychological disorders, life events, and socio-demographic factors in an extensive, nationally representative sample. In addition to this, the scales used in the APMS are largely identical to those used in the BPMS. Having the same set of survey questions administered to two separate large-scale community-based samples provides a unique opportunity to attempt to replicate the findings of complex statistical analyses such as LCA. Despite this however, the measures and methodology used during the APMS and its predecessor were not ideal. In particular, the use of the 5 probe items of the PSQ to measure psychosis is a potential drawback. It could be argued that the use of such a brief scale which uses single items to measure five general positive psychosis symptom categories is inadequate and may not perform as effectively as a more detailed measure such as the CIDI (Johns, Cannon, Singleton, Murray, Farrell, & Brugha et al. 2004). Additionally, as these items were probes, they were intentionally worded more generally than their accompanying secondary questions. This could result in inflated endorsement rates compared to more strictly worded psychosis measures. Another point that should be noted is that the PSQ only enquires about psychotic experiences in the year previous to the scale being administered. Clearly this is not ideal, and a measure of lifetime psychosis prevalence would be preferable. These limitations aside, the use of the PSQ probe items was warranted as it ensured consistency across the two analyses.

Murphy et al., (2007) raised the point that the quality of information available surrounding traumatic experiences in the dataset was another drawback to this study. As was the case with the BPMS, the APMS enquired about a number of traumatic experiences however, it did not collect any information about the circumstances surrounding these traumas. For example, it did not ask at what age these traumatic experiences occurred or the frequency at which they occurred. While the four trauma experiences included in both the current study and Murphy et al.'s original work were selected specifically because they were the most likely to have occurred in childhood, one cannot say for sure that this is the case for all respondents. The ONS surveys also did not record information about the duration or severity of a given trauma, only whether or not it occurred. This is arguably quite a crude way of dealing with traumatic experience as it groups together what could be vastly different events in terms of impact on the individual. Aside from this, it's also important to note that some have questioned the validity of the retrospective self-reporting of traumatic experiences. Research has found that whether or not an individual who has experienced a traumatic event will self-report it as part of a survey varies based on factors such as gender and type of trauma experienced (Frissa et al., 2016).

Finally, another limitation of the current research is that the use of cross-sectional data is arguably inappropriate for investigating paranoia's role in psychosis development. One of the key aspects of the current thesis is that it is grounded in a continuum based theoretical approach to psychosis. It assumes that psychotic symptoms exist along a continuum of severity and that individuals can move along said continuum. One if its core objectives is learning how paranoia interacts with other psychotic experiences and because of this, there is a significant focus on understanding how different psychotic symptoms develop over time. Therefore, some may make the argument that on a theoretical level, the use of cross-sectional datasets and statistical techniques is not compatible with the aims of the current thesis. However, while it is true that temporal associations cannot be established from this type of analysis and longitudinal research will undoubtedly be required to shed light on how paranoid ideation affects the development of other psychotic experiences, it is also important that the underlying structures of psychotic symptoms and their distribution in the general population are understood. This is where cross-sectional data such as this is required. The information contained in large epidemiological datasets like the APMS is valuable and it would be foolish not to exploit it.

2.4.6. Implications for clinical practice and future research.

These limitations notwithstanding, the current study findings have a number of implications for the clinical treatment of psychosis. First and foremost, psychotic experiences were found to be relatively common in the general population. The development of initiatives that aim to normalise these experiences could be beneficial. This information could be disseminated in a number of forms including pamphlets displayed in GP clinics or through social media websites. The regression analysis, which found that the classes with greater risk of experiencing psychotic symptoms were also more likely to have experienced childhood trauma is also relevant to clinicians and has implications for their practice. It indicates that when treating individuals experiencing psychotic symptoms, clinicians should be aware of the likelihood that a history of childhood trauma could be present. Additionally, it also suggests that therapeutic interventions aimed at minimising the negative effects of trauma in childhood could be an effective strategy to prevent future development of psychotic disorders. Another important finding from the current study was the identification of a sub-group of individuals characterised by extremely high levels of paranoia who were at increased likelihood of experiencing childhood trauma. This class represented over 10% of the sample and possibly represents a group of individuals at increased risk of transitioning to full-blown psychosis in the future. The delivery of a targeted intervention strategy focusing on the reduction in paranoid cognitions could be beneficial to this group of individuals.

The current findings also present a number of avenues for future research. First of all, these findings demonstrated that there are subgroups of individuals in the general population with varying levels of psychotic experience. Moreover, these subgroups appear to be at varying levels of risk to developing a clinical disorder in the future. Further investigation into these groups could therefore provide meaningful insights into how psychosis develops in the general population. For example, it may be beneficial to explore the levels of distress associated with psychotic experience across these subgroups.

Similarly, in order to determine how relevant these groupings are in terms of the treatment of psychotic disorders, future research should investigate their outcomes over time. Comparing the four latent classes in terms of a range of outcome factors such as suicidality, contact with psychological services, drug or alcohol abuse, or development of a clinical psychotic disorder could be instrumental in understanding the pathways between psychotic experiences and negative outcomes. In terms of the aims of the current thesis, further investigation of the paranoia class would be particularly relevant. It may be the case that over time, individuals in this class can transition into the diagnostic class or develop a psychotic disorder. Longitudinal analysis would reveal if this happens at higher rates compared to those in the baseline and intermediate classes. This type of research could reveal that the paranoia class represents a group of individuals at ultra-high risk of developing psychosis.

2.4.7. Conclusion

The current analysis has successfully replicated the findings of Murphy et al.'s (2007) latent class analysis of positive psychosis symptoms. Not only was the number and nature of latent classes consistent across the two studies, but the relationships between the four classes and trauma variables were also comparable between the current study and Murphy et al.'s original work. To the author's knowledge, this is the first study of its kind to replicate a latent class analysis of psychotic symptoms in this way. Taking all of this into account, the current study has certainly strengthened the findings of the original work, demonstrating that the patterns of subclinical psychotic symptom distribution appear to be consistent when their measurement is consistent. The author was particularly interested in whether or not a paranoid class would be identified in the LCA. The fact that it was is an encouraging result in terms of the cascade model being investigated in this thesis. While this does not provide any concrete evidence that paranoid ideation precedes and precipitates the development of other psychotic experiences, at the very least it undoubtedly demonstrates that this is a fruitful area for further investigation. Paranoid ideation does appear to be an important factor in the emergence of psychosis. Gaining a better understanding of the precise nature of the role that paranoia plays will require further study and the utilisation of statistical techniques that can shed light on the complex symptom interactions that underlie psychosis development.

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Chapter 3: Exploring the relationships between psychotic experiences and the continuum of psychosis: an IRT analysis

Abstract

Traditionally, psychotic symptoms have been treated as interchangeable markers of an underlying disease entity (Thorpe & Favia, 2012). In recent times, symptom level research has demonstrated that these are better conceptualised as multi-dimensional experiences and researchers should attempt to understand their specific causes and developmental trajectories (Owen, O'Donovan, Thapar, & Craddock, 2011). To date, the relationships between different psychotic experiences and the construct of psychosis itself remains poorly understood. To address this, the current study aimed to examine how the symptoms of Schizotypal Personality Disorder (SPD) were distributed along the continuum of psychosis severity. The author was particularly interested in where the paranoia items would be located in this distribution. Based on the cascade model, it was predicted that paranoia items would be closely related to the underlying psychosis construct and would be associated with lower levels of psychosis severity. Two large epidemiological community samples were used. The first of these was the British Psychological Morbidity Survey (BPMS), which collected data from 8393 participants. The second was the second wave of the national epidemiologic survey of alcohol and related disorders NESARC, which collected data from 34,653 participants. A number of unidimensional item response theory (IRT) models were estimated to examine the difficulty, and in some cases, discrimination of each SPD item in the BPMS and NESARC. While there was variation across the different models obtained, the paranoia items displayed consistently strong relationships with the underlying psychosis construct. In addition, aside from in one model, the paranoia items obtained some of the lowest difficulty scores across both datasets. These findings suggest that paranoid ideation is more characteristic of low-level psychosis than other psychotic symptoms such as

odd beliefs or perceptual abnormalities. To the author's knowledge, this study was the first of its kind to use IRT techniques to examine how different psychotic symptoms relate to an underlying psychosis construct across 2 large community-based samples. Within the context of the Cascade model, these findings are congruent with the prediction that paranoia may emerge before other psychotic symptoms manifest themselves, prompting further study into paranoia's role in the genesis of psychotic experience.

3.1. Introduction

The first empirical chapter (chapter 2) explored the distribution of psychotic experiences in the general population. The analysis identified 4 latent subgroups of individuals characterised by varying levels of psychotic experience. Interestingly, one of the 4 subgroups was characterised by a high likelihood of endorsing paranoia. Moreover, members of the paranoia group were found to be at increased risk of risk factors for psychosis development.

Following this, the current chapter (chapter 3) aims to learn more about the underlying structure of psychosis by examining the nature of the relationships between individual psychotic experiences and the underlying continuum of psychosis severity. To achieve this, a series of items measuring psychotic experience will be assessed in terms of how closely they are related to the underlying construct of psychosis. These items will also be assessed in terms of the level of psychosis severity at which they are performing best. The author is particularly interested in the performance of items measuring paranoid ideation.

The latent class analyses conducted in the previous chapter investigated subclinical symptom profiles across different sub-groups of people in the general population. The identification of a group of individuals characterised primarily by an extremely high likelihood of experiencing paranoid ideation suggested that paranoid cognitions may play a key role in the early stages of psychosis development. The next question that must be answered is at what point along the psychosis continuum does paranoid ideation emerge? One of the core theoretical assumptions underpinning this thesis is that a continuum of psychotic experience exists in the population and that an individual can transition along this continuum. As one progresses along this continuum, the severity of psychosis increases. This means that progression is marked by the emergence of new psychotic experiences, the intensification of existing symptoms, and ultimately, the emergence of a clinically relevant psychotic disorder. If paranoia is indeed, the main symptom that drives psychosis development in its early stages, one would assume that it emerges at an earlier point along the continuum compared to other symptoms such as hallucinations. While this may seem like a relatively simple question to answer, selecting a statistical paradigm that can do so effectively is not straightforward. The chosen paradigm would need to be capable of exploring the associations between observed symptoms and an underlying latent construct. Additionally, it would need to be able to represent said latent construct as a continuum of severity. It became clear that exploring paranoia's relationship to the psychosis continuum could be achieved through the novel application of a sophisticated analytic approach called item response theory (IRT). The next section of this introduction will provide an account of the theoretical underpinnings of IRT.

3.1.1. Background

Psychometric scales are one of the most widely used tools in the field of Psychology, playing a key role in both research and practice. The use of these scales is based on the assumption that responses that individuals give to the scale items are manifestations of latent psychological constructs. Item Response Theory (IRT) is a set of methods that attempt to model how these constructs manifest themselves in observable item responses (Harvey & Hammer, 1999). It was developed during the 50s and 60s as a response to some of the limitations of another measurement theory called Classical Test Theory (CTT). Like IRT, CTT attempts to explain how psychological scales tap into latent constructs. The main difference between these two measurement scales is their unit of focus. CTT focuses on an individual's observed score on an entire scale. Their observed score is the unweighted sum of scores on each item in the scale (de Ayala, 2013). IRT instead focuses on how individuals respond to individual items in a scale.

One of the issues with CTT is that it assumes that individual test items within a scale are interchangeable (Thorpe & Favia, 2012). Consider, for example, a psychometric scale containing 5 items. If one respondent answers yes to item 1 and 2, and another respondent answers yes to 3 and 4, they would both receive an identical score of 2, even though they have completely different response patterns. CTT has also received criticism for how it handles the metrics of likert scales (Thorpe & Favia, 2012). Unlike the yes/no response format, likert scales usually have 5 response options (Strongly disagree, disagree, neutral, agree, strongly agree) and these are scored as follows: SD = 1, D = 2, N = 3, A = 4, SA = 5. CTT assumes that the distances between the 5 response options are equal. In other words, it assumes that the distance between strongly disagree and disagree is the same as the distance between agree and strongly agree. Another issue with CTT is that it does not take into account the difficulty of the different items in a scale. Thorpe and Favia (2012) illustrated why this is problematic using 2 items from a phobic anxiety scale.

- I am so anxious that I have not left my house for five years
- I feel uncomfortable in large crowds, though I do not avoid them

While both items are in the same scale, it is clear that item 1 is more difficult to respond 'yes, definitely' to than item 2. It has been argued that item scorings should be adjusted in accordance with how difficult they are to respond to however this does not happen with CTT.

As mentioned before, IRT methods were developed in the 50s and 60s however they were not widely used until much more recently. This is mostly due to the high computational demands of these methods. Until a few decades ago, the lack of affordable and efficient computer hardware and software meant that IRT models were too expensive and too difficult to be used (Harvey & Hammer, 1999).

In order to discuss IRT models in more detail, some key concepts must be explained. When discussing a scale item in relation to IRT, two main characteristics of that item are discussed; difficulty and discrimination.

3.1.2.1. Item Difficulty

Difficulty relates to the level of the underlying construct you need to possess in order to endorse an item. The higher the level of the underlying construct an item needs to be endorsed, the more difficult it is said to be. Difficulty is operationally defined as the score of ϴ (theta) associated with a 50% likelihood of endorsing the item.

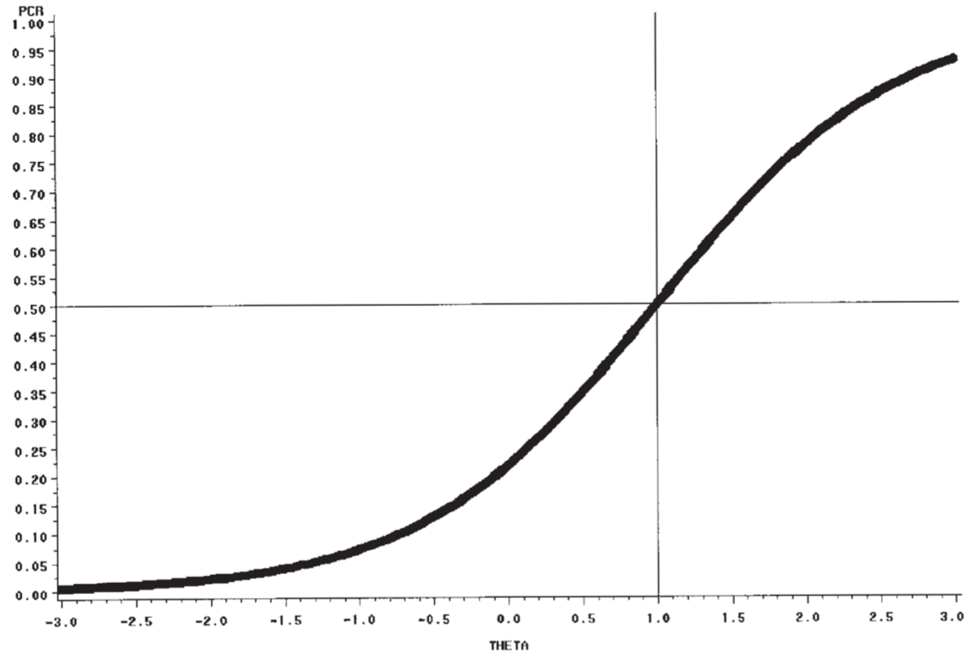
3.1.2.2. Item Discrimination

Discrimination relates to how well an item discriminates between individuals at a certain level of the latent construct. To put it another way, the discrimination of an item is how rapidly the odds of endorsement increase or decrease as you increase the level of Θ. The smaller the increase in the Θ level needed to increase the likelihood of item endorsement, the stronger the item discrimination. Discrimination is operationally defined as the slope of the curve associated with a 50% likelihood of endorsing the item.

3.1.2.3. Item characteristic curve

The difficulty and discrimination of an item can be represented on a graph called the item characteristic curve (ICC). As previously mentioned, IRT assumes that latent psychological constructs can be measured through responses to a number of items. The ICC is a two-dimensional scatterplot which displays the probability of endorsing an item for different levels of the latent construct (Θ). The level of the latent variable of interest is displayed on the X axis and the probability of endorsing the item in question is displayed on the Y axis. An example of an ICC is displayed in figure 3.1.1 below.

Figure 3.1.1. Item Characteristic curve



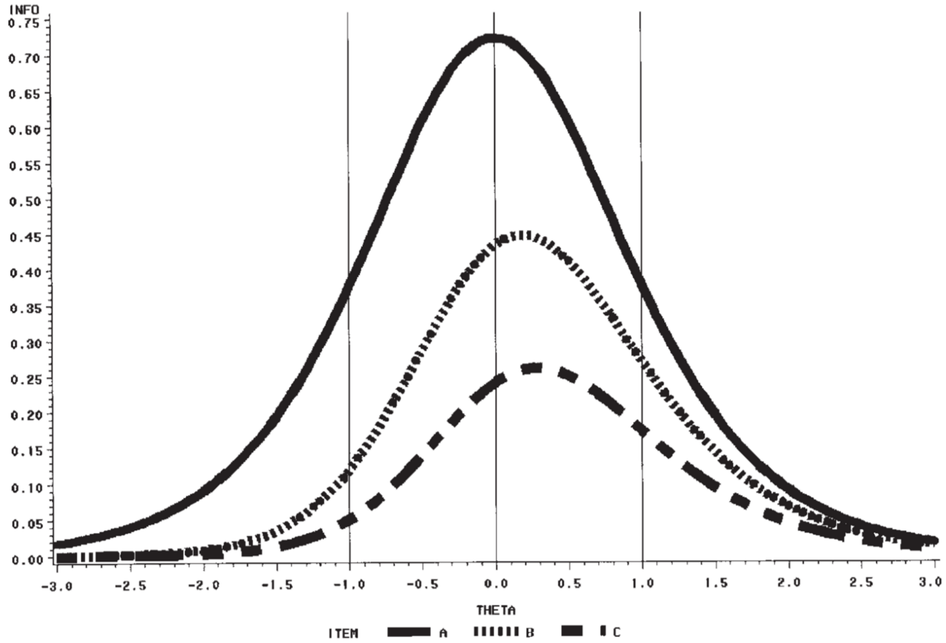
3.1.2.4. Information

Information in IRT is similar to the concept of reliability in CTT. Both are ways of assessing measurement precision. In CTT, an item gets a single score of how reliably it measures the underlying construct. The issue with this is that while an item may have high reliability for people who are, for example, high on the underlying construct, it may not be appropriate for individuals at all levels of the construct. Information in IRT addresses this issue. Instead of producing a single score, a continuous function representing the item's information at all levels of the underlying construct. This allows the level at which the item is performing best to be identified. An item is said to provide the most information where the slope of that item's item characteristic curve is the steepest. The steeper the slope, the more information being provided.

3.1.2.5. Item information function

An item information function is a graphical representation of item information. Like the ICC, it is a two-dimensional scatter plot. The underlying construct is displayed on the X axis and the amount of information is displayed on the Y axis. Figure 3.1.2 below contains information functions for 3 items.

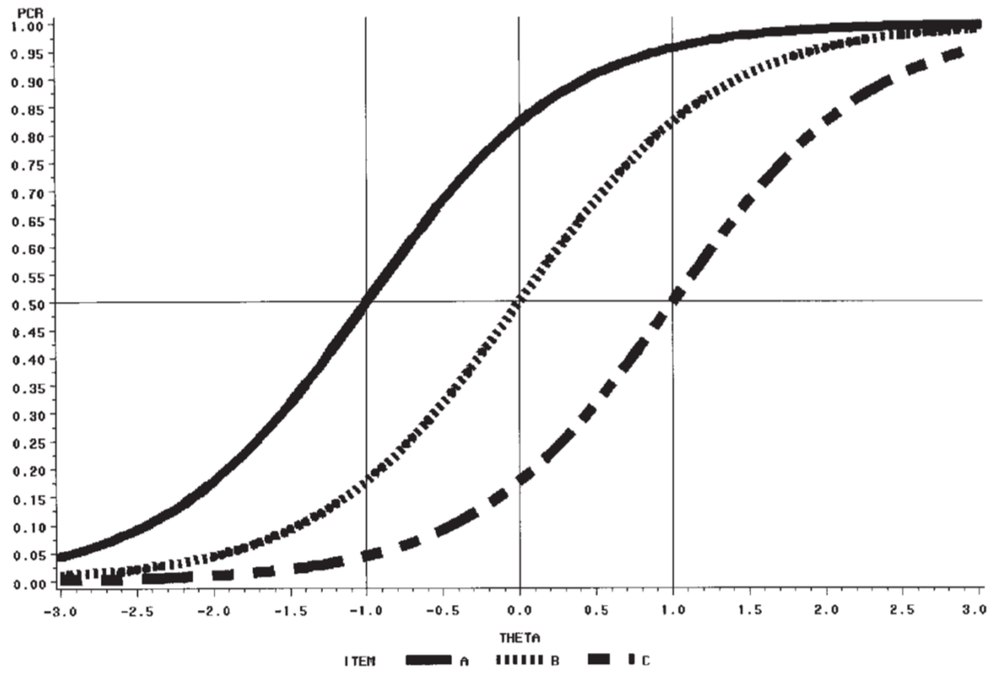
Figure 3.1.2. Information functions



3.1.2.6. 1-parameter models

The 1-parameter model, commonly known as the Rasch model, is the simplest IRT model used in psychology. In these models, a group of items are only represented and compared in relation to their difficulty (location along the X axis) while their discrimination values (slope of curve) are held constant. Figure 3.1.3 below contains ICCs of 3 items in a 1-parameter model. As discrimination is being held constant, the item curves are all the same shape. They are differentiated solely by their position along the X axis.

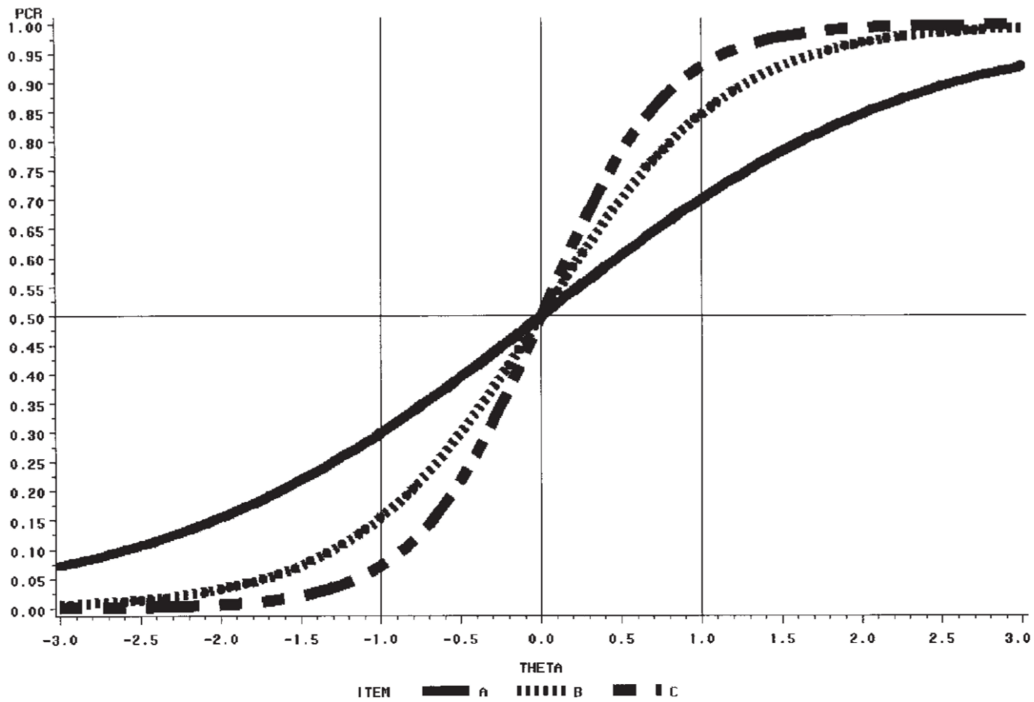
Figure 3.1.3. 1 parameter model



3.1.2.7. 2-parameter models

As the name suggests, 2 parameter models explain test items in terms of 2 item parameters; difficulty and discrimination. This allows items to be examined not only in terms of how difficult they are to endorse but also in terms of how well they discriminate between individuals at a given level of the underlying variable. Figure 3.1.4 below contains ICCs of 3 test items. Each item has the same difficulty score meaning they are all tapping into the same level of the underlying construct however they have different discrimination values meaning item C is providing more information than items A or B. This example demonstrates how taking discrimination into account can be beneficial. If these items had been represented in a 1-parameter model, they would have been described as being completely identical even though this is clearly not the case.

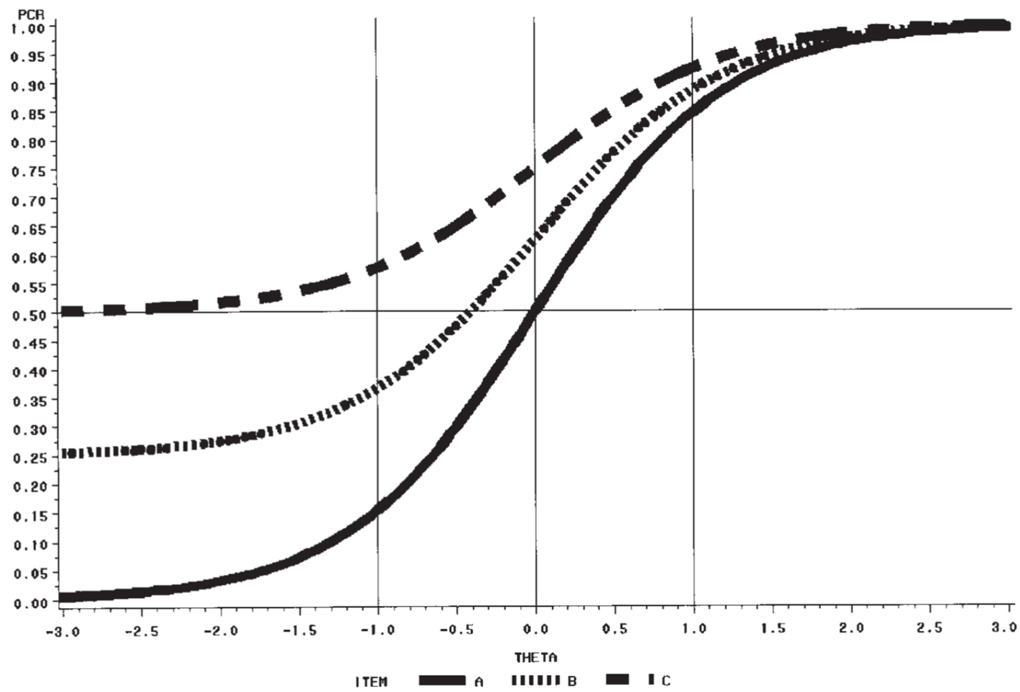
Figure 3.1.4. 2-parameter model



3.1.2.8. 3-parameter models

While the addition of discrimination in the 2-parameter model addressed limitations of the Rasch model, one issue that remains is that both of these models assume that the lower asymptote of any item characteristic curve is zero. In other words, they assume that individuals who are very low on the underlying construct have zero probability of endorsing the item measuring it. This may not always be the case as it is possible that other variables such as social desirability may lead an individual to endorse an item even if they are very low on the underlying trait. 3 parameter models address this issue by allowing items to have non-zero minimum values (lower asymptotes). Figure 3.1.5 below contains ICC curves for 3 items that have identical difficulty and discrimination values but different lower asymptote values. The figure demonstrates how the higher an item's lower asymptote, the less information that item will provide.

Figure 3.1.5. 3-parameter model



3.1.3. Applications of IRT in Psychopathology

Initially, IRT was used for the development of aptitude tests scored in a yes/no format (Harvey & Hammer, 1999) but over the years, IRT methods have been applied in a number of different ways in the field of psychopathology. This next section will provide a brief overview of the current uses of IRT methods in psychopathology.

3.1.3.1. Scale Development

IRT methods are particularly useful when it comes to developing and validating psychometric scales. Scale development using IRT can be achieved by either developing new scales or re-validating and optimising existing scales which were originally developed using classical test theory (Edelen & Reeve, 2007). It can also be used to develop shorter forms of existing questionnaires. Argyropoulos et al., (2007) developed a new scale to measure generalised anxiety disorder, which addressed several shortcomings of previous GAD scales. IRT methods allowed the researchers to identify 1) which items to include from a large item bank? and 2) At what level of the underlying trait the scale provided the most information? This is particularly relevant when designing a scale to assess individuals at a certain point along the latent trait of interest. For example, if researchers wanted to measure depression in a clinical sample, the scale they use should be providing information for the more severe end of the depression construct. These details about where a scale is performing best would not be captured using classical test theory. In recent years, IRT methods have aided the development of precise psychometric instruments measuring a range of constructs including emotional intelligence (Cooper & Petrides, 2010), maladaptive personality traits (Krueger, Derringer, Markon, Watson, & Skodol, 2012), Social anxiety, (Peters, Sunderland, Andrews, Rapee, & Mattick, 2012) and PTSD (Bliese, Wright, Adler, Cabrera, Castro, & Hoge, 2008). Gomez, Cooper and Gomez (2005) revalidated the BIS/BAS scales using an IRT framework. Since their development in 1994 the BIS/BAS have become the most widely used instruments measuring trait level behavioural inhibition and activation (Poythres et al., 2008). Despite their extensive use, Gomez et al.'s (2005) analysis found that there were some limitations in the scales' psychometric qualities including considerable overlap in some scale items and low measurement precision at certain levels of the underlying trait. IRT has also been used for scale development in the field of psychosis. For example, Kim, Seung Chang, Huang, Seo Yi, Hee Cho, and Yeon Jung (2013) used IRT to study the item performance and measurement precision of the Peters et al.,delusion inventory in a Korean sample of adolescents, reporting good scale performance for the lower end of delusion proneness. The Positive and Negative Syndrome Scale (PANSS), which is the most widely used instrument measuring symptom severity in schizophrenia, was assessed using IRT (SantorAscher-Svanum, Lindenmayer, & Obenchain). The analysis identified several key improvements that could be made including removing one item from the scale and using some of the sub scales as stand-alone mini scales. Winterstein, Ackerman, Silvia, and Kwapil (2011) examined the psychometric properties of the Wisconsin Schizotypy Scales (which had originally been developed using CTT) using IRT. They found that while overall, the scales performed well, some of the items had low discrimination. Subsequent to this study, Gross, Sylvia, Barrentes-Vidal, and Kwapil (2012) used IRT to validate short forms of the Wisconsin Schisotypy Scales and found that these abbreviated versions had good reliability and validity. Being able to re-assess and improve older psychometric scales and develop shorter forms of these scales can mean quicker and more precise psychological assessments, both in clinical and community settings (Gross, et al. 2012). This is one of the major benefits of IRT. These methods can also be used to learn more about the influence of factors such as guessing on subsequent test scores. Ngee Kiong Lau and colleagues (2011) explored the extent to which guessing, partial knowledge, and misconceptions affected students' responses to multiple choice questionnaires in schools. By obtaining a 3 parameter model of the questionnaire items and comparing the results to a 2 parameter model, the researchers were able to estimate the magnitude of influence that these factors were having on questionnaire scores (Ngee Kiong Lau, Hoe Lau, Sam Hong, & Hasbee Usop, 2011). This is another example of a way in which IRT methods can be used to enhance and refine the measurement tools which are used so frequently in the fields of research and education.

3.1.3.2. Scale Comparison/Integration

A number of researchers have used IRT to compare the performance of different psychometric scales measuring the same underlying construct. An example of IRT being applied in this way in psychosis research is Kim et al.'s, (2013) study in which they compared the psychometric properties of two self-report instruments measuring delusion experiences. Their analysis found that one scale was tapping into the lower range of delusion proneness and the other was tapping into the higher range of the construct. The researchers suggested that combining the two scales would be an effective way to evaluate a wide range of delusion experiences. Another example is Van Den Berg, Paap, and Derks, (2012) who compared two measures of Schizotypy. Unlike the delusion scales in the previous study, the two instruments in this study had different methods of administration (one scale was self-report and the other was administered by clinical interview). IRT analysis revealed that while both instruments were useful, the clinical interview-based scale did not provide good information for the lower end of the underlying schizotypy construct. Researchers suggested that clinicians could use the self-report questionnaire to augment their report. The ability to compare and combine different scales that are measuring the same trait holds major relevance in both clinical and research fields. The way in which IRT relates item responses to the underlying trait they are measuring makes these types of comparisons possible.

3.1.3.3. Differential Item Functioning

One of the major benefits of IRT is its ability to detect differential item functioning (DIF). DIF occurs when two people belonging to different groups with the same level of the latent trait get different have different probabilities of endorsing an item (Jane, Oltmanns, South, & Turkheimer, 2007). To put it differently, DIF occurs when a scale is biased towards certain groups. IRT is able to identify these biases. Jane et al., (2007) investigated gender biases in the diagnostic criteria for personality disorders. They found significant gender biases for 6 personality disorder (PD) criteria. When a scale is translated into a different language, the DIF of the two versions of that scale can be examined. Azocar, Arean, Miranda, and Munos (2001) examined DIF in a Spanish translation of the Beck depression inventory. They found that regardless of level of trait, Latinos were more likely to endorse some of the scale items and less likely to endorse others. DIF has also been investigated in scales measuring psychotic symptoms. Prieto, Novick, Sacristan, Edgell, & Alonso (2003) wanted to investigate the cross-cultural validity of a scale measuring quality of life in individuals with schizophrenia. Researchers often want to administer the same questionnaire in different cultures in order to compare their levels of a certain trait. The problem is that they run the risk of encountering cultural biases. The researchers need to know that the questionnaire they choose is performing in the same way in different cultures. IRT allowed Prieto and colleagues to confirm that the scale's performance is comparable across different cultures and languages. Earleywine (2006) examined DIF in Schizotypy scores between cannabis users and non-cannabis users. It has been widely reported that psychosis and cannabis use are correlated. Earleywine aimed to investigate whether this correlation may be partly due to a bias in the measure used. Results found that some of the test items function in different ways for users and non-users. Cannabis users were more likely to endorse some of the test items even though their level of the underlying trait was not higher. IRT allows researchers to identify biases across gender, ethnicity, language, and many other groups. This is an invaluable tool when developing a scale.

3.1.3.4. Computer Adaptive Testing

One of the more recent applications of IRT is the development of computer adaptive testing (CAT). CAT is a computerised method of questionnaire administration where instead of an individual answering every question in a scale, they are only asked the most informative questions for them based on their response to the previous questions (De Beurs, De Vries, de Groot, de Keijser, & Kerkhof, 2014). This is made possible by an IRT based algorithm which first, estimates an individual's level of the latent trait based on their response to the first item, and then chooses the most informative item for that level of the trait in the item bank to administer next. This process continues until the computer's estimation of the individual's trait level is precise enough, at which point the algorithm stops administering items and the test is complete (Gardner, Kelleher, & Pajer, 2002). The major benefit of this approach that the individual has to answer much fewer questions to achieve an accurate measure of their underlying trait level. CATs have been developed for a wide range of applications in the field of psychology. De Beurs et al., (2014) developed a CAT to assess suicidal behaviour. Results found that an average of 4 items were required to accurately estimate an individual's risk of suicidal behaviour compared to 19 items using the standard scale. Gardner et al., (2002) developed a CAT to screen for mental health problems in children. From the original 35-item scale, participants had to respond to 11.5 items on average to reach the desired level of measurement precision. CAT based assessments can be particularly useful for certain groups, e.g. children where respondent fatigue can be particularly problematic. Becker et al., (2008) examined the effectiveness of measuring anxiety using a CAT. It took participants under 3 minutes on average to complete the instrument and individuals were asked a mean of 6 items from a bank of 50. They concluded that this was a valid and effective way of assessing anxiety, suggesting that it could be useful for initial assessments in a therapeutic context. A CAT was also developed to effectively measure depression (Fliege, Becker, Walter, Rose, Bjorner, & Klapp, 2009). The instrument was completed quickly, requiring 6 items on average to be considered reliable. CATs have also been developed for use in psychosis research. Fonseca-Pedrero, Menendez, Paino, Lemos-Giraldez, & Muniz (2013) developed a CAT for schizophrenia assessment, finding that the computerised version was more efficient than the original paper and pencil scale. Participants answered 34 questions on average compared to 51 in the original scale.

3.1.4. More Recent Applications

In recent years, some researchers have moved away from the more traditional applications of IRT discussed above and are using IRT methods in novel ways. In these new applications, the focus is not on learning more about the test items but on learning more about the underlying trait itself. A prime example of IRT being used in this way is in the field of personality disorders (PDs). Over the past 20 years, there's been a large shift in how PDs are conceptualised. While in the past, they were considered categorical disorders distinct from normal functioning, many researchers now agree that they exist along a continuum with normal personality functioning at one end and clinical PDs at the other (Suzuki, Samuel, Pahlen, & Krueger, 2015). Several studies have employed IRT methods to support this dimensional conceptualisation of PDs. A study carried out by Devine and colleagues employed IRT as part of a staged analysis aiming to explore the underlying structure of paranoid personality disorder (PPD) criteria in the general population. The researchers wanted to examine the appropriateness of using unweighted sum scores to measure PPD severity. Their analysis focused on 7 PPD items from the Structured Clinical Interview for the fourth edition of the diagnostic and statistical manual (DSM-IV) axis II disorders (SCID-II). Differences in difficulty scores indicated that these items were distributed along a continuum of PPD severity. Moreover, these items were found to vary in terms of their discrimination, indicating that some of them were more closely related to the underlying construct than others. Taken together, these findings highlighted the need to understand PPD symptoms on an individual level (Devine, Bunting, McCann, & Murphy, 2008).

Samuel, Simms, Clark, Livesly, & Widiger (2010) hypothesised that if personality disorders are maladaptive extremes of general personality traits, then measures of general personality and measures of personality disorders should be tapping into different levels of the same underlying trait. Their IRT analysis, (involving comparison of the psychometric properties of a PD measure with two personality measures) supported this hypothesis, finding that the PD scale shared a common hierarchical structure with two normative personality scales. More recently, Suzuki et al., (2015) compared the DSM-5 PD criteria to a normative personality inventory. They found that there was large overlap between the two scales with the PD items providing more information for the upper levels of the trait and the personality items providing more information for the lower levels. Similar results were obtained in research looking specifically at the Neuroticism-Borderline PD continuum (Samuel, Carroll, Rounsaville, & Ball, 2013). These studies were made possible by IRTs ability to compare multiple questionnaires measuring the same trait by placing their scores on a standard metric.

This categorical vs. dimensional conceptualisation debate is not unique to personality disorder research. In recent years, limitations of categorical models have resulted in dimensional models of many mental disorders gaining more recognition (Widiger & Samuel, 2005). Take, for example, alcohol use disorder (AUD) research. The DSM 4 characterises AUD in terms of two distinct entities, alcohol abuse and alcohol dependence where the abuse symptoms are described as less severe than the dependence symptoms (Saha, Chou, & Grant, 2006). Saha et al., (2006) suggested that this model may not be accurate and instead, hypothesised that the abuse and dependence criteria exist along a continuum of severity. To investigate this, they examined and compared these criteria in relation to their item difficulty. The researchers found that these criteria were arrayed along a continuum of increasing severity. They also found that the dependence criteria were not distinct or more severe than the abuse criteria. Some dependence criteria were found at the lower end of the continuum and abuse criteria at the higher end. Examining the latent structure of a psychological construct in this way offers the researcher important insights and could lead to more accurate and more clinically useful conceptualisations

Some researchers have used IRT to study the hierarchical structure of a latent trait. Xie et al., (2012) hierarchically modelled depression and anxiety in pain patients. The two symptoms often co-occur however, since depression motivates inhibition, but anxiety motivates action, one would expect them to be negatively correlated. The researchers wanted to shed some light on why this co-occurrence exists. Using IRT techniques, they identified a common underlying factor of distress that explained the co-occurrence. They also found that when distress was controlled for, depression and anxiety were negatively correlated (Xie et al., 2012). A study conducted by Sturm (2016) used IRT to investigate the hierarchical structure of ADHD symptoms. Previous theories of ADHD had conceptualised it as having 2 subtypes: inattentive and hyperactive/impulsive. IRT methods allowed Strum to examine this structure by first running IRT models with multiple underlying traits or dimensions and also looking at the organisation of the ADHD symptoms by examining their item parameters. Results suggested that the subtypes model was not an appropriate way to examine ADHD symptoms as inattention and impulsivity appear to be linked. Researchers studying psychosis have also made use of IRT in this way. Reininghaus, Priebe, & Bentall (2013) used IRT to examine whether psychosis consists of one general dimension or five specific dimensions. They found strong evidence of a general psychosis dimension however evidence of 5 specific dimensions was also found. These findings have implications in both research and clinical fields regarding how psychosis is conceptualised (Reininghaus et al., 2013). These studies show that IRT is not only a useful scale development and assessment tool but also a powerful way to investigate latent psychological traits when used appropriately.

Despite the fact that in recent years, IRT methods have become more popular as a tool to explore the nature of unobserved psychological traits, to date, there have been few studies using these methods to investigate the latent underlying structure of psychosis. IRT has several characteristics that make it an attractive analysis to use in the context of the Cascade model. Firstly, it is theoretically complimentary to the Cascade model. This is reflected both in its focus on the item level and in its recognition that different items are not equally difficult to endorse and therefore should not be treated as interchangeable. Its ability to represent how closely related an item is to the underlying construct could shed light on the relative importance of different psychotic symptoms such as paranoia in the development of psychotic disorders. Additionally, the way in which IRT provides information about the severity level of the underlying construct an individual requires in order to endorse a particular item could shed light on where along the psychosis continuum that paranoid symptoms begin to emerge.

3.1.5. Study Aims

The current study aims to examine how the symptoms of Schizotypal Personality Disorder (SPD) were distributed along the continuum of severity. The author is particularly interested in where the paranoia items will be located in this distribution, focusing on both how closely related to the underlying trait they will be and on the level of severity with which they will be associated. Two large epidemiological community samples will be used used. The Office of National Statistics' 2000 Survey of Psychiatric Morbidity is a nationally representative sample of the UK population, which collected data from 8393 participants. The second wave of the National Epidemiologic Survey of Alcohol and Related Conditions is a nationally representative sample of the US population, which collected data from 34,653 participants. IRT methods will be used to examine the difficulty and discrimination scores of each SPD item in both datasets. A series of 1 and 2 parameter models will be estimated. 3 parameter models are not appropriate in this context as the items in this analysis would not be expected to obtain non-zero lower asymptope scores. This parameter is mainly used when modelling items such as multiple-choice questions assessing knowledge or ability where some respondents could get the right answer by guessing (Thompson, 2018). The author makes several predictions about how these scores would look based on the Cascade model. The Cascade model is built upon the idea that paranoia plays a central role in the genesis and development of psychotic experiences. If this were the case, it would be expected that items measuring paranoia would be closely related to the underlying psychosis construct. Therefore, it was predicted that items measuring paranoia would obtain some of the highest discrimination scores in the IRT models. Additionally, if paranoid ideation emerges earlier than other psychotic experiences as the Cascade model suggests, it is reasonable to expect that items measuring paranoia would be associated with the less severe levels of the psychosis construct. Therefore, it was predicted that paranoia items would obtain some of the lowest difficulty scores in the IRT models.

3.2. Method

3.2.1. Datasets used

3.2.1.1. BPMS

The Survey of Psychiatric Morbidity in Great Britain (BPMS), which was conducted by the Office of National Statistics (ONS) in 2000, aimed to assess the prevalence of a range of psychiatric disorders such as Neurotic disorders, Psychoses, Personality disorders, and substance abuse disorders in the adult household population in Great Britain (Singleton, Bumpstead, O'Brien, Lee, & Meltzer, 2003). The BPMS was part of a series of such surveys, the first of which was carried out in 1993.

3.2.1.2. Sample

The survey collected data from (8580) participants aged between 16 and 74 living in private households in England, Scotland, and Wales. 55.1% of the sample was female. 28.9% were aged between 16 and 34, 39.5% between 35 and 54, and 31.6% between 55 and 74. The sample was predominantly White (93.6%) with small numbers of Black (2.2%), Indian/Pakistani/Bangladeshi (1.7%) and other ethnic groups (1.8%). A two-stage sampling approach taking advantage of the small-user Postcode Address File was used. First, postcode sectors were stratified in relation to socio-economic status and then addresses were randomly selected from each selected postcode sector for inclusion in the study. Selected addresses were visited by interviewers to identify households with at least one person aged 16 to 74 and one person per household was selected for interview (Singleton et al., 2003).

3.2.1.3. Measures

Psychological disorders were assessed in two stages. First, initial structured interviews were carried out by ONS lay-interviewers. Next, some respondents took part in a second stage consisting of a semi-structured clinical interview focusing on Psychosis and Personality disorders. Respondents who had at least one indication of possible psychosis at the initial interview progressed to the stage 2 clinical interviews, which used the SCAN (Schedule of Clinical Assessment in Neuropsychiatry). A random sub-sample of respondents who screened positive or negative for personality disorders were followed up with a clinical interview using the SCID-II (Structured Clinical Interview for DSM-IV Axis 2). The SCID-II is a self-report measure assessing a range of personality disorders. It consists of 116 items, each of which using a 3-point response format ('yes', 'no', 'don't know/does not apply') and was completed using Computer-Assisted Self-Interviewing procedures. There are 16 items in the SCID-II assessing Schizotypal Personality disorder. 15 of these items were used in the current study. One item (Have you often suspected that your spouse or partner has been unfaithful?) was not included as it may not have been applicable to all respondents. The SPD items in the SCID-II are divided into 6 diagnostic criteria; ideas of reference, odd beliefs or magical thinking, unusual perceptual experiences, paranoid ideation, lack of close friends, and excessive social anxiety. The 15 items used are listed in table 3.2.1 below (Paranoia items are marked with an asterisk).

Table 3.2.1. BPMS items.

1*	Do you often have to keep an eye out to stop people from using you or hurting you?
2*	Do you spend a lot of time wondering if you can trust your friends or the people you work with?
3*	Do you find that it is best not to let other people know much about you because they will use it against you?
4*	Do you often detect hidden threats or insults in things people say or do?
5	When you are out in public and see people talking, do you often feel that they are talking about you?
6	Do you often get the feeling that things that have no special meaning to most people are really meant to give you a message?
7	When you are around people, do you often get the feeling that you are being watched or stared at?
8	Have you ever felt that you could make things happen just by making a wish or thinking about them?
9	Have you had personal experiences with the supernatural?
10	Do you believe that you have a ‘sixth sense’ that allows you to know and predict things that others can’t?
11	Do you often think that objects or shadows are really people or animals or that noises are actually people’s voices?
12	Have you had the sense that some person or force is around you, even though you cannot see anyone?
13	Do you often see auras or energy fields around people?
14	Are there very few people that you’re really close to outside of your immediate family?
15*	Do you often feel nervous when you are with other people?

3.2.1.4. Demography

In total, 222 respondents (2.6%) met diagnostic criteria for SPD. The disorder was more prevalent in females (3%, compared to 2.1% in males). The youngest age category, 16 to 34, had the highest rates of SPD at 4.1%. It was less prevalent in the 35 to 54 category at 2.1% and the oldest age category, 55 to 74 had the lowest prevalence of SPD at 1.3%.

3.2.2.1. NESARC

The National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) was a large-scale longitudinal survey carried out by the National Institute on Alcohol Abuse and Alcoholism, which aimed to study patterns of alcohol use, alcohol use disorders, and their associations with physical and psychological disorders. The survey aimed to be representative of the non-institutionalised adult population in the United States. The first wave of the survey was conducted in 2000/2001. Respondents from the first wave were re-interviewed for wave 2, which was conducted in 2004/2005. The current study focused on data collected in wave 2.

3.2.2.2. Sample

The first wave survey collected data from 43,093 respondents. In wave 2, 34,653 of the wave 1 respondents were re-interviewed. There were 8440 respondents from wave 1 who were not re-interviewed either because they were ineligible (3,134) or because they refused (5,306) (Intro book). 58% of the sample was female. The BPMS and NESARC samples differed in terms of their age profiles. The NESARC included individuals aged 18 and older while the BPMS had a lower age limit of 16. Also, the NESARC included individuals aged 90 and over but the BPMS had an upper age limit of 74. In the NESARC, 23.2% were aged between 18 and 34, 41.3% between 35 and 54, 25.3% between 55 and 74, and 10.2% aged 75 and up. The NESARC and BPMS also differed in terms of their ethnic profiles. 58% of the NESARC sample was White compared to almost 94% of the BPMS sample. It also had a larger portion of Black respondents (19% compared to 2.2% in the BPMS). The NESARC also had respondents who were Hispanic (18.4%), Asian/Hawaiian, and Native American (1.7%). A three-stage sampling approach was used that took advantage of the Census 2000/2001 Supplementary Survey (C2SS) and the Census 2000 Group Quarters Inventory. In the first stage, 655 sampling areas were selected and stratified in relation to socio-economic status. In the second stage, housing units in each of the sampling areas were systematically selected with Black and Hispanic households being selected at higher rates than other households. In the third stage, one person per household was selected for interview.

3.2.2.3. Measures

The NESARC made use of the Alcohol Use Disorder and Associated Disabilities Interview Schedule DSM-IV version (AUDADIS-IV) to measure Personality Disorders. The AUDADIS-IV is a fully-structured, self-report, diagnostic interview designed to be delivered by clinicians or trained laypersons. It assesses the occurrence of a variety of psychiatric disorders, including substance use disorders, major depression, anxiety disorders, psychosis and personality disorders. The authors developed the personality disorders section to be conceptually similar to the

SCID-II (Ahmed, & Green, 2013). The AUDADIS-IV's measure of Schizotypal PD consists of 17 items, each asking the respondent about a different experience. A two-stage response format is used. Stage 1 involves a "yes" "no" endorsement of the experience. If the respondent endorses the experience, they progress to stage 2 which asks if the experience ever troubled them or caused problems at work or school or with family or other people. the SPD items in the AUDADIS-IV could be divided into a number of diagnostic criteria. Like the SCID-II used in the BPMS, there were items measuring ideas of reference, odd beliefs or magical thinking, unusual perceptual experiences, paranoid ideation, lack of close friends, and excessive social anxiety. Unlike the SCID-II, the AUDADIS-IV also contained questions designed to measure disorganization. The measure has shown good test-retest reliability and internal consistency (Ruan et al., 2008). The items used are listed in table 3.2.2 below. (Paranoia items are marked with an asterisk).

Table 3.2.2. NESARC items.

1	Have you had trouble expressing your emotions and feelings?
2	Have you rarely shown emotion?
3*	Have you often felt nervous when you are with other people even if you have known them for a while?
4*	Have you felt suspicious of people, even if you have known them for a while?
5*	When you are around people, have you often had the feeling that you are being watched or stared at?
6	When you've been under a lot of stress, have you gotten suspicious of other people or felt spaced out?
7	Have there been very few people that you're really close to outside of your immediate family?
8	Have people thought you act strangely?
9	Have people thought you have strange ideas?
10	Have people thought you are odd, eccentric or strange?
11	Have you had personal experiences with the supernatural?
12	Have you had the sense that some force is around you, even though you cannot see anyone?
13	Have you believed that you have a "sixth sense" that allows you to know and predict things that others can't?
14	Have you often seen auras or energy fields around people?
15	Have you ever felt that you could make things happen just by making a wish or thinking about them?
16	Have you often had the feeling that things that have no special meaning to most people are really meant to give you a message?
17	Have you often thought that objects or shadows are really people or animals, or that noises are actually people's voices?

3.2.2.4. Demography

SPD was more prevalent in the NESARC than in the BPMS. In total, there were 1,534 respondents (4.4%) who met the diagnostic criteria for SPD. The disorder was also slightly more prevalent among males (4.7%) than females (4.2%). The opposite was found in the BPMS. The diagnosis was most common in the youngest age category, 18-34 (5.4%). The prevalence was lower among 35-54-year olds, (5.1%) lower again among 55-74-year olds, (3.4%) and lowest among the highest age category, 75-90+ (1.9%). This is similar to what was found in the BPMS.

3.2.3. Statistical analysis

A number of unidimensional IRT models were used to examine the difficulty, and in some cases, discrimination of each SPD item in the BPMS and NESARC. In order to find the best fitting and most parsimonious models of the two sets of data, the analysis was carried out in 2 stages. In the first stage, 1-parameter models were used to represent and examine the datasets. As mentioned previously in the introduction, 1-parameter models compare items solely in relation to their difficulty parameter. In the second stage, the datasets were represented and examined using a number of 2 parameter models that take item difficulty and discrimination into account. The purpose of running both 1 and 2 parameter models was to establish which type of model best represented the data. While 1-parameter models are more parsimonious, taking the discrimination variable into account may provide better fitting model. At each stage, there were two sets of analysis carried out on the NESARC data. In the first set of analysis, an item was marked present if the respondent endorsed the experience. In the second set, the item was not marked present unless the respondent both endorsed the experience and reported being bothered by it.

All analyses were conducted using Mplus 7. Maximum likelihood estimation with robust standard errors was used for parameter estimation. Relative model fit was established using the Bayesian Information Criterion (BIC). A lower BIC value indicates a better fitting model, with a difference greater than 10 being considered a significant difference (Raftery, 1995).

3.3. Results

3.3.1. Descriptive Statistics

Table 3.3.1 contains frequencies of endorsement for each of the 15 SPD items in the BPMS. (Paranoia items are marked with an asterisk). The question relating to a lack of close friends was endorsed by over half of the sample (54.6%) making it the most endorsed item. The four paranoia items also had some of the highest percentages of endorsement (29.5%, 23.1%, 19%, 16.3%). The lowest levels of endorsement were found in items asking about unusual perceptual experiences like seeing auras around people (2.3%) and seeing faces in shadows (2.9%) followed by items enquiring about ideas of reference like finding special meaning in things (6.7%) and believing people are talking about you (6.9%).

Table 3.3.1. Frequencies and percentages of endorsement of SPD items in BPMS.

Item	N	%
Keep an eye out*	2460	29.5
Wondering if you can trust*	1352	16.3
Use it against you*	1918	23.1
Detect hidden threats*	1579	19.0
Talking about you	577	6.9
Special meaning	527	6.7
Watched/stared at	853	10.2
Make things happen	1470	17.6
Supernatural	1062	12.8
Sixth sense	1027	12.3
Shadows	240	2.9
Force	1524	18.3
Auras	188	2.3
Few people close to	4540	54.6
Nervous	1465	17.5

Table 3.3.2 contains the frequencies of endorsement for each of the 17 SPD items in the NESARC. (Paranoia items are marked with an asterisk). Similar to the BPMS, the item enquiring about having a lack of close friends was the most endorsed (32.4%). The 3 paranoia items varied in terms of endorsement rates. Feeling suspicious of others was among the most endorsed items (12.8%), Feeling like you're watched or stared at had less endorsement (9.7%), and Feeling nervous around people had one of the lowest percentages of endorsement (6.5%). As was the case in the BPMS, the lowest levels of endorsement were found in items asking about unusual perceptual experiences like seeing auras around people (2.8%) and seeing faces in shadows (1.8%)

Table 3.3.2. Frequencies and percentages of endorsement of SPD items in NESARC (Frequency)

Item	N	%
Trouble expressing emotion	4694	13.6
Rarely shown emotion	5720	16.6
Nervous*	2253	6.5
Suspicious*	4412	12.8
Watched/stared at*	3330	9.7
Spaced out	3063	8.9
Few people close to	11130	32.4
Act strangely	2810	8.2
Strange ideas	4343	12.7
Odd/eccentric	3658	10.7
Supernatural	3098	9.0
Force	6454	18.8
Sixth sense	3192	9.3
Auras	963	2.8
Make things happen	2462	7.2
Special meaning*	3348	9.8
Shadows	608	1.8

Table 3.3.4 contains frequencies of respondents who both endorsed and reported being troubled by each of the 17 SPD items in the NESARC. (Paranoia items are marked with an asterisk). The 3 paranoia items had some of the highest percentages of endorsement (3%, 2%, 1.4%) along with items measuring emotional expression (5.1%, 2.2%). Once again, the lowest levels of endorsement were for the items enquiring about seeing auras (0.2%) and seeing faces in shadows (0.4%).

Table 3.3.4. Frequencies and percentages of endorsement of SPD items in NESARC (Distress)

Item	N	%
Trouble expressing emotion	1762	5.1
Rarely shown emotion	749	2.2
Nervous*	491	1.4
Suspicious*	1033	3.0
Watched/stared at*	682	2.0
Spaced out	1318	3.8
Few people close to	492	1.4
Act strangely	455	1.3
Strange ideas	524	1.5
Odd/eccentric	438	1.3
Supernatural	210	0.6
Force	268	0.8
Sixth sense	222	0.6
Auras	68	0.2
Make things happen	166	0.5
Special meaning*	397	1.2
Shadows	124	0.4

3.3.5. Model Testing

3.3.5.1. Stage 1: 1-Parameter Models.

As outlined in the method section, the statistical analysis was carried out in 2 linked stages. In the first stage, the SPD items from the BPMS and NESARC were modelled in relation to item difficulty only while item discrimination was held constant. The results from these 1-parameter models are detailed below.

3.3.5.1A. BPMS

The model attained a BIC score of 87864.835. Item parameter scores (difficulty and discrimination) for each SPQ item are contained in table 3.3.5 below and their associated Item characteristic curves are contained in figure 3.3.1. The easiest item to endorse related to having a lack of close friends. The 5 items measuring paranoid ideation were all located in the milder half of the severity spectrum. 3 of the 5 paranoia items had the 2nd, 3rd, and 4th lowest difficulty scores in the model. The other two paranoia items' (item 4 & 15) difficulty scores fell in the middle of the spectrum. The more severe end of the spectrum contained items measuring odd beliefs, ideas of reference, and unusual perceptual experiences. The highest difficulty scores were associated with items measuring unusual perceptual experiences; seeing auras around people and seeing faces in shadows. Table 3.3.6 contains the 15 items arranged in order of difficulty.

Table 3.3.5. Item difficulties and discriminations of SPD items in BPMS

Item	Difficulty	Discrimination
Keep an eye out*	0.875	1.414
Wondering if you can trust*	1.565	1.414
Use it against you*	1.179	1.414
Detect hidden threats*	1.367	1.414
Talking about you	2.410	1.414
Special meaning	2.424	1.414
Watched/stared at	2.039	1.414
Make things happen	1.447	1.414
Supernatural	1.827	1.414
Sixth sense	1.885	1.414
Shadows	3.100	1.414
Force	1.432	1.414
Auras	3.350	1.414
Few people close to	-.139	1.414
Nervous*	1.485	1.414

Figure 3.3.1. ICCs of 15 SPD items in BPMS.

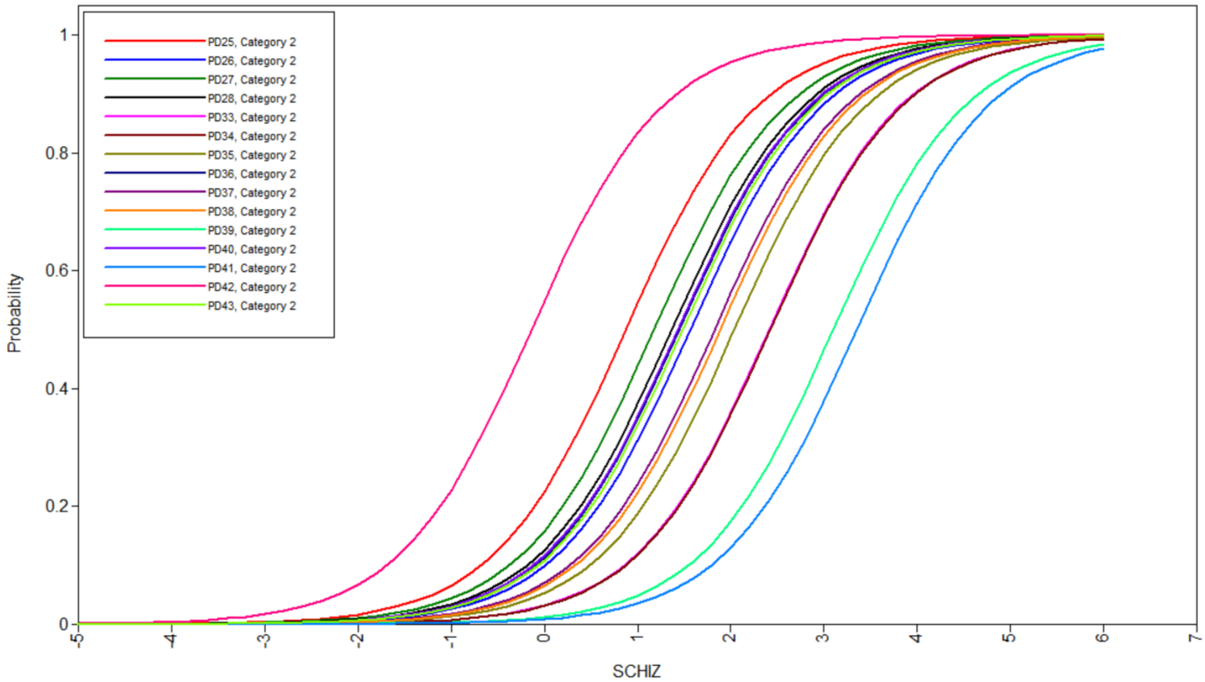


Table 3.3.6. BPMS items in order of difficulty.

Item	Difficulty
Few people close to	-.139
Keep an eye out*	0.875
Use it against you*	1.179
Detect hidden threats*	1.367
Force	1.432
Make things happen	1.447
Nervous*	1.485
Wondering if you can trust*	1.565
Supernatural	1.827
Sixth sense	1.885
Watched/Stared at	2.039
Talking about you	2.410
Special meaning	2.424
Shadows	3.100
Auras	3.350

3.3.5.1B. NESARC

As outlined in the method section, 2 models were run on the NESARC data at each stage of analysis. In the first model, an item was marked present if the respondent endorsed it (Frequency), in the second model, the item was not marked present unless the individual both endorsed it and reported being distressed by it (Distress).

The first model obtained a BIC of 325672.428. Difficulty and discrimination values for each SPD variable are displayed in table 3.3.7 below and their associated item characteristic curves are displayed in figure 3.3.2 Once again, having a lack of close friends obtained the lowest difficulty score. The emotional expression items and two of the three disorganization items were all located in the less severe half of the spectrum. It's important to note that the BPMS didn't contain comparable items measuring disorganization or emotional expression. The three paranoia items were spread throughout the severity spectrum with difficulty scores located in 6th, 11th, and 15th positions in the continuum. As was the case in the BPMS, seeing auras around people and seeing faces in shadows obtained the highest difficulty scores. The more severe end of the spectrum also contained items measuring odd beliefs. Table 3.3.8 contains the 17 items arranged in order of difficulty.

Table 3.3.7. Item difficulties and discriminations of SPD items in NESARC (Frequency)

Variable	Difficulty	Discrimination
Trouble expressing emotion	1.653	1.533
Rarely shown emotion	1.470	1.533
Nervous*	2.356	1.533
Suspicious*	1.836	1.533
Watched/stared at*	2.096	1.533
Spaced out	2.088	1.533
Few people close to	0.752	1.533
Act strangely	2.131	1.533
Strange ideas	1.734	1.533
Odd/eccentric	1.917	1.533
Supernatural	2.066	1.533
Force	1.360	1.533
Sixth sense	2.139	1.533
Auras	3.091	1.533
Make things happen	2.314	1.533
Special meaning	2.085	1.533
Shadows	3.392	1.533

Figure 3.3.2. ICCs of 17 SPD items in NESARC (Frequency)

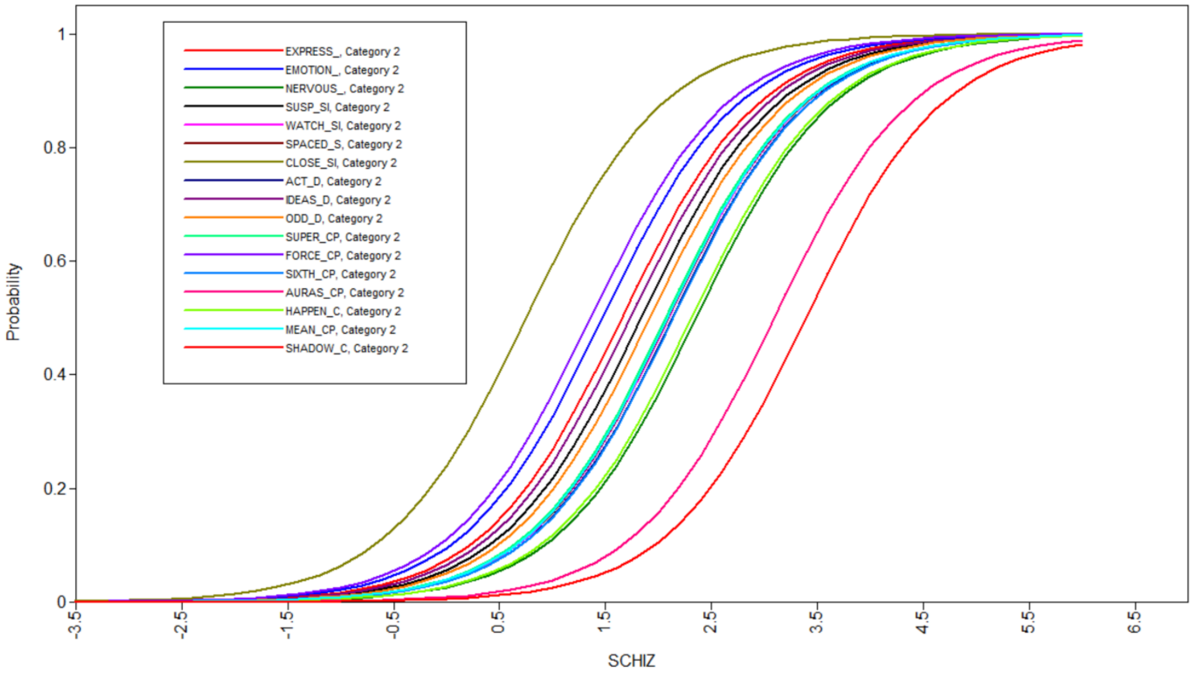


Table 3.3.8. NESARC items in order of difficulty

Variable	Item Difficulty
Few people close to	0.752
Force	1.360
Rarely shown emotion	1.470
Trouble expressing emotion	1.653
Strange ideas	1.734
Suspicious*	1.836
Odd/eccentric	1.917
Special meaning	2.085
Supernatural	2.066
Spaced out	2.088
Watched/stared at*	2.096
Act strangely	2.131
Sixth sense	2.139
Make things happen	2.314
Nervous*	2.356
Auras	3.091
Shadows	3.392

The second NESARC model obtained a BIC score of 64510.028. Difficulty, and discrimination values for each SPD item are shown in table 3.3.9 below. Associated item characteristic curves are displayed in figure 3.3.3. The 3 paranoia items' difficulty scores were all located in the lower half of the severity spectrum, obtaining the 3rd, 5th, and 7th lowest difficulty scores. In keeping with the previous NESARC model, the less severe end of the continuum also contained items relating to emotional regulation and disorganization however unlike the two models discussed previously, the item regarding a lack of close friends was located in the middle of the severity spectrum, not at the lower end. The higher end of the continuum contained items measuring odd beliefs and unusual perceptual experiences and once again, seeing auras and seeing faces in shadows obtained the two highest difficulty scores. Table 3.2.10 contains the 17 items arranged in order of difficulty.

Table 3.3.9. Item difficulties and discriminations of SPD items in NESARC (Distress)

Variable	Difficulty	Discrimination
Trouble expressing emotion	1.939	2.829
Rarely shown emotion	2.417	2.829
Nervous*	2.647	2.829
Suspicious*	2.309	2.829
Watched/stared at*	2.520	2.829
Spaced out	2.139	2.829
Few people close to	2.651	2.829
Act strangely	2.713	2.829
Strange ideas	2.633	2.829
Odd/eccentric	2.707	2.829
Supernatural	3.029	2.829
Force	2.941	2.829
Sixth sense	3.052	2.829
Auras	3.554	2.829
Make things happen	3.160	2.829
Special meaning	2.797	2.829
Shadows	3.264	2.829

Figure. 3.3.3. ICCs of 17 SPD items in NESARC (Distress)

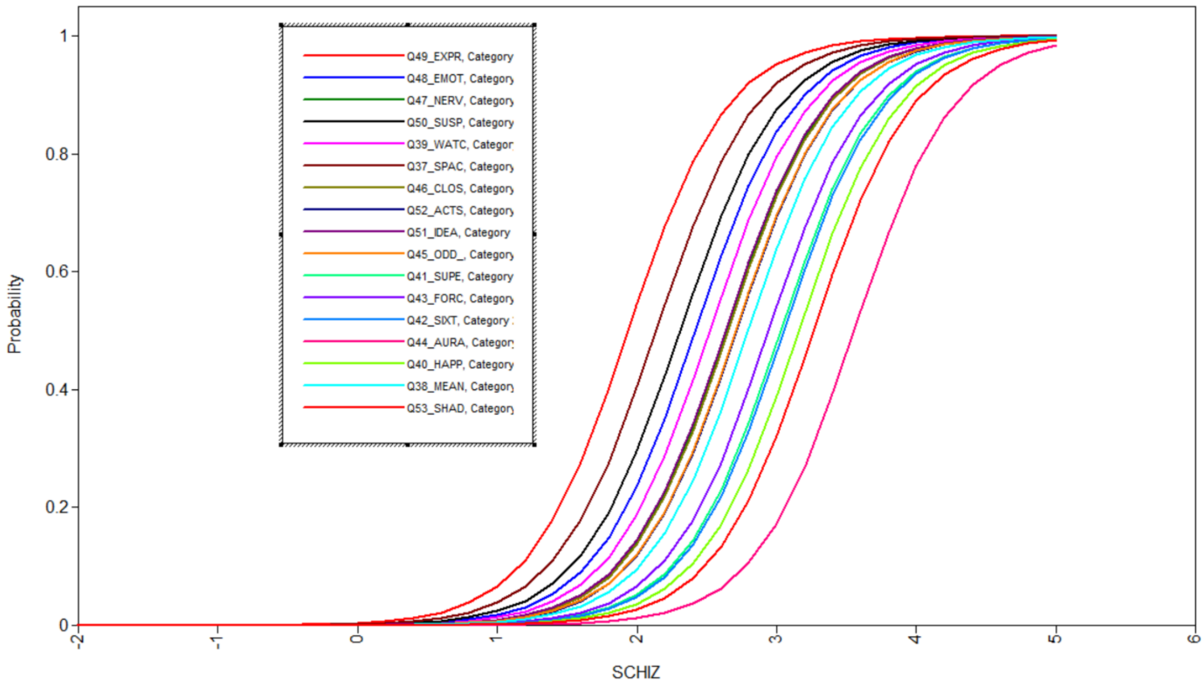


Table 3.3.10. NESARC items in order of difficulty

Variable	Item Difficulty
Trouble expressing emotion	1.939
Spaced out	2.139
Suspicious*	2.309
Rarely shown emotion	2.417
Watched/Stared at*	2.520
Strange ideas	2.633
Nervous*	2.647
Few people you're close to	2.651
Odd/Eccentric	2.707
Act strange	2.713
Special meaning	2.797
Force	2.941
Supernatural	3.029
Sixth sense	3.052
Make things happen	3.160
Shadows	3.264
Auras	3.554

3.3.5.2. Parameter Models

In the second stage of analysis the SPD items from the BPMS and NESARC were modelled taking both item difficulty and discrimination into account. These two parameter models were compared to the 1 parameter models detailed in the previous section to determine which provided better model fit. The results from these 2 parameter models are detailed below.

3.3.5.2A. BPMS

The model attained a BIC score of 86601.021. This is more than 10 points lower than the 1-parameter model score of 87864.835 indicating that adding the discrimination parameter significantly improved the model. Item parameter scores (difficulty and discrimination) for each SPQ item are contained in table 3.3.11 below and their associated Item characteristic curves are displayed in figure 3.3.4 Taking item discrimination into account resulted in several changes to item positions compared to the 1-parameter model. Two of the paranoia items moved towards the lower end of the continuum, shifting from 7th and 8th positions to 5th and 6th. Three of the items measuring odd beliefs and one item measuring perceptual experiences climbed towards the more severe end of the spectrum. The items with highest and lowest difficulty scores remained unchanged with a lack of close friends at the bottom, and auras and shadows at the top. Table 3.3.12 contains the 15 items arranged in order of difficulty.

The BPMS items assessing paranoid ideation and ideas of reference obtained the highest discrimination values in the model suggesting that these items are most closely related to the underlying construct. They were followed by items measuring perceptual experiences, and then by items assessing odd beliefs. The item assessing emotional regulation had the lowest discrimination value.

Table 3.3.11. Item difficulties and discriminations of SPD items in BPMS

Item	Difficulty	Discrimination
Keep an eye out*	0.819	1.637
Wondering if can trust*	1.258	2.277
Use it against you*	1.042	1.830
Detect hidden threats*	1.116	2.201
Talking about you	1.847	2.455
Special meaning	1.987	2.047
Watched/stared at	1.518	2.774
Make things happen	1.751	1.051
Supernatural	2.360	0.963
Sixth sense	2.060	1.221
Shadows	2.785	1.668
Force	1.587	1.198
Auras	3.387	1.373
Few people close to	-.267	0.550
Nervous*	1.510	1.378

Figure 3.3.4. ICCs of 15 SPD items in BPMS

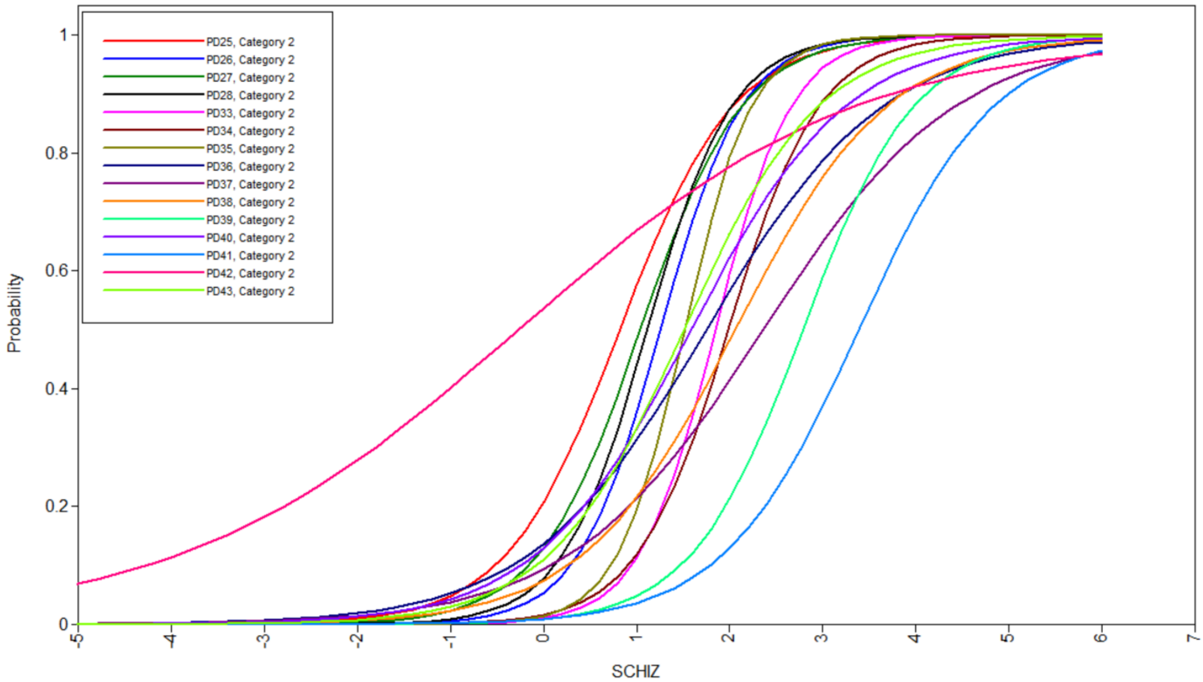


Table 3.3.12. BPMS items in order of difficulty

Item	Difficulty
Few people close to	-.267
Keep an eye out*	0.819
Use against you*	1.042
Detect hidden threats*	1.116
Wondering if you can trust*	1.258
Nervous*	1.510
Watched/Stared at	1.518
Force	1.587
Make things happen	1.751
Talking about you	1.847
Special meaning	1.987
Sixth sense	2.060
Supernatural	2.360
Shadows	2.785
Auras	3.387

3.3.5.2B. NESARC

The first 2-parameter model of the NESARC data (Frequency) obtained a BIC score of 321493.432. As this BIC is more than 10 points lower than the previous model, (BIC = 325672.428) it can be said that the 2-parameter model is a significant improvement on the 1 parameter model. Difficulty and discrimination scores for each variable are shown in table 3.3.13 below. Associated item characteristic curves are displayed in figure 3.3.5. Taking discrimination into account resulted in several changes to item positions compared to the 1-parameter model. Three of the paranoia items moved towards the less severe end of the spectrum (from 10th to 8th position, from 11th to 7th position, from 15th to 13th position). The three disorganization items also moved towards the lower end of the spectrum in this model. Conversely, the two questions assessing emotional regulation and one of the perceptual items moved from the milder half of the spectrum to the more severe half. The items with highest and lowest difficulty scores remained unchanged with a lack of close friends at the bottom, and auras and shadows at the top. Table 3.3.14 contains the 17 items arranged in order of difficulty.

Discrimination scores were highest in the three items relating to disorganization. The items measuring perceptual abnormalities and paranoid ideation also obtained some of the higher discrimination scores. Items enquiring about odd beliefs had slightly lower discriminations, while the lowest discrimination scores were obtained by the emotion expression items and the item asking about a lack of close friends.

Table 3.3.13. Item difficulties/discriminations of 17 SPD items in NESARC (Frequency)

Variable	Difficulty	Discrimination
Trouble expressing emotion	2.005	1.119
Rarely shown emotion	2.326	0.781
Nervous*	2.181	1.758
Suspicious*	1.649	1.904
Watched/stared at*	1.832	2.004
Spaced out	1.904	1.826
Few people close to	1.072	0.883
Act strangely	1.629	2.948
Strange ideas	1.395	2.585
Odd/eccentric	1.532	2.596
Supernatural	2.112	1.471
Force	1.421	1.423
Sixth sense	2.107	1.570
Auras	2.677	1.962
Make things happen	2.288	1.555
Special meaning	1.944	1.743
Shadows	2.692	2.339

Figure 3.3.5. ICCs of 17 SPD items in NESARC (Frequency)

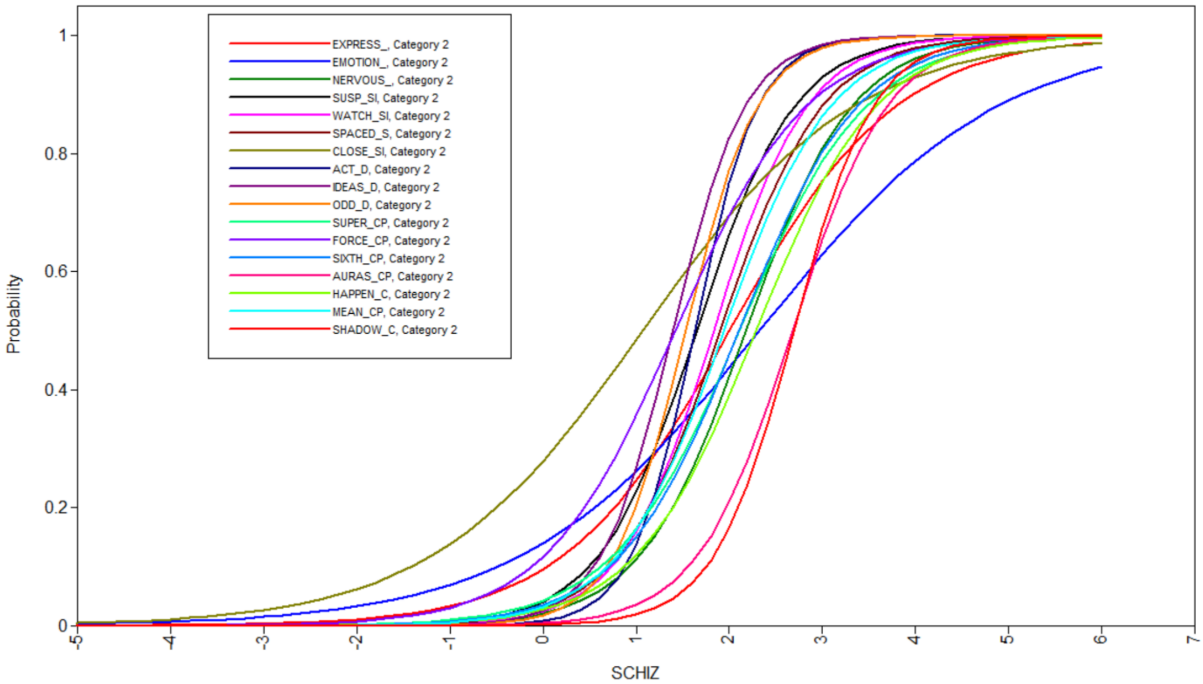


Table 3.3.14. NESARC items in order of difficulty

Variable	Item Difficulty
Few people close to	1.072
Strange ideas	1.395
Force	1.421
Odd/eccentric	1.532
Act strange	1.629
Suspicious*	1.649
Watched/Stared at*	1.832
Spaced out	1.904
Special meaning	1.944
Trouble expressing emotion	2.005
Sixth sense	2.107
Supernatural	2.112
Nervous*	2.181
Make things happen	2.288
Rarely shown emotion	2.326
Auras	2.677
Shadows	2.692

The second 2-parameter model of the NESARC data (distress) obtained a BIC score of 64332.826. As this BIC is more than 10 points lower than the previous model, (BIC = 64510.028) it can be said that the 2-parameter model is a significant improvement on the 1 parameter model. Difficulty and discrimination scores for each variable are shown in table 3.3.15 below. Associated item characteristic curves are displayed in figure 3.3.6. While taking discrimination into account did make a significant improvement to the previous model, it didn't result in many changes to item positions. All paranoia items were still located at the milder end of the spectrum and items relating to perceptual experiences and odd beliefs were still located at the more severe end. One change that did take place was the three disorganization items moving towards the less severe end of the spectrum. Table 3.3.16 contains the 17 items arranged in order of difficulty.

In the current model, the disorganization items, along with some of the items measuring perceptual experiences, obtained the highest discrimination scores, followed by items measuring paranoid ideation and odd beliefs. The lowest discrimination scores were associated with the two items relating to emotional expression.

Table 3.3.15. Item difficulties and discriminations of SPD items in NESARC (Distress)

Variable	Difficulty	Discrimination
Trouble expressing emotion	2.108	2.209
Rarely shown emotion	2.589	2.314
Nervous*	2.530	3.293
Suspicious*	2.258	3.065
Watched/stared at*	2.426	3.225
Spaced out	2.182	2.652
Few people close to	2.691	2.686
Act strangely	2.429	4.495
Strange ideas	2.413	4.029
Odd/eccentric	2.581	3.311
Supernatural	3.090	2.640
Force	2.955	2.755
Sixth sense	3.013	2.895
Auras	3.324	3.362
Make things happen	2.597	3.438
Special meaning	2.705	3.121
Shadows	2.970	3.818

Figure 3.3.6. ICCs of 17 SPD items in NESARC (Distress)

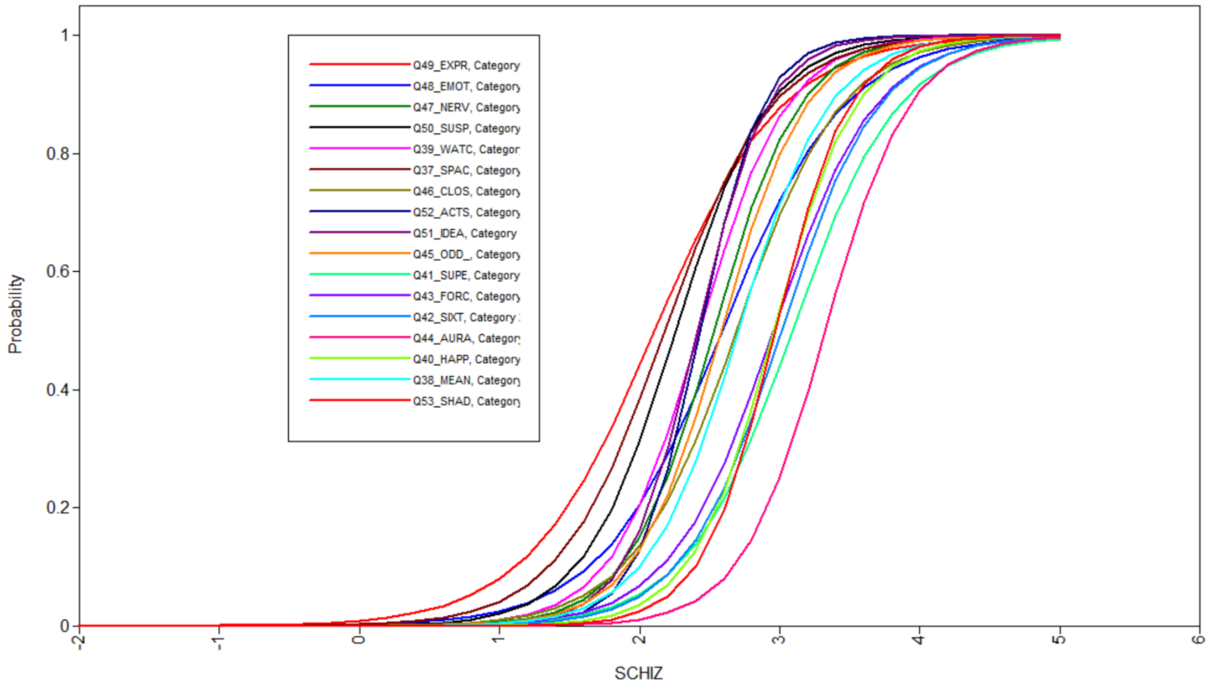


Table 3.3.16. NESARC items in order of difficulty

Variable	Item Difficulty
Trouble expressing emotion	2.108
Spaced out	2.182
Suspicious*	2.258
Strange ideas	2.413
Watched/Stared at*	2.426
Act strange	2.429
Nervous*	2.530
Odd/Eccentric	2.581
Rarely shown emotion	2.589
Few people close to	2.691
Make things happen	2.597
Special meaning	2.705
Force	2.955
Shadows	2.970
Sixth sense	3.013
Supernatural	3.090
Auras	3.324

3.4. Discussion

3.4.1. Study findings

To the author's knowledge, this study was the first of its kind to use IRT techniques to examine how different psychotic symptoms relate to an underlying psychosis construct across 2 large community-based samples. It was predicted that items measuring paranoia would display strong links to the underlying psychosis construct and would be particularly associated with lower levels of psychosis severity compared the other items in the scales. The first section of this discussion will outline the study findings in relation to these hypotheses.

Firstly, each of the two-parameter models, which took item discrimination into account, were superior to their one-parameter counterparts. The 2-parameter model obtained using the BPMS data were in keeping with this study's predictions. Difficulty scores associated with all five items measuring paranoid ideation were among the lowest in the distribution (2^{nd}, 3^{rd}, 4^{th}, 5^{th} & 6^{th} positions). Moving along the continuum of severity, the paranoia items were followed by items measuring ideas of reference and odd beliefs, and finally by items relating to perceptual anomalies, which obtained the highest difficulty scores. This was in keeping with the prediction that paranoia items would be most closely associated with less severe forms of SPD. One aspect of the model that, on the surface, seemed to go against expectations was that the item enquiring about having very few close friends obtained a lower difficulty score than any of the paranoia items. However, when the associated discrimination values for each item began to be examined, the validity of this item came under scrutiny.

As mentioned previously in the introduction to this chapter, discrimination describes to how closely an item is related to the underlying construct. As was anticipated, the paranoia items all obtained high discrimination values. In fact, they obtained higher scores than the items measuring odd beliefs and some of the items measuring perceptual abnormalities. This conformed to what was predicted and indicates that paranoid ideation is strongly related to the underlying construct of SPD. Conversely, the "has few close friends" item received the lowest discrimination score in the analysis. So, while this item did have a lower difficulty score than the paranoia items, its low discrimination value indicates that it may be a measure of SPD.

Before the results from the NESARC models are discussed, it is important to remember that the NESARC and the BPMS used different scales to measure SPD. Some relevant differences between the scale items used in the NESARC and those used in the BPMS must be considered. Firstly, the NESARC contained some items designed to measure diagnostic criteria that were not measured in the BPMS; namely, disorganisation and emotional expression. In addition, some of the diagnostic criteria that were common to both datasets were measured using different items. The BPMS contained five paranoia items and the NESARC contained four however only one of these items was common across both scales. The item in question focused on feeling nervous around others and it's important to point out that the phrasing of the item was not identical across the two scales. The BPMS asked "Have you often felt nervous when you are with other people?" however the comparable item in the NESARC asked the respondent if they have felt nervous around others “even if you have known them for a while”. It is important to consider these differences in phrasing as it may affect how difficult it is to endorse the item.

The model obtained using the NESARC (frequency) data differed from the BPMS model in a number of ways. In relation to the difficulty parameter, it was the disorganisation variables obtained some of the lowest scores. Three of the four paranoia items were found towards the middle of the distribution (6^{th}, 7^{th} & 8^{th} positions) while the fourth was located towards the more severe end of the distribution (13^{th} position). At first glance, this seems to be at odds with the BPMS model however as mentioned previously, the disorganisation items were not present in the BPMS and when these items are ignored, the current model bears closer resemblance to the previous one. Additionally, it was the “nervous” paranoia item that was located towards the more severe end of the spectrum. The aforementioned difference in phrasing may have played a role in its higher difficulty score. Similar to the BPMS, items measuring odd beliefs and perceptual abnormalities obtained some of the highest difficulty scores. The emotional expression items were also located in the more severe half of the distribution. These findings do not support the prediction that paranoia items would be among the easiest items to endorse and instead, seem to suggest that disorganisation items are associated with lower levels of psychosis severity.

As predicted and as was the case in the BPMS model, the paranoia items obtained high discrimination values, scoring higher than the odd belief items or the “few people close to” item. The emotional expression items obtained some of the lowest discrimination scores, bringing their ability to measure SPD into question. The disorganisation items obtained the highest discrimination scores indicating that disorganisation is closely related to the underlying psychosis construct.

As mentioned in the method section, the second NESARC model (distress) focused solely on experiences that respondents found distressing. Once again, it is important to acknowledge how this change in language may affect responses. For example, reporting that you have very few close friends is not the same as reporting that you have few close friends and that you are distressed by that. There are several noteworthy differences between this model and the previous one. In terms of the difficulty parameter, the paranoia items were all located in the lower half of the distribution (2nd, 3rd, 5th, & 7th positions). This is in keeping with both the results of the BPMS model and the study predictions. The disorganisation items were all located in higher positions compared to the first NESARC model (4th, 6th, & 8th positions compared to 2nd, 4th & 5th positions). The emotional expression variables were found at the lower end and middle of the distribution instead of at the higher end. Once again, odd beliefs and perceptual abnormalities obtained the highest difficulty scores.

In terms of the discrimination parameter, the current model showed many similarities with the previously discussed NESARC model. Once again, paranoia items achieved higher discrimination scores than those measuring odd beliefs. The emotional expression variables obtained the lowest discrimination scores overall, and the disorganisation items obtained the highest.

3.4.2. Within the context of the current literature

It is important to discuss the current findings within the context of the existing literature. First and foremost, the current results are congruent with existing literature surrounding the Psychosis continuum. It is now a widely accepted that the psychosis phenotype is continuous in nature; that psychotic experiences can be found in non-clinical samples and that they are more common than the psychotic disorders themselves (Van Os, Linscott, Myin-Germeys, Delespaul, & Krabbendam et al., 2009). This finding was mirrored in the samples used in this study. For example, while 2.6% of the BPMS sample received a diagnosis of SPD, 19% of respondents reported experiencing a paranoid symptom. Also, the finding that different psychotic experiences were associated with different levels of psychosis severity is compatible with continuum models. This result would not be expected if all psychotic experiences developed concurrently, as categorical models would suggest.

Moreover, the current findings potentially shed light on the nature of the psychosis continuum. The precise meaning of a continuum of psychotic experience is still being actively debated in the literature (DeRosse & Karlsgodt, 2015). Some have put forward a quasi-dimensional model, which acknowledged that psychotic experience is dimensional in nature, but that only a subsection of the population (~10%) with a genetic predisposition could be represented along this continuum (Meehl, 1989). Alternatively, others have adopted a fully dimensional model, suggesting that psychotic experiences are present throughout the general population (Claridge & Hewitt, 1987). Of the two approaches, the current findings are more supportive of a psychosis continuum that is fully dimensional in nature. This is mainly due to the fact that the frequencies of psychotic experiences observed were higher than would be expected based on a quasi-dimensional model.

The variation in item distribution between the distressing and non-distressing NESARC models is a relevant finding in relation to some of the cognitive theories of psychosis development. Researchers in this area have proposed that the cognitive appraisals of psychotic experiences are related to negative outcomes and could be related to later emergence of a clinical disorder (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001; Morrison, 2001). In the current study, the items measuring paranoia were located at the lower end of the distribution in the distress model, a finding that was in line with the study predictions. Paranoia did not perform as predicted in the non-distress model. These differences provide support for the cognitive approaches that focus on the distress that psychotic experiences can elicit. Indeed, the structural changes in psychotic symptoms overall between the distress and non-distress models reflect the impact that negative appraisals of these experiences can have.

3.4.3. Implications for the overall thesis aims

The findings from this analysis have a number of implications for the cascade of misinformation model being investigated throughout this thesis. By and large, the results were in keeping with the predictions of the current study. In all models, the paranoia items consistently obtained strong discrimination values, suggesting a close relationship exists between paranoid ideation and the construct of psychosis. This was a critical finding because one of the central aspects of the Cascade model is that paranoid ideation plays a central role in the genesis and early development of psychotic experiences. If this link between paranoid ideation and the underlying psychosis construct had not been reflected in the current results, it would have severely undermined the Cascade model.

The findings in relation to item difficulty were slightly less clear-cut. If paranoid ideation does emerge at an earlier stage than other psychotic experiences as the Cascade model suggests, it is reasonable to expect that items measuring paranoia would be associated with difficulty scores that are lower than those measuring other psychotic experiences. This prediction was mostly supported. In both the BPMS model and the NESARC (distress) model, the paranoia items were located at the less severe end of the severity continuum, obtaining some of the lowest difficulty scores. The NESARC (frequency) model was the exception, identifying disorganisation as being lower on the spectrum than paranoia. It is interesting that one of the NESARC models supported the study's predictions while the other did not. The reasons for this are still unclear, however the model focusing solely on distressing experiences is arguably the more relevant and informative of the two in terms of psychotic disorder research. It may be the case that the elicitation of distress is an integral aspect of how paranoid thoughts influence psychosis development. Ultimately, the current results highlighted the complexity of the relationships between psychotic symptoms and the underlying construct itself. The different symptoms of psychosis clearly vary in terms of how closely they are associated with the latent psychosis construct and in terms of the point along the continuum of psychosis severity at which they become most relevant. The findings in relation to paranoia give credence to the suggestion that it holds a prominent position in the early stages of psychosis development.

3.4.4. Limitations

While these current findings are promising, there are a number of limitations of this research that must be discussed. Firstly, there may be issues surrounding the age range in the BPMS sample which included individuals as young as 16. The questions that are being asked surrounding psychotic experiences may not have the same meaning to a 16-year-old as they would have for an older respondent. However, previous studies have successfully measured subclinical experiences in adolescent samples, suggesting that the data contained in the BPMS is relevant (Ruhrmann et al., 2010). Moreover, it's important to note that unlike the BPMS, the NESARC did not include 16 or 17-year-old respondents. This should be kept in mind when comparing findings across the two datasets. Another limitation of the current research is that the two datasets used different scales to measure SPD. This meant that some diagnostic criteria could not be compared across all models because the relevant items were not present in one of the scales. Other diagnostic criteria were measured in both datasets but were not measured using the same scale items. These slight variations in how different scale items were phrased could influence responses. This also limited the researcher's ability to compare results between the BPMS and NESARC models.

There is a risk that the current study could be interpreted as attempting to infer causal relationships in cross-sectional data. It is important to be clear that this is not the case. The purpose of this analysis was to learn more about the relationship between paranoid ideation and the latent construct of psychosis. While this study is being contextualised within the Cascade model, which is attempting to explain how psychosis develops over time, it is not attempting to use the current results to make assumptions about when different psychotic symptoms emerge.

It is also important to acknowledge that while this study was designed to partially investigate a theory of how individuals move along the psychosis continuum, the finding that different psychotic symptoms are associated with different points on a continuum of severity doesn't necessarily mean that individuals transition along said continuum. It is not possible to tell whether or not a respondent who endorsed a less severe item will ever go on to develop more severe symptoms in the future by looking at cross-sectional data. Indeed, the majority of individuals who report subclinical psychotic experiences will not go on to develop a psychotic disorder (Poulton, et al., 2000). Answering these types of questions will undoubtedly require the longitudinal investigation of psychosis development in some form. That being said, the current literature suggests that psychosis exists as a continuum of severity in the population, and that individuals can move along this continuum over time. The findings of the current study suggest that different symptoms of SPD are associated with different points along this continuum. Therefore, if this were the case, it would imply that different symptoms develop at different stages of psychosis development. It would also make sense that if an individual were to progress along the continuum, that they would develop the milder symptoms, which are more common in the population, before they develop the rarer, more severe ones. Coming from this perspective, the prediction that paranoia could precede the development of other psychotic symptoms such as hallucinations is a reasonable one.

3.4.5. Clinical Implications & Avenues for Future Research

These limitations notwithstanding, the current study's findings have a number of implications for clinical practice. First and foremost, these findings are relevant in terms of the psychological scales used to measure psychosis. This analysis identified several scale items that were not performing well in these samples. In particular, the item regarding having few people in one's life that you are close to obtained low discrimination scores. This would indicate that these items are not accurate measures of psychosis and therefore, it may be beneficial to consider removing them from psychosis questionnaires. Secondly, the current findings can help inform decisions around psychosis treatment. Obviously, one of the main concerns for clinicians is the selection of effective interventions for the prevention and treatment of psychosis. A treatment approach that has often been recommended in the literature is the targeting of specific symptoms. The assumption is that treating specific symptoms will have positive knock-on effects on other psychotic symptoms. An example of these targeted treatments would be the use cognitive therapy for the treatment of command hallucinations (Trower, Birchwood, Meaden, & Byrne, 2004) or group cognitive therapy targeting delusions (Landa, Silverstein, Schwartz, & Savitz, 2006). One of the main obstacles to the development of these types of intervention is the identification of symptoms that would be the optimum targets for intervention. The findings from the current study have demonstrated that different psychotic symptoms are particularly relevant to specific levels of psychosis severity.

This indicates that deciding which symptom to treat may be more complex than one might think. Instead, the optimum symptom to target may vary from person to person based on their level of psychosis severity. So, if an individual is exhibiting a lower level of psychosis, they may benefit most from a treatment targeting paranoid cognitions. Alternatively, if their level of psychosis was more severe, an intervention targeting auditory hallucinations may be more appropriate.

The current findings also have a number of implications for future research. Firstly, this study has demonstrated that IRT methods can be used effectively as an investigative tool to learn more about the symptom structure of underlying psychological constructs. These techniques could certainly be used more in psychosis research. For example, it may be worthwhile using it to investigate psychotic disorders in clinical samples and to compare their structure to the current findings. Secondly, since the current analysis was so novel, the interpretations that have been put forward regarding the development of different psychotic symptoms at different points along the psychosis continuum must be further explored. Ideally, this would involve the longitudinal prospective analysis of psychotic symptom development within a general population sample over a significant period of time. Finally, the results obtained from this analysis surrounding paranoid ideation suggest that further research investigating the Cascade model is warranted and may be fruitful. This research has demonstrated that paranoid ideation is closely related to low level psychosis but how it relates to other psychotic symptoms is still unknown. The next step in investigating the Cascade model should involve further analysis shedding light the nature of these relationships between paranoid ideation and the other symptoms of psychosis.

3.4.6. Conclusion

To the best of the researchers' knowledge, this is the first study of its kind to investigate the structure of psychotic experiences in two large community-based samples using IRT methods. This study is also unique in terms of how it examined this symptom structure by running multiple models in two large epidemiological datasets. This afforded the author the ability to examine how these psychotic symptoms performed across different samples, different IRT models, and different psychological scales; something that was not possible in the few existing studies which have used IRT to shed light on a latent psychological construct. While there was variation across the different models obtained, the paranoia items displayed consistently strong relationships with the underlying psychosis construct. In addition, aside from in one model, the paranoia items obtained some of the lowest difficulty scores across both datasets. These findings suggest that paranoid ideation is more characteristic of low-level psychosis than other psychotic symptoms such as odd beliefs or perceptual abnormalities. Within the context of the Cascade model, these findings are congruent with the prediction that paranoia may emerge before other psychotic symptoms manifest themselves, prompting further study into paranoia's role in the genesis of psychotic experience.

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Chapter 4: A network analysis of subclinical psychotic experiences using the BPMS and the NESARC

Abstract

Network analytic techniques can enhance our understanding of how psychological disorders develop by shedding light on how different symptoms cluster together and interact. Network analysis is theoretically complimentary with the cascade model of psychosis development being investigated in the current thesis in a number of ways. Moreover, to the author's knowledge, no study has compared the structure of two networks of subclinical positive psychotic experiences across 2 large-scale non-clinical samples. The current study aims to model psychotic symptoms in two large epidemiological studies using network analytic techniques. Specifically, it aims to first examine symptom centrality to identify the core symptoms of psychosis. Secondly, explore the role that the paranoia symptoms play in the network. And finally, compare the psychosis networks across two large epidiemlogical datasets in order to assess how replicable the network structures are. The author predicts that items measuring paranoia will play central roles in the psychosis networks. The present analyses were conducted using two large epidemiological datasets: the British Psychiatric Morbidity Survey (BPMS), which contained 8393 participants, and the National Epidemiologic Survey of Alcohol and Related Disorders (NESARC), which contained 34,653 respondents. Of the BPMS, 15 items assessing SPD were selected for analysis. The 16 NESARC items assessing SPD were selected for the current analysis. In total, three network analyses were performed. The first modelled data from the BPMS while the second and third utilised the NESARC dataset. High levels of consistency in terms of structure and centrality were observed across the three networks, indicating that the structure of psychotic experiences are reasonably stable in the general population. As predicted, items measuring paranoid ideation consistently obtained some of the highest centrality

scores across the networks, suggesting that paranoia is a core experience in subclinical psychosis. The current study succeeded in shedding light on the dynamic nature of the relationships that exist between paranoia and the other symptoms of psychosis. Importantly, these results provide support for the Cascade hypothesis. Additionally, the connections revealed in the networks revealed a number of possible pathways to psychosis development, thereby opening up new avenues for investigation. Ultimately, the next step in exploring the role of paranoia in psychosis development must explore these experiences longitudinally to test these potential pathways to clinical psychosis.

4.1. Introduction

The previous chapter investigated how different psychotic experiences varied in terms of their relationship to the underlying psychosis continuum. This was achieved through the novel use of item response theory (IRT) to investigate how different schizotypal personality disorder (SPD) symptoms related to a latent underlying psychosis construct. IRT possessed several qualities that made it an appealing analysis to investigate psychotic symptom structure. Its main advantage was a focus on the symptom level of psychopathology that was theoretically complimentary to the study aims. The use of these methods provided valuable insights into the relevance of psychotic ideation at milder levels of psychosis. Building on this research, the current chapter aims to explore psychotic experiences in the general population further, this time focusing on how these experiences co-occur and interact with each other. In particular, the author is interested in learning more about how paranoia interacts with and influences these other subclinical experiences such as hallucinations.

The way in which psychosis has been conceptualised in the past has impeded researchers' ability to effectively study its epidemiology (Kendler, McGuire, Gruenberg, & Walsh, 1994). One aspect of research which has been affected is the development of statistical paradigms. The range of statistical techniques that are currently used in the field were developed to compliment specific theoretical viewpoints. This means that our current understanding of psychopathology is shaped by theoretical assumptions that underlie the statistical tests used by researchers in the field. This is an important point to understand as it means that new and novel explanations of psychological phenomena may be restricted by the lack of appropriate investigative paradigms. In other words, progress in psychology research can be impeded by the absence of alternative and innovative statistical techniques. These are points which must be kept in mind in relation to this thesis to ensure the methods being employed to investigate the cascade model complement its theoretical underpinnings.

4.1.1. Latent variable models of psychological disorders

As is the case with multiple statistical methods used in psychology research, IRT assumes the existence of a latent underlying psychological construct that drives the development of a number of observed variables. The fact that so many of these techniques are built upon this premise is no surprise. The latent variable model is the prevailing explanation of psychopathology in the fields of psychology and psychiatry. Why this model has gained so much popularity and the issues associated with it must now be discussed. The finding that some psychological symptoms consistently co-occur with one another more often than with others is undisputed (Cramer & Borsboom, 2015). It was proposed that groups of symptoms were showing these consistent patterns of co-variation because they shared a common cause which was driving their mutual development. This lead to the idea that there were latent mental disorders underlying these groups of symptoms. The concept that observable psychological phenomena are symptoms of distinct and separate, yet unobserved disorders such as depression and psychosis has permeated the fields of psychology and psychiatry to such an extent that it is easy to forget that these disorders are constructs, not natural kinds. Several limitations of the latent variable model have been pointed out. One limitation centres around co-morbidity. Studies have reported that many individuals who are diagnosed with one psychological disorder also receive additional diagnoses (Kessler, 2005). It has been suggested that these high levels of overlap are an artefact of how these disorders are described and classified. Another issue with how we currently conceptualise mental illness involves poor reliability and validity associated with current diagnostic categories. Disease categories such as depression and schizophrenia have been criticised for performing poorly when predicting things like prognosis and treatment outcome (Fried, 2015; Bentall, Jackson, & Pilgrim, 1988).

4.1.2. The network approach

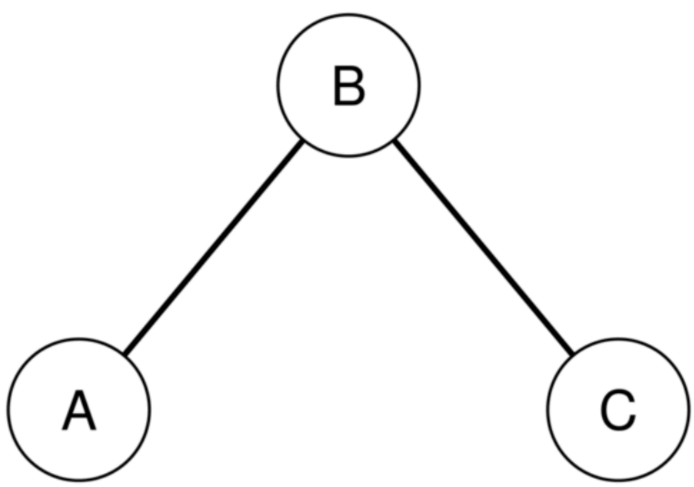
In response to the aforementioned issues, an alternative and novel way of conceptualising psychopathology has been proposed in recent years. This new approach rejects the idea that mental disorders cause symptoms such as low mood and hallucinations and instead, focuses on networks of symptoms that interact and influence each other (Cramer & Borsboom, 2015). This explanation is called the network perspective. The network approach suggests that psychological symptoms cluster together because they play causative roles in each other's development; not because they share a common underlying cause. Put simply, it suggests that the experience of one symptom can lead to the development of other symptoms (Fried et al., 2017). Fried and colleagues used depression symptoms as an example. If an individual is experiencing insomnia, it is easy to imagine how this could cause them to have issues with concentration. This, in turn, could then cause them to experience sadness or anhedonia (Fried et al., 2017) . By thinking of mental illness purely in terms of clusters of interacting symptoms, researchers avoid the problems associated with the latent disorder approach and recognise the levels of complexity involved in the development of mental illness (Schmittmann et al., 2013). Network perspectives are not only preferable on theoretical grounds, but also appear to be supported by empirical evidence (Bringmann et al., 2013). Cramer, Waldorp, van der Maas, & Borsboom (2010) pointed out that the majority of individuals working in clinical fields would discuss psychological disorders in terms of complex networks of interacting experiences and would reject any explanations which focused on a common cause. Conversely however, some researchers may find it difficult to adjust to network-based explanations because psychopathology research has been so influenced and dominated by categorical diagnostic accounts up to this point. In recent years, more and more researchers are recognising that cognitions, feelings, and behaviours dynamically interact however they are still using analytic techniques that obscure these interactions (Cramer et al., 2010).

4.1.3. Network analysis

The network perspective was formulated in 2008 and rapidly attracted attention as a promising alternative approach that could improve our understanding of mental illness (Fried et al., 2016). Despite its potential however, the paradigm was of little use if it could not be empirically investigated and the majority of existing statistical techniques were not appropriate for this task. This meant that a new statistical paradigm was required before network models of mental disorders could be explored. The solution to this came in 2010 when researchers began to develop a group of innovative statistical techniques, collectively known as network analysis

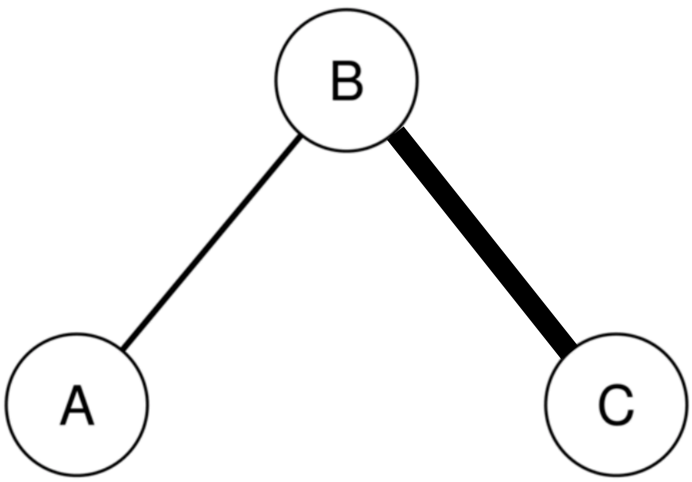
(Fried et al., 2016). The next section of this introduction will discuss network analysis in more detail. In basic terms, Network Analysis involves using mathematical models to obtain something called a psychological network. Psychological networks are used to portray possible patterns or interaction between a number of psychological variables such as symptoms of a psychological disorder (Epskamp, Borsboom, & Fried, 2018). In other words, they are graphical representations of how a number of psychological variables interact. A network is comprised of two main components: nodes and edges. Each node represents a variable. When network analysis is applied in psychology research, nodes would typically represent symptoms of a disorder such as depression however they could be used to represent any type of entity. Each edge in the network represents a connection between two nodes. Once again, depending on the type of research, these edges could represent many different types of connection however in psychology research, they usually represent correlation between two nodes. Figure 4.1.1 below contains an example of a simple network. A, B, and C are the nodes. As you can see, nodes A and B and nodes B and C are connected by an edge, but A and C are not, indicating that they are not connected.

Figure 4.1.1. Simple network



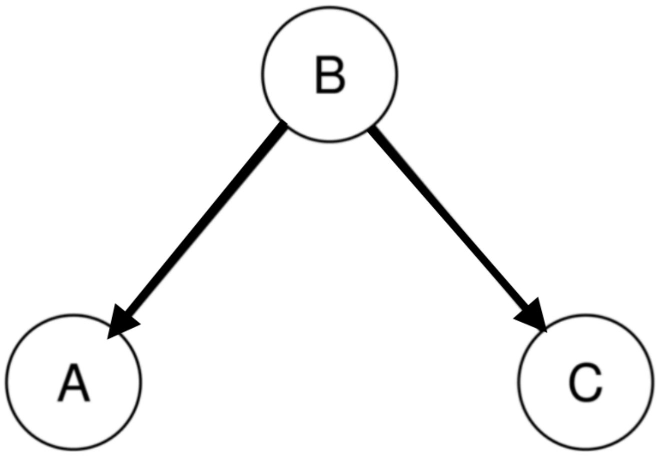
There are a number of different types of network that can be obtained depending on the characteristics of the dataset being represented. A simple network like the one in figure 1 above only contains information on whether or not two nodes are connected and does not contain any information on the nature of these connections. More complex networks can describe these connections in terms of weight and directionality. Weight relates to the strength of connection between two nodes. In a weighted network, the weight of an edge is represented by line thickness. The thicker the edge, the stronger the connection between the two nodes (Cramer & Borsboom, 2015). Edges can also be positively or negatively weighted. Figure 4.1.2 contains an example of a weighted network. Nodes B and C are share the thicker edge and are therefore more closely related than nodes A and B.

Figure 4.1.2. Weighted network



Directionality relates to how two nodes are connected. It can be used to display causation in a network (Cramer & Borsboom, 2015). Directed networks can be used to represent longitudinal data where one variable predicts another. Figure 4.1.3 contains an example of a directed network. The arrows indicate the directionality of the relationships between nodes. It can be seen that node B is causally related to nodes A and C.

Figure 4.1.3. Directed network



Network analysis consists of 2 main stages; network estimation and network inference. In the first stage, the network itself is obtained. In order to do this, the statistical relationships between all of the variables in the analysis need to be estimated using mathematical modelling techniques (Epskamp, Borsboom, & Fried, 2018). In psychological research, the network estimation stage calculates correlations between the variables in question. This produces an undirected weighted network called a correlation network. Simple correlation networks are not appropriate representations of psychological phenomena however. If one of these networks was used to model the symptoms of depression for example, the levels of correlation between symptoms would be so high that the resulting network would be uninterpretable. In order to examine the relationship between two nodes in a psychological network, it is first necessary to control for the effects of all other nodes in the network (Epskamp & Fried, 2018). In order to achieve this, researchers developed regularised partial correlation networks. In these networks, each edge represents a partial correlation coefficient between two nodes after conditioning for all other variables (Epskamp & Fried, 2018). Partial correlation networks have become the models of choice for psychological research. In particular, a group of models called “pairwise Markov random fields (PMRFs)” are commonly used. One of the main benefits of these models is that they employ regularisation at the estimation stage. Regularisation is a statistical procedure that searches for the network structure that can explain the covariance between variables using the fewest connections possible. In doing so, it controls for spurious connections and produces a parsimonious and easily interpretable network (Epskamp & Fried, 2018). For the purposes of the current study, 2 types of PMRFs will be briefly discussed; the Ising model and the Gaussian Graphical model. The former is used when estimating a network using binary data. The latter is the model of choice when estimating data that is continuous and normally distributed.

Once the network has been estimated, the next step is interpretation. Stage 2 of network analysis focuses on network inference. In this stage, how different variables are related to one another and the roles that different nodes play in the network are examined. In short, the aim is to identify the most important nodes in the network (Epskamp, Borsboom, & Fried, 2018). This is done by measuring something called centrality. Centrality describes how connected a given variable is to the other variables in the network. Network analysis focuses on 3 centrality indices that measure different aspects of a node's centrality. The first is called node strength centrality. Node strength describes how many *direct* connections a given node has with other nodes in the network. The second is called closeness centrality. Closeness describes how many *indirect* connections exist between a given node and the other nodes in the network. The third measure is called betweenness centrality. For each pair of nodes in a network, there is a "shortest path" between them. The shortest path is the one with the lowest amount of nodes in it. A node's betweenness value relates to how many of the shortest paths in the network it is included in (Epskamp, Borsboom, & Fried, 2018). Investigating these centrality measures within the context of psychological disorders can shed light on the underlying structure of psychological disorders and on how different psychological symptoms interact.

4.1.4. Current applications of network analysis

Now that the underlying theory and utility of network analysis have been outlined, this next section will discuss how network analysis has been applied in the field of psychology to date. The use of network analytic techniques first began to appear in the psychological literature in 2010. Since then, the framework has been used to examine a number of different disorders in a number of different ways. When providing a summary of the current literature, Fried, van Borkulo, Cramer, Boschloo, Schoevers, & Borsboom (2017) grouped studies into 3 main themes; those that aimed to predict the development of a disorder, those that aimed to improve clinical interventions, and those that investigated co-morbidity between disorders. This introduction will follow a similar structure.

4.1.4.1. Prediction

A widely reported finding in the field of psychopathology in general is that symptoms of psychological disorders appear in the general population at higher rates than the disorders themselves (Hanssen, Bak, Bijl, Vollerbergh, & van Os, 2005). While the majority of individuals exhibiting 1 or 2 symptoms will not go on to develop a full-blown disorder, they have been found to be at increased risk of developing a need for care in the future. Therefore, many researchers have investigated how these subclinical symptoms develop into a clinical disorder and in more recent times, some of these researchers have used network analysis to shed light on the issue. One way that network analysis has been applied in this context involves comparing the network structures of cognitive/emotional experiences in clinical and non-clinical groups. This technique was adopted by Pe and colleagues (2015) to investigate depression development. In their study, two networks of emotional symptoms were estimated; one made up of individuals diagnosed with major depression and the other made up of healthy controls. They found that the depression group were characterised by a denser emotion network indicating that their emotional systems are more resistant to change. A similar technique was employed in a study conducted by Boschloo, van Borkulo, Borsboom, and Oldehinkel (2016). Their analysis also involved comparing networks of MDD symptoms in clinical and non-clinical samples. They found that in a network of subclinical depressive symptoms, the more central nodes were better predictors of future onset of a full-blown depressive disorder. In other words, it indicates that these core depression symptoms could play key roles in the development of MDD. This is an important finding that implies that symptoms of a disorder should not be treated as interchangeable. That the nature of the symptoms an individual is experiencing must be taken into account as well as the amount of symptoms they are experiencing. Another way that network analysis has been used to study how different types of psychological illness develop involves focusing on disorder development at the individual level. To do this, an individual's symptoms are first repeatedly measured at different time points as they progress from a subclinical state to a clinically relevant one. These symptoms are then modelled in order to identify changes in network structure that precede development of a need for care. Wichers and Groot (2016) adopted this approach when investigating early warning signs for depression development. Depression symptoms in a single depressed patient were measured repeatedly for 239 days and the data collected at different time points was modelled and compared. By tracking the dynamic interactions between emotional symptoms of depression, the researchers were able to predict rapid increases in symptom severity that precedes the onset of clinical disorder. Findings like this indicate that network analytic techniques could be useful for predicting future onset of a clinical disorder by tracking and modelling an individual's symptoms. Techniques that allow clinicians to effectively identify individuals who are at heightened risk of developing a clinical disorder are necessary for early intervention paradigms.

4.1.4.2. Intervention

The development of reliable and effective paradigms for the treatment of psychological disorders is at the centre of psychopathology research. Statistical models can provide an evidence base for researchers when designing new interventions or improving existing ones. Network analysis has emerged as a useful exploratory tool that can inform the development of improved clinical interventions for psychological disorders. The ability to compare different symptoms in terms of their network centrality is particularly useful in this context. If clinicians can identify which symptoms are playing the most central roles in a disorder, they can develop targeted interventions that focus on these symptoms. Network analytic techniques have been applied to PTSD research in this way. McNally et al., (2015) obtained network models of PTSD symptoms in a sample of earthquake survivors in China. The analysis identified a number of symptoms that play central roles in the disorder. First of all, hyper vigilance and sleep difficulty were found to be central nodes in the network, indicating that these symptoms should be urgent targets for intervention. This finding was interesting, as sleep issues are not traditionally identified as a core symptom of PTSD. Additionally, future foreshortening also played an important role in the network. Unlike the two previously mentioned symptoms, it did not exhibit particularly high strength. Instead it appeared to form a bridge node between symptoms of fear/intrusive memories and emotional numbness/anhedonia. The authors suggested that targeting this symptom could have a cascade effect on other symptoms in the network. The information that network analysis provides is more complex than simply listing which symptoms are most important. It can shed light on how different symptoms of a disorder influence and interact with each other. Armed with this information, clinicians can make educated predictions about how treating a certain symptom will affect the overall disorder. Another study explored the symptoms of Bulimia Nervosa (BN) in a similar way. A network of BN symptoms was estimated in a clinical sample of adults with BN. A number of core symptoms were identified in their analysis. In particular, a fear of weight gain was highlighted as a promising target for intervention (Levinson et al., 2017). As part of their analysis, they examined the effect that removing certain nodes would have on the overall network structure. During this process, they found that removing symptoms measuring dietary restraint resulted in a fractured network. These symptoms were therefore identified as key players in the network and advised that interventions targeting these nodes could be effective. A number of studies have explored the symptoms of Major Depressive Disorder in this way. Boschloo, van Borkulo, Borsboom, and Schoevers (2016) estimated a network of MDD symptoms and identified low mood and fatigue as fruitful targets for intervention. A study conducted by Fried, Epskamp, Nesse, Tuerlinckx, and Borsboom (2016) conducted a network analysis on a large sample of depressed outpatients. The authors wanted to compare the relevance of DSM (diagnostic and statistical manual) and non-DSM depression symptoms in order to identify the core symptoms of depression. They found that the DSM symptoms were not more central than the non-DSM ones. Instead, the core nodes in the network were a mix of both symptom groups. Studies like this one highlight how network analysis can allow researchers to challenge assumptions surrounding the clinical relevance of different psychopathological symptoms. Bringmann, Lemmens, Huibers, Borsboom, and Tuerlinckx (2015) used network analytic techniques to examine how responses to the Beck Depression Inventory II changed over time from session to session. In doing so, the authors were able to see how different depression symptoms interact dynamically over time.

They found that if one symptom in the network increased in severity, this would directly influence other symptoms in the network. They also identified several symptoms that had particularly strong effects on the network as a whole and would therefore be key targets for intervention. Using techniques like this to conceptualise mental illness as a system of interacting symptoms is an exciting step forward in psychopathology research.

4.1.4.3. Comorbidity

It is well documented in the literature that comorbidity is a common occurrence across many psychological disorders. Many researchers have attempted to understand how different disorders are linked and why some co-occur so frequently. The amount of research which has focused on co-morbidity is understandable considering that being diagnosed with multiple disorders is associated with both worse treatment outcomes and higher suicide rates (Nock, Hwang, Sampson, & Lessler, 2010). Traditionally, comorbidity was understood in terms of distinct and separate latent disorders that co-occurred. Network analysis has provided an alternative way of thinking about this widely reported phenomenon. In doing so, it has shed light on the nature of the links between different psychological phenotypes. When applying network analysis in this way, researchers focus on identifying bridge nodes connecting the two disorders. This perspective posits that disorders can co-occur when some of the symptoms of the first disorder can spark the development of the second disorder. In other words, directly related symptoms form a bridge connecting the two. The first study to use Network analysis to investigate comorbidity was published in 2010 and focused on major depression and generalised anxiety. The authors reported that there were high levels of entanglement between the symptoms of the two disorders (Cramer, Waldorp, van der Mass, & Borsboom, 2010). These findings were replicated in a more recent study conducted by Beard and colleagues, (2016). Levinson and colleagues (2017) used network analysis to gain a better understanding of how Bulimia Nervosa is linked to anxiety and depression. The authors wanted to identify which symptoms of anxiety and depression are most likely to impact on BN symptoms and vice versa. They found that feelings of dizziness and unsteadiness were bridging connections between anxiety and BN. Similarly, they found that changes in appetite and reduced sex drive acted as bridge nodes between BN and depression. Network analysis has been applied to study the connections between autism and obsessive-compulsive disorder. Repetitive behaviours were identified as bridge symptoms between the two disorders (Ruzzano, Borsboom, & Geurts, 2014). Boschloo and colleagues (2015) took a more general approach when examining comorbidity. Instead of focusing on comorbidity between two specific disorders, they took a broad look at 12 major DSM IV disorders using a large epidemiological dataset, the NESARC. Their aim was to gain a better understanding of the utility of current classification systems used in psychopathology. The analysis involved estimating a network of 120 psychiatric symptoms and was much more extensive than previous network studies in the area. The authors found that many of the symptoms were shared across multiple disorders and that there were high levels of connectivity across disorders. Additionally, the results suggested that the way in which current diagnostic symptoms sum symptoms leads to loss of information. The resulting network demonstrated the complexity of psychopathology and the shortcomings of our existing classification systems (Boschloo et al., 2015).

It is clear from the research discussed here that the rich information provided by network analytic techniques can help both researchers and clinicians to better understand and tackle complex cases of comorbidity.

A large portion of network analysis research to date has focused on depression. Indeed, depression has been more commonly investigated using network analytic techniques than any other psychological disorder to date. There are a number of reasons for this. Depression is a heterogeneous diagnostic category that has historically been poorly handled by researchers. Traditionally, depressive symptoms have been treated as interchangeable markers of a discrete latent condition. Due to how engrained in the minds of researchers these assumptions have been, they are still widely accepted even though they are contrasted by much of the evidence in the field (Fried, 2015). Network analysis is therefore a natural choice to help combat these problematic assumptions. The issues facing depression research made it a perfect candidate for investigation using network analytic techniques. It is apparent from chapter 1 that psychosis research is also facing similar issues. Psychotic symptoms have been treated as interchangeable indicators of latent underlying constructs and the possible interactions and causal relationships between these symptoms have remained unexplored. However, despite these similarities, Psychosis has not enjoyed the same research attention that Depression has. Studies applying network analytic techniques to the study of psychotic disorders are few and far between. One such study, conducted by Wigman et al., (2015) compared the momentary mental states of individuals with a psychotic disorder to those of a depressed group and a group with no diagnosis. While this study did look at psychosis, it did not use network analysis to examine the underlying structure of psychotic symptoms. A more recent study conducted by Isvoranu et al., (2017) analysed the relationship between psychosis and different types of trauma in a clinical sample of patients with psychotic disorders. They found that the relationships between trauma and psychosis appear to be mediated by general psychopathology symptoms. Once again, this study did not examine the underlying network structure of psychotic symptoms.

4.1.5. Study Aims

From reviewing the existing body of research in this area, it is clear that network analytic techniques can enhance our understanding of how psychological disorders develop by shedding light on how different symptoms cluster together and interact. Network analysis is theoretically complimentary with the cascade model of psychosis development being investigated in the current thesis in a number of ways. First of all, it does not assume that a latent underlying construct is driving the development of psychotic symptoms. Additionally, it acknowledges that different symptoms can interact and influence one another in different ways. It therefore seems apparent that visualizing psychotic symptoms as a psychological network would be a fruitful endeavour. To the author's knowledge, no study has compared the structure of two networks of subclinical positive psychotic experiences across 2 large-scale non-clinical samples. Therefore, the current study aims to model psychotic symptoms in two large epidemiological studies using network analytic techniques. In doing so, the authors hope to

a) Examine symptom centrality to identify the core symptoms of psychosis. Specifically, the authors are interested in the role that the paranoia symptoms play in the network.

b) Compare the psychosis networks across both datasets in order to assess how replicable the network structures are.

The researcher made predictions regarding how these networks would be structured. These assumptions were based on the Cascade model and the results obtained from the analyses carried out in the previous chapters. Ultimately, it was predicted that the items measuring paranoia would play central roles in the networks generated. Visually, the paranoia items were expected to be located towards the centre of the networks as opposed to on the periphery. Additionally, the paranoia items were expected to obtain some of the highest scores on all 3 centrality statistics: strength, closeness, and betweenness.

4.2. Method

4.2.1. Sample

The present analyses were conducted using two large epidemiological datasets: the BPMS and the NESARC. A detailed description of these datasets including information on respondents, scales used, sampling procedures, and data collection is contained in chapter 2, section 2.2.1.

4.2.2. Measures

For the purposes of the current study, a number of items assessing Schizotypal personality disorder were selected from each dataset for analysis. A detailed discussion of how SPD was assessed in the BPMS and NESARC as well as the demographic characteristics associated with these scales is contained in chapter 2, section 2.2.2.

4.2.2.1. BPMS

15 items assessing SPD were selected for analysis. While the BPMS contains 16 SPD items in total, 1 item (Have you ever suspected that your spouse or partner was unfaithful?) was deemed unsuitable for the current analysis, as it may not have been applicable to all respondents. Each item used a dichotomous response format (0 = experience not present, 1 = experience present). The BPMS items are listed in table 4.2.1 below.

Table 4.2.1. BPMS items.

1	Do you often have to keep an eye out to stop people from using you or hurting you?
2	Do you spend a lot of time wondering if you can trust your friends or the people you work with?
3	Do you find that it is best not to let other people know much about you because they will use it against you?
4	Do you often detect hidden threats or insults in things people say or do?
5	When you are out in public and see people talking, do you often feel that they are talking about you?
6	Do you often get the feeling that things that have no special meaning to most people are really meant to give you a message?
7	When you are around people, do you often get the feeling that you are being watched or stared at?
8	Have you ever felt that you could make things happen just by making a wish or thinking about them?
9	Have you had personal experiences with the supernatural?
10	Do you believe that you have a 'sixth sense' that allows you to know and predict things that others can't?
11	Do you often think that objects or shadows are really people or animals or that noises are actually people's voices?
12	Have you had the sense that some person or force is around you, even though you cannot see anyone?
13	Do you often see auras or energy fields around people?
14	Are there very few people that you're really close to outside of your immediate family?
15	Do you often feel nervous when you are with other people?

4.2.2.2. NESARC

The 16 NESARC items assessing SPD were selected for the current analysis. The items made use of a 3-point response format. (0 = experience not present, 1 = experience present, 2 = experience present and distressing) The NESARC items are listed in table 4.2.2 below.

4.2.3. Missing data

In total, 186 BPMS respondents (2.2% of the sample) and 182 NESARC respondents (0.5% of the sample) had complete missing data across all SPD items. These cases were therefore, excluded from the present analysis. While an additional 885 respondents from the BPMS (10.3% of the sample) and 929 respondents from the NESARC (2.7% of the sample) had missing data on at least one of the items, they were still included in the analysis.

Table 4.2.2. NESARC items.

1	Have you had trouble expressing your emotions and feelings?
2	Have you rarely shown emotion?
3	Have you often felt nervous when you are with other people even if you have known them for a while?
4	Have you felt suspicious of people, even if you have known them for a while?
5	When you are around people, have you often had the feeling that you are being watched or stared at?
6	Have there been very few people that you're really close to outside of your immediate family?
7	Have people thought you act strangely?
8	Have people thought you have strange ideas?
9	Have people thought you are odd, eccentric or strange?
10	Have you had personal experiences with the supernatural?
11	Have you had the sense that some force is around you, even though you cannot see anyone?
12	Have you believed that you have a "sixth sense" that allows you to know and predict things that others can't?
13	Have you often seen auras or energy fields around people?
14	Have you ever felt that you could make things happen just by making a wish or thinking about them?
15	Have you often had the feeling that things that have no special meaning to most people are really meant to give you a message?
16	Have you often thought that objects or are really people or animals, or that noises are actually people's voices?

4.2.4. Statistical Analysis

In total, three network analyses were performed. The first modelled data from the BPMS while the second and third utilised the NESARC dataset. The analyses were carried out using the statistical program "R version 3.3.1".

4.2.4.1. Network estimation

The R-package, qgraph (Epskamp et al., 2012) was used to estimate the network structures of the three models. The first model contained the 15 BPMS symptoms. The second model contained the 17 "frequency" symptoms from the NESARC and the third model contained the 17 "distress" symptoms from the NESARC. All three models were undirected due to the data being cross-sectional in nature. In the BPMS data, the network was estimated using an Ising model. This model was chosen because the BPMS data is binary. Similarly, the ising model was used to estimate the NESARC "distress" data. The NESARC model that used the "frequency" data, was instead, estimated using a Gaussian Graphical model. The GGM was more appropriate in this case as the data were continuous. The Graphical Lasso (GLasso) procedure was employed in order to achieve regularised partial correlation networks. As detailed in the introduction to this chapter, this means that edges in the network represent the relationship between two variables after controlling for all other relationships in the network. The Lasso also reduces the smallest edges in the network to zero in order to control for the effects of noise in the data. In doing so, the authors hoped to have the best chance of estimating parsimonious and easily interpretable networks that would be most reflective of the underlying symptom structures.

4.2.4.2. Centrality estimation

The network structures were then analysed further by obtaining centrality scores for each node in the networks. Three measures of centrality were included in the present analysis. These were node strength, node betweenness, and node closeness (descriptions of these centrality indices can be found in the chapter introduction).

4.2.4.3. Visualisation

The R-package graph was also used to obtain visual representations of the networks estimated in the current analysis. The Fruchterman and Reingold layout was used to compute the network graphs. This layout places the more central nodes towards the centre of the network and the less central ones towards the periphery (Fruchterman & Reingold, 1991). This layout was chosen to aid visual interpretation of the graphs.

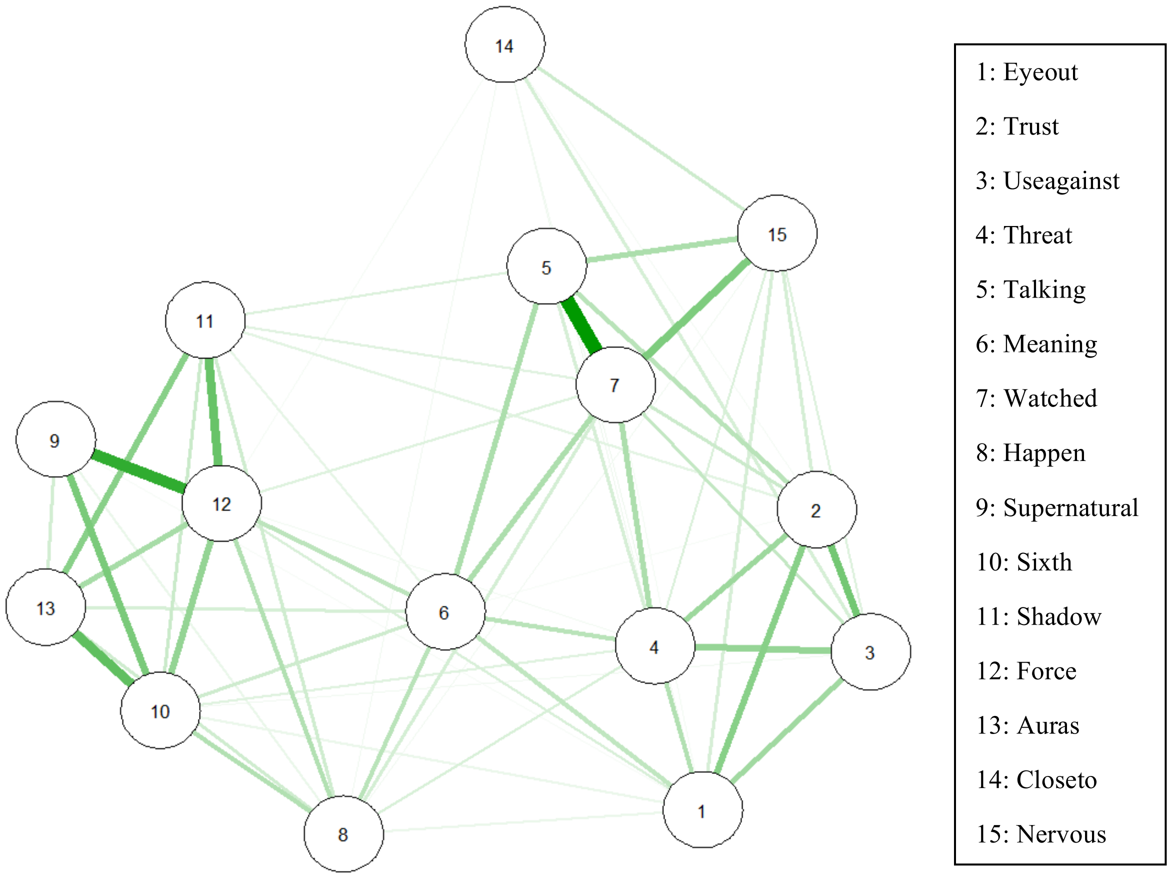
4.3. Results

4.3.1. BPMS:

4.3.1.1. Ising Model

Figure 4.3.1 contains the network of BPMS items estimated using the Ising model. Overall, the network was well connected and did not contain any isolated nodes. A number of particularly strong connections emerged. High levels of connection were apparent among the paranoia items. Nodes 5 (Talking) and 7 (Stared at) appeared to be the most closely connected items in the network. Strong connections were also observed between items 1 (eye out), 2 (trust), 3 (use against), and 4 (hidden threat). Additionally, strong associations were evident between items relating to hallucinatory/delusional experiences. Nodes 9 (personal experience with the supernatural), 10 (believing you have a sixth sense), 11 (Sees faces in shadows), 12 (believing a strange force is around you), and 13 (seeing auras around people) all shared close associations with one another. Conversely, node 14 (few people who you are close to) was located on the periphery of the network and didn't display strong links with any of the other nodes

Figure 4.3.1. Estimated Ising network model of BPMS Schizotypy items.



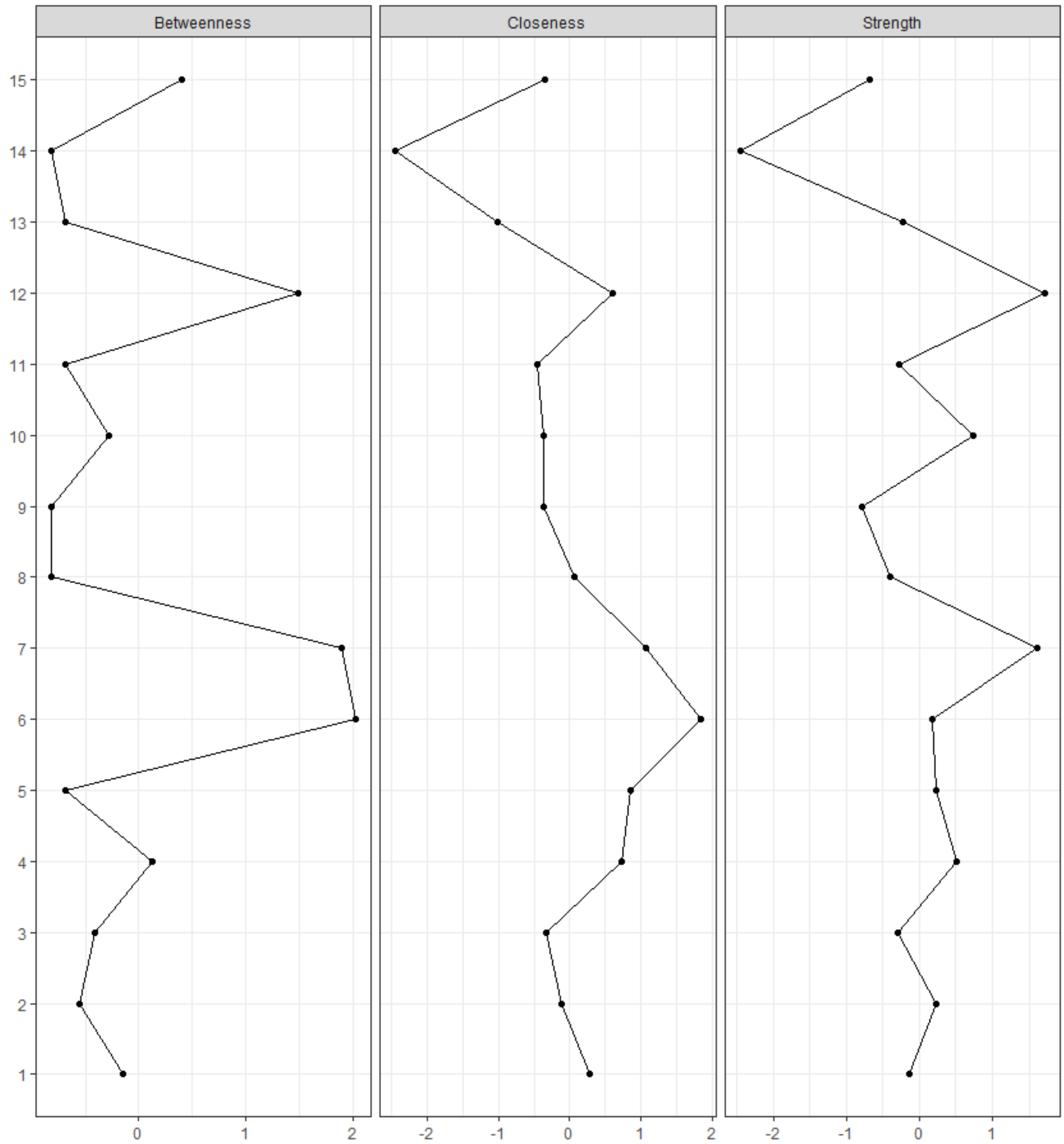
4.3.1.2. Centrality estimates

Figure 4.3.2 contains the centrality scores for each of the Schizotypy items in the network. In terms of betweenness, node 6 (things with no special meaning are giving you messages) obtained the highest score. Node 6 was followed by node 7 (stared at) and node 12 (believing a strange force is around you) respectively. In fact, five of the six nodes with the highest betweenness scores were paranoia items. Node 14 (few people who you are close to) obtained the lowest betweenness score. This was to be expected, as it was located on the periphery of the network.

As was the case with betweenness, nodes 6 (things with no special meaning are giving you messages) and 7 (stared at) obtained the top scores in terms of closeness. The nodes relating to paranoia dominated the network in terms of closeness scores. Eight of the top ten scores were obtained by paranoia items while hallucinatory/delusional items were generally associated with lower closeness estimates. In other words, the items measuring paranoid ideation show high levels of indirect connection to all other schizotypy items in the network. Node 14 was once again at the bottom of the list, obtaining the lowest closeness estimate.

The strength estimates looked slightly different to the closeness and betweenness scores. Node 12 (believing a strange force is around you) obtained the highest strength score. Another hallucinatory item, note 10 (believing you have a sixth sense), obtained the third highest score in terms of strength. Despite this, the network was still mostly dominated by paranoia items in terms of strength centrality. Node 7 (stared at) obtained the second highest strength score and in total, six of the eight top strength scores were associated with paranoia nodes. Finally, node 14 obtained the lowest strength estimate.

Figure 4.3.2. Centrality indices for the Ising model network of BPMS Schizotypy items.

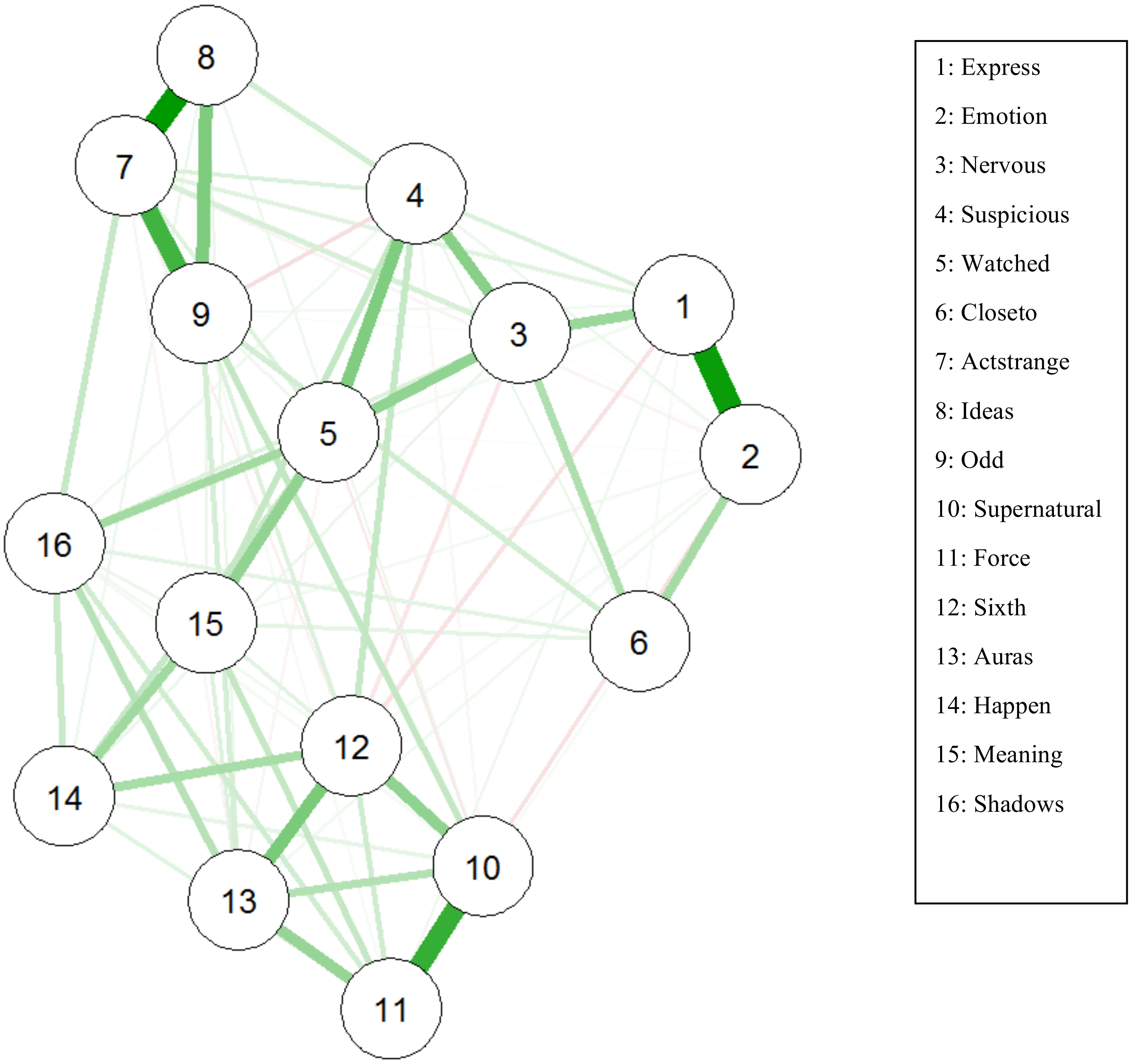


4.3.2. NESARC:

4.3.2.1. Gaussian Graphical Model

Figure 4.3.3 contains the network of NESARC items estimated using the Gaussian Graphical model. Once again, the network that was obtained displayed high levels of connectivity and no isolated nodes were present. Several particularly strong connections were obtained in the network and are worth noting. There was a close association between node 1 (trouble expressing emotion) and node 2 (difficulty regulating emotion). The three items measuring odd ideas/behaviour (nodes 7, 8, & 9) were also closely related. Additionally, a number of the hall/del variables were strongly linked (nodes 10, 11, 12, & 13).

Figure 4.3.3. Estimated Gaussian Graphical network model of NESARC Schizotypy items.



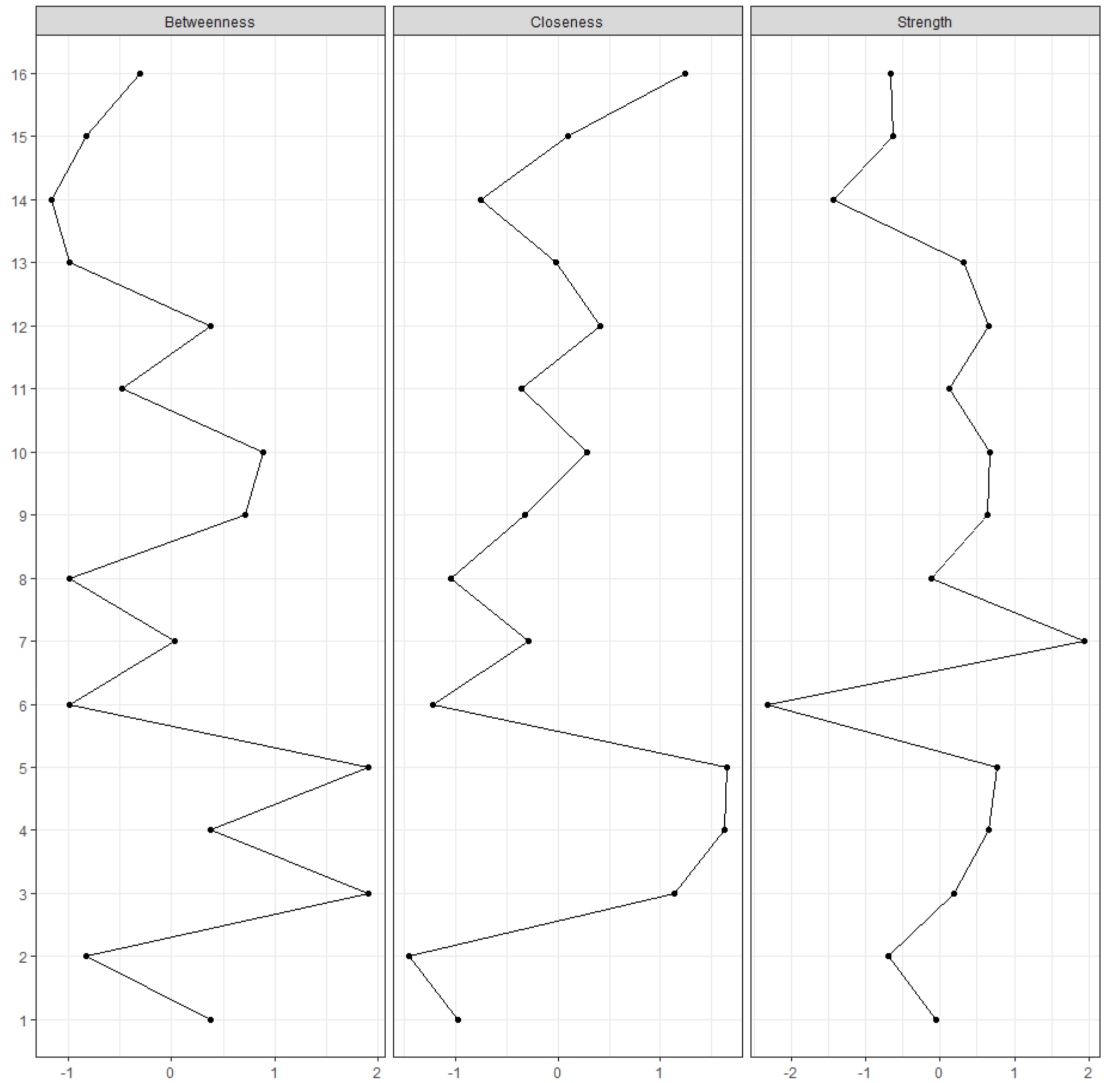
4.3.2.2. Centrality estimates

Figure 4.3.4 contains the centrality scores for each of the Schizotypy items in the network. Node 3 (feeling nervous around others) obtained the highest betweenness score followed by node 5 (Feeling watched/stared at) and 10 (personal experience with the supernatural). 3 out of the 4 paranoia items were among the highest in terms of betweenness (1st, 2nd & 5th positions) however node 15 (things with no special meaning are giving you messages) obtained one of the lower scores (12th position). The odd thought/behaviour nodes were spread throughout the distribution of betweenness estimates (4th, 8th, & 14th positions). Hall/del nodes were also spread throughout the distribution with nodes 13 (seeing auras around people) and 14 (can make things happen by wishing) obtaining the lowest betweenness estimates in the network.

The two highest closeness estimates in the network were both associated with paranoia nodes (5 & 4 respectively). All four paranoia nodes were located in the upper half of the distribution (1st, 2nd, 4th, & 7th positions). The odd thought/behaviour items obtained some of the lowest closeness estimates in the network (9th, 10th, & 14th positions). The two nodes at the bottom of the distribution were 6 (few people who you are close to) and 2 (difficulty regulating emotion).

Finally, node 7 (others believe you act strangely) obtained the highest score in terms of strength. This was followed by two paranoia items: node 5 (Feeling watched/stared at) and node 4 (suspicious of others intentions). The other two paranoia items had lower associated strength estimates (8th & 12th positions). The hall/del nodes were spread throughout the distribution of scores. For example, nodes 10 (personal experience with the supernatural) and 12 (believing you have a sixth sense) obtained high estimates (4th & 5th positions) however items 16 (Sees faces in shadows) and 14 (can make things happen by wishing) obtained some of the lowest strength estimates in the network (13th & 15th positions). Node 6 (few people who you are close to) obtained the lowest associated strength score.

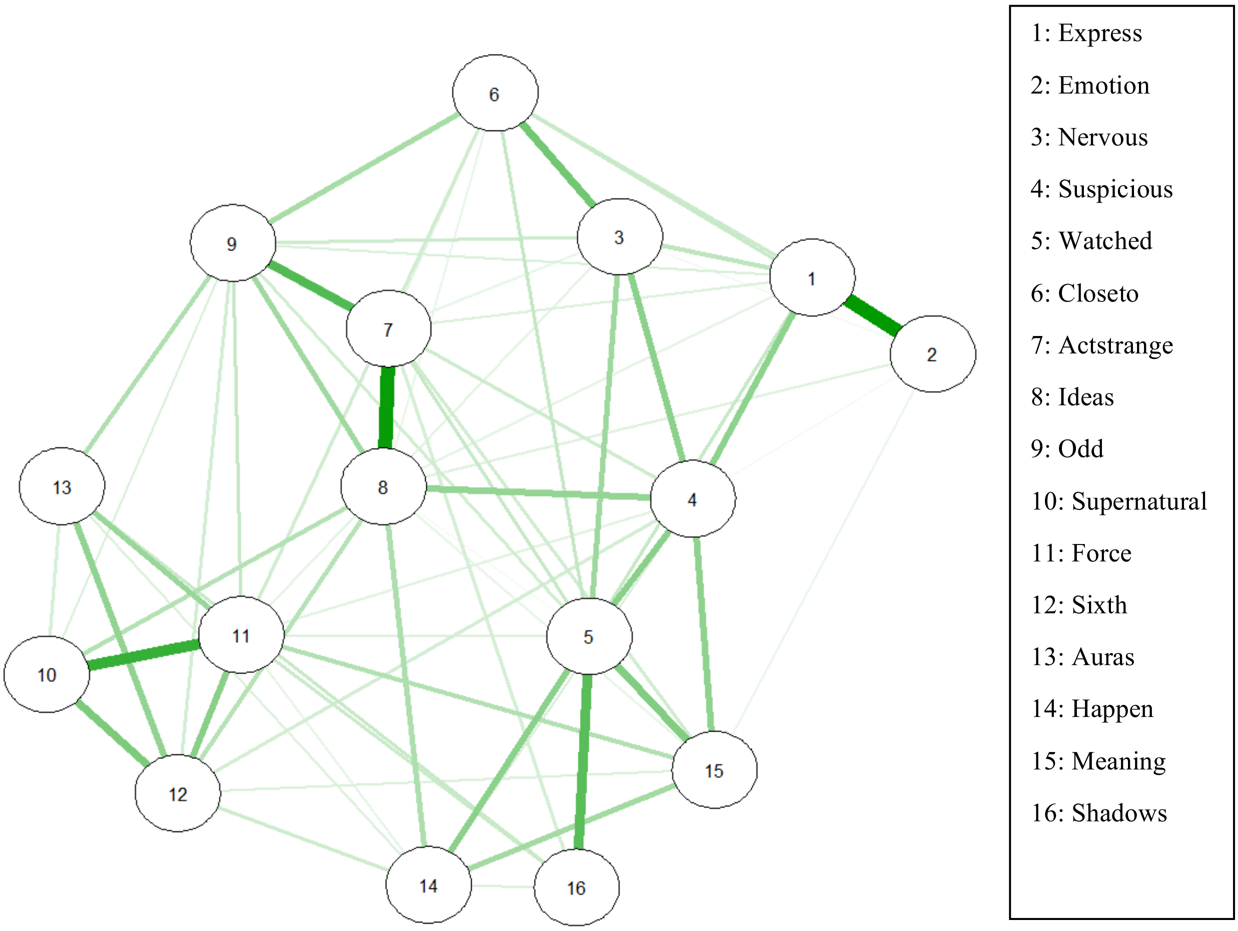
Figure 4.3.4. Centrality indices for the Gaussian Graphical model network of NESARC Schizotypy items.



4.3.2.3. Ising Model

Figure 4.3.5 contains the network of NESARC items estimated using the Ising model. The network displayed high levels of connectivity and no isolated nodes were present. A number of particularly strong connections stood out. One of the closest connections was between nodes 7 (act strange), 8 (Having strange ideas), and 9 (others believe you are odd). Nodes 1 (trouble expressing emotion) and 2 (difficulty regulating emotion) were strongly associated with each other but did not appear to be very connected to any other nodes in the network. Strong associations were present between some of the hall/del variables. Nodes 10 (personal experience with the supernatural), 11 (believing a strange force is around you), 12 (believing you have a sixth sense), and 13 (seeing auras around people) were closely linked to each other.

Figure 4.3.5. Estimated Ising network model of NESARC Schizotypy items.



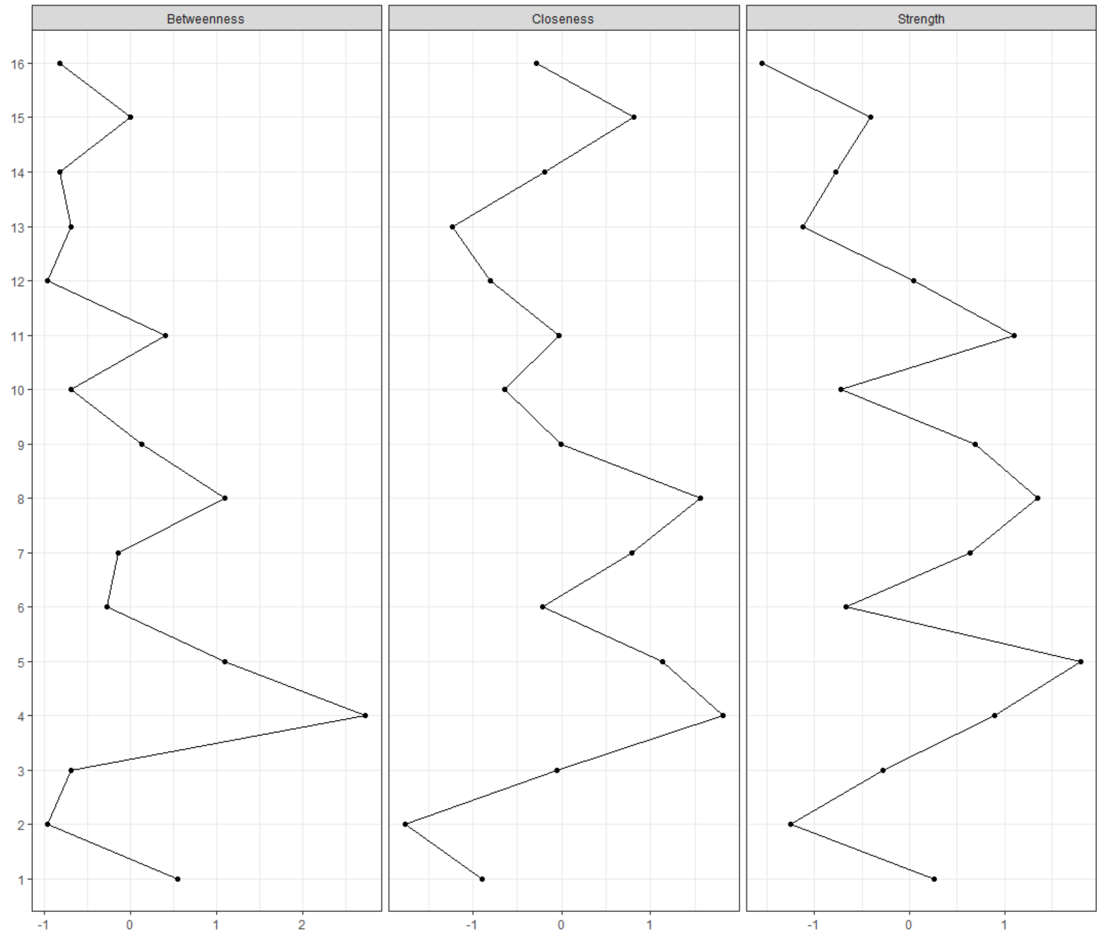
4.3.2.3. Centrality estimates

Figure 4.3.6 contains the centrality scores for each of the Schizotypy items in the network. In terms of betweenness, the highest score was obtained by node 4 (suspicious of others intentions) followed by nodes 5 (Feeling watched/stared at) and 8 (Having strange ideas). In contrast to the Gaussian model where the odd thought/behaviour nodes were spread throughout the distribution, in the current network they obtained some of the highest betweenness scores (3rd, 6th & 8th positions). The three nodes assessing odd ideas and behaviour were all located in the upper half of betweenness scores. The other two paranoia nodes obtained the 7th and 11th highest scores and the hall/del items obtained some of the lowest betweenness scores in the network. Node 2 (difficulty regulating emotion) had the lowest associated betweenness estimate. This was to be expected based on its peripheral location in the network.

Node 4 (suspicious of others intentions) also obtained the highest closeness estimate. It was followed by nodes 8 (Having strange ideas) and 5 (Feeling watched/stared at). Once again, the Ising model contradicted the Gaussian model in terms of the odd thought/behaviour items that obtained some of the highest closeness estimates in the network (2nd, 3rd, & 6th positions). Additionally, all 4 paranoia items were in the upper half of closeness estimates (1st, 3rd, 4th, & 8th positions). The lower closeness estimates were associated with nodes relating to hall/del experiences and emotional expression. Mirroring the betweenness scores, node 2 was associated with the lowest closeness estimate.

Node 5 (feeling watched/stared at) obtained the highest strength score in the network. It was directly followed by nodes 8 (Having strange ideas) and 11 (believing a strange force is around you). The higher strength scores were mainly associated with nodes relating to odd thought/behaviour (2nd, 5th, & 6th positions) and paranoid ideation (1st, 4th, & 8th positions) while the lower scores were mainly associated with hall/del experiences (12th, 13th, 14th, & 16th positions). In terms of the role of paranoia, there is one variable that is particularly interesting. The variable enquiring about feeling watched or stared at is present in both datasets. In the BPMS network, it was labelled as node 7 and in the NESARC networks, it was labelled as node 5. Across the 2 datasets, 3 networks, and 3 centrality measures, "watched or stared at" was consistently identified as one of the top 5 most central items in the network.

Figure 4.3.6. Centrality indicies for the Ising model network of NESARC Schizotypy items.



4.4. Discussion

4.4.1. Study findings

The current study investigated the structure of psychotic symptoms in two large epidemiological datasets using a network analytic approach. It was unique in that to the author's knowledge, it was the first study of its kind to explore subclinical psychotic symptoms in this way. It is also the first study of its kind to attempt to compare the structures of different psychosis networks across different datasets. This discussion will contextualize what was found in this analysis, both in terms of the existing literature and the cascade model. It will also outline the limitations associated with this study as well as its implications for clinical practice and potential avenues for future research.

This next section will discuss the findings from the BPMS network. In terms of network centrality, paranoia items were identified as core symptoms in the network. In fact, items relating to paranoid ideation were associated with some of the highest scores across the three centrality indices. These findings are in keeping with the author's prediction that paranoia would play a central role in the psychosis network. This result provides support for the cascade model as it implies that paranoia is central to the psychosis construct and that changes in paranoia could have large knock-on effects on the other symptoms in the network. In general, the network was characterised by two main clusters of nodes. The left half of the network was occupied by hallucinatory/delusional items and the right half was dominated by items relating to paranoid ideation. The connections between these two clusters were generally weak, however, one of the paranoia nodes appeared to play an interesting role in the network. Item 6 (things with no special meaning are giving you messages) was located in the centre of the network and had relatively strong connections to both the hallucinatory/delusional and the paranoia symptom clusters. This would suggest that this node was acting as a bridging node between these two clusters. As the network is undirected, it is not possible to know for sure what this means for the development of psychosis over time. One possible explanation is that paranoid experiences emerge first and can lead to a search for special meaning that in turn, leads to the development of more severe symptoms such as hallucinatory and delusional experiences. This certainly seems like a plausible explanation. If an individual has a predisposition to interpret ambiguous information from their environment as being personally meaningful, it makes sense that they would be constantly searching for this information. The resulting hyper-vigilant state could provide the backdrop for the emergence of hallucinations. This explanation is also in line with the cascade model being investigated. However, it is also possible that the process is working in reverse; that hallucinations develop first, leading to a feeling that the world is personally meaningful and resulting in the development of paranoid thought patterns. Nonetheless, the high centrality scores associated with the paranoia items indicates that the former explanation may be the more plausible of the two.

Moving on to the NESARC frequency network, paranoia items were once again identified as core psychosis symptoms. As was the case in the BPMS network, the items measuring paranoia were among the top ranked items across the 3 centrality measures. Once again, this finding is in line with the study predictions. In terms of node clustering, some interesting patterns emerged. Firstly, items 1 (trouble expressing emotion) and 2 (difficulty regulating emotion) clustered together however they were located on the periphery of the network due to their lack of connections with other nodes. Interestingly, two distinct clusters of hall/del items were present, and they appeared to be associated with the paranoia nodes in different ways. The first consisted of items 14 (can make things happen by wishing) and 16 (sees faces in shadows), which occupied the bottom portion of the network. These items were directly linked to paranoia, displaying strong links in particular to nodes 5 (feeling watched/stared at) and 15 (things with no special meaning are giving you messages). The second and larger cluster occupied the lower left quadrant of the network and consisted of nodes 10 (personal experience with the supernatural), 11 (believing a strange force is around you), 12 (believing you have a sixth sense), and 13 (seeing auras around people). It did not appear to be directly associated with the paranoia items. Instead, a small cluster of nodes relating to odd thoughts and behaviour (nodes 7, 8, & 9) seemed to bridge this association. The paranoia items themselves were located in a band that ran along the right-hand side of the network. This band contained nodes 3 (feeling nervous around others), 4 (suspicious of others intentions), 5 (Feeling watched/stared at), and 15 (things with no special meaning are giving you messages). Once again, this could mean a number of things in relation to psychosis development. In terms of the paranoia items themselves, they appear to form a pathway or ladder, beginning with feeling nervous around others, followed by being suspicious of others, and ending in feeling watched. This may represent a pattern caused by different paranoid thoughts building upon one another and becoming more persecutory in nature. As mentioned before, the nature of the data used to create these networks means that the temporal ordering of which symptoms emerge first is yet to be explored, however, a cascade of paranoid thinking is a credible explanation for how these items are structured in this network. On the other hand, the causal pathways being discussed here could just as easily be working in reverse. Another possibility is that the patterns being observed in the network may not reflect any patterns of causality at all. Instead, they could be indicative of experiences that are correlated due to the sharing of a common cause.

In this network, it would appear that the paranoia items are directly related to some hallucinatory and delusional variables (can make things happen by wishing & seeing faces in shadows) but indirectly related to others through the variables measuring odd thought/behaviour. From the perspective of paranoia emerging first and leading to hallucination and delusion development, it is possible that there are two pathways at play. Firstly, there is a direct path where paranoid thoughts, particularly feeling like you are being watched or stared at, can lead to the emergence of hallucinatory experiences like seeing faces in shadows. Secondly, there is an indirect path where paranoid thinking patterns can cause odd thoughts and behaviours which in turn, precipitate the emergence of more severe symptoms such as believing you have a sixth sense or seeing auras around people. However, as was the case with the BPMS model, the direction could be reversed with aberrant perceptual experiences causing odd thought/behaviour and leading to paranoid ideation. Additionally, while it may appear upon first inspection that the current network structure differs from the BPMS model, it's important to keep in mind that the odd behaviour/thought variables that were present in the psychosis scale administered in the NESARC data were not present in the BPMS scale.

Finally, the findings from the NESARC distress model must be discussed. Consistent with the two previous networks, paranoia items were once again associated with high centrality scores indicating that they play important roles in the psychosis network. In terms of structure, many of the patterns of association observed in the previously discussed NESARC network were also present in this one. For example, the three variables measuring odd thought/behaviour were once again clustered together. The paranoia items formed a cluster and so did the items measuring hall/dels. Items 14 (can make things happen by wishing) and 16 (Sees faces in shadows) were once again strongly associated with item 5 (Feeling watched/stared at), while items 1, 2, and 6 were located on the periphery of the network. Despite these similarities, some notable structural differences exist between this network and the one obtained using the Ising model. It is important that these differences are briefly discussed. Firstly, the paranoia nodes (3, 4, 5, & 15) occupied the centre of the network and were surrounded by clusters of nodes on each side. The cluster of hall/del variables occupied the bottom of the network (10, 11, 12, 13, 14, 16) while the top of the network was characterised by the cluster of nodes relating to odd thoughts/behaviour (7, 8, 9). The two nodes measuring emotional expression were located to the right of the paranoia items. The paranoia items appear to be well connected to all of these surrounding nodes. Interestingly, while the odd thought/behaviour nodes appeared to be acting as a bridging cluster between paranoia and halls/dels in the Ising network, this does not appear to be the case in the Gaussian network. In terms of what the structure of the current network tells us about how psychosis may develop, it clearly indicates that paranoid ideation is playing a key role. The centre of the network is exclusively occupied with paranoia items while all other symptoms are spread around the periphery. This would suggest that changes in those central paranoia items would have significant knock-on effects on all other symptoms in that network.

While there are clear structural differences between the three psychosis networks estimated in this study, they undoubtedly share a number of common features. The nodes appeared to cluster in consistent and reasonably predictable ways across all three networks. While they were connected in different ways from model to model, each network contained a cluster of paranoia items and a separate cluster of hallucinatory/delusional items. The other feature that appeared consistently across all networks was the high centrality scores associated with paranoia items. Paranoid ideation was consistently identified as a core symptom of psychosis. This finding is reinforced by the fact that it was replicated in two large epidemiological datasets. It supports the predictions outlined at the beginning of this study and is complimentary to the cascade hypothesis.

4.1.2. Within the context of existing literature.

The findings from the current study also have a number of implications for existing research. The current findings provide support for cognitive models of psychosis development. A number of these models have suggested that the way an individual responds to initial psychotic experiences can influence their chances of developing a clinical disorder. In other words, if an anomalous experience is interpreted in a paranoid way, it is more likely to be distressing, to be persistent, and to lead to a clinical disorder (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001; Morrison, 2001). The psychosis networks generated in this analysis highlighted the importance of these cognitive responses in several ways. Firstly, the central roles that paranoia items played in these networks implies they are heavily involved in the maintenance of the other psychotic experiences in the network like the hallucinatory items. Secondly, in one of the networks, a tendency to interpret irrelevant things as being personally meaningful was found to bridge hallucinatory items and paranoia items. This suggests that interpreting random social information as being directed towards the self could exacerbate other psychotic experiences as these cognitive models predict. Finally, when the psychosis network which was generated using all psychotic experiences contained in the NESARC dataset was compared to its counterpart which only included the psychotic experiences that were distressing, a number of structural differences were observed. Finally, this study has underscored the utility of studying psychotic experience from a network perspective. The network analysis carried out in this chapter illustrated the high levels of dynamic interaction taking place between different psychotic experiences. The output from this chapter emphasises the need for more symptom level research of this type.

4.1.3. Limitations

Despite obtaining promising results, it is important to note that the current study also had several shortcomings. The first of which is in relation to a potential issue with the statistical paradigms used by the current analysis to assess item centrality. The three measures of centrality used in the current study were item strength, item betweenness, and item closeness. The statistical package R uses mathematical models to estimate these parameters from the available data in a given sample. Some researchers have criticized these estimations of centrality, raising concerns that they may not always be estimated accurately. Inaccurate centrality estimates could undermine the network estimation itself and in turn, any measures derived from it (Epskamp, Borsboom, & Fried, 2017). That being said however, they also stated that these issues surrounding accuracy are tied to sample size, and they become less of an issue when modelling larger datasets such as the ones used in this analysis.

Additionally, there are also a number of issues that need to be discussed in relation to the two datasets used for the current analysis. The BPMS and the NESARC both contain rich information regarding psychotic experiences in 2 large non-clinical populations. They are both invaluable tools in the examination of psychosis in the general population. However, the fact that the two datasets used in this analysis used different scales to measure schizotypal personality disorder means that the comparisons that can be made across the two samples are somewhat limited. While a considerable amount of the items are common to both scales, there are also a number of questions that only appear in one or the other. For example, in the NESARC, there are items relating to thinking/acting strangely that are not present in the BPMS. It is unknown how the presence of these items would affect the BPMS network if they had been included. Additionally, the NESARC scale collected information on whether or not the respondent was distressed by each experience they endorsed. This type of information is not present in the BPMS. In addition to the differences in scale content across the two datasets, they also differed in terms of the age range of their cohorts. Specifically, while the NESARC collected information from individuals aged 18 and over, the BPMS also collected information from 16- and 17-year olds. It is unknown how the inclusion of responses from adolescents would affect the structure of the BPMS network. Indeed, it is possible that the patterns of psychotic experiences are different in adolescent samples compared to adult samples.

Another important characteristic of the data used in this study that could potentially be viewed as a shortcoming in the current analysis is that it was cross-sectional in nature. Therefore, only undirected connections could be examined between symptoms and cause-effect relationships could not be explored. Now, this is not an issue with the current analysis in and of itself. Modelling the network structure of subclinical psychotic symptoms across multiple datasets is undoubtedly a worthwhile endeavour and provides insights into the underlying structure of psychotic symptoms that simply could not be obtained using other analyses. However, as was the case with the analyses carried out in the previous chapters of this thesis, one could argue that the analysis of cross-sectional data is of limited use when following a line of investigation built around the cascade model. While it is true that no direct observations about the causal links between paranoia and other psychotic experiences can be drawn from this analysis, the author contends that the information gained from it is still vital to understand paranoia's role in the development of psychosis.

4.1.4. Implications for future research & clinical practice

Aside from these limitations, the current analysis has provided a number of new insights into the underlying structure of psychotic symptoms and these findings have a number of important implications for both researchers and clinicians. First of all, the findings from this analysis have a number if implications for clinical practice. The current results have highlighted the utility of conceptualising paranoia as a system of interacting symptoms. The similarities between the networks obtained using the NESARC and BPMS data demonstrated that the symptoms of psychosis appear to cluster together in ways that are relatively consistent and predictable. An awareness of these patterns of connection could enhance clinicians' ability to understand their patient's experiences and inform their decisions surrounding interventions. The high levels of connectedness found between the different psychotic experiences in these networks suggest that improvements in any one of them could have positive knock-on effects on the other experiences. This would imply that treatments that target specific symptoms of psychosis should also result in global improvements in the disorder as a whole. The fact that the items measuring paranoid ideation were consistently identified as playing central roles in the network of psychosis and their high levels of connectedness to all other psychotic symptoms would suggest that symptom specific interventions targeting paranoia would be particularly effective in the treatment of psychotic disorders. Specifically, the results from the BPMS dataset imply that addressing feelings of being watched could be beneficial. Additionally, finding spurious meaning emerged as a good target for intervention as it acted as a bridge symptom in the BPMS network. In general, approaching psychosis from a network perspective and treating symptoms individually could be a beneficial approach in clinical practice. Conversely, a number of variables were identified as having low centrality scores suggesting that they may not be the best measures of psychosis. Specifically, feeling close to very few people, having trouble expressing emotion, and rarely showing emotion were consistently located on the periphery of the networks. Removing these items from clinical scales may produce more accurate and streamlined diagnostic tools.

In addition to having implications for clinical practice, the current findings also open up a number of avenues for future research in this area. This study provided new insights into the dynamic relationships that exist between the symptoms of psychosis however, there is still much that we do not understand. The use of network analysis in psychosis research is still in its early years and studies like this one need to be replicated. In particular, applying network analytic techniques to longitudinal data could be a fruitful area for exploration. Being able to capture causal links between different psychotic experience and represent these relationships within a network framework could provide fascinating insights into how psychosis develops. Another interesting application of network analysis would be the investigation of clinical data. Obtaining a network of psychotic symptoms in a clinical dataset and comparing its structure to the networks obtained in the current analysis would undoubtedly have implications relevant to research exploring the psychosis continuum. In a broader sense, the current findings have implications for how psychosis as a construct should be conceptualised and how it should be approached by psychosis researchers. The current results suggest that psychosis may be best thought of as a system of interconnected symptoms that mutually interact and influence one another. Research avenues that focus on understanding how these symptoms interact could expand our understanding of the mechanisms underlying psychotic illness.

4.1.5. Conclusion

To the author's knowledge, this is the first study of its kind to use network analysis to examine the structure of psychotic symptoms across 2 non-clinical samples. Moreover, it generated 3 separate networks of psychotic symptoms using 2 large-scale epidemiological datasets allowing the stability of the network structure to be assessed. High levels of consistency in terms of structure and centrality were observed across the three networks, indicating that the structure of psychotic experiences are reasonably stable in the general population. The study findings suggest that conceptualizing psychosis as a network of interacting symptoms has benefits for both research and clinical purposes. This is a recommendation with wide reaching implications for the future of how psychosis is understood, studied, and treated in the future. As predicted, paranoid ideation emerged as a core symptom of psychosis. This finding was replicated across both datasets and all 3 networks. The current study succeeded in shedding light on the dynamic nature of the relationships that exist between paranoia and the other symptoms of psychosis. Importantly, these results provide support for the Cascade hypothesis. Additionally, the connections revealed in the networks revealed a number of possible pathways to psychosis development, thereby opening up new avenues for investigation. Ultimately, the next step in exploring the role of paranoia in psychosis development must explore these experiences longitudinally to test these potential pathways to clinical psychosis.

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Chapter 5: Exploring the temporal relationships between subclinical psychotic experiences: a cross-lagged panel model analysis

Abstract

There are numerous studies in the existing literature which have investigated the development of psychosis over time (Cannon et al., 2008; Zammit et al., 2013; Poulton et al., 2000). However, to date, there is a lack of longitudinal research exploring the causal links between specific subclinical psychotic experiences in the general population. The findings from the previous chapters have highlighted that paranoia is an important experience in relation to subclinical psychosis and indicated that it may precede the development of other psychotic experiences. To explore this, therefore, the central aim of the current study is to examine the temporal relationships between paranoid ideation and other psychotic experiences. Moreover, based on the existing literature highlighting the increased risks associated with persistent psychotic experiences, this study also aims to explore the causal links between sustained paranoid ideation over a period of time and later development of additional psychotic symptoms. Finally, this study aims to examine the causal pathways between sustained paranoid ideation and specific psychotic symptoms (hallucinations and thought interference). The current study examined data from the Avon Longitudinal Study of Parents and Children (ALSPAC). Analysis focuses on psychotic experiences which were measured at four time-points covered in these questionnaires are 140 months (11.5 years), 157 months (13 years), 169 months (14 years), and 198 months (16.5 years). The sample contained 8949 children. Statistical analysis involved the estimation of a number of Cross Lagged Panel (CLP) models. Contrary to what was predicted, results of the analysis indicated that the causal relationships which exist between paranoid ideation and other psychotic experiences are reciprocal in nature. These experiences were found to predict each other with equal magnitude over time.

To the author's knowledge, the current study was the first of its kind to use Cross Lagged Panel Modelling to investigate whether or not paranoia plays a causal role in the development of other psychotic experiences in the general population. The current findings demonstrate that subclinical psychotic experiences can interact and mutually influence each-other's development over time. While the reciprocal relationships which were observed appear to indicate that no psychotic experience holds causal predominance over the other, it is also possible that there are multiple distinct causal pathways present in this data. Future research should investigate the possibility of heterogeneous pathways to psychosis development.

5.1. Introduction

In the previous chapter (chapter 4), subclinical psychosis was visualised as a network of interconnected and interacting experiences. This allowed the relationships between paranoia and other psychotic experiences to be explored in a way that had not been possible until this point in the thesis. The analysis examined the network structure of subclinical psychosis across 2 large community-based datasets, thereby demonstrating its' stability and replicability. Importantly, paranoia emerged as playing a central role in these networks. In the current chapter (chapter 5), the author aims to build upon the previous chapters by investigating the temporal ordering of psychotic experiences. The central aim of the current analysis is to establish whether or not paranoia will precede the development of subsequent additional psychotic experiences as posited by the cascade model.

Put simply, the central aim of this thesis has been to understand paranoia's role in the early stages of psychosis development. The underlying structure of psychotic experiences within the general population has been examined in detail in the previous chapters of the thesis. This was achieved through the examination of psychotic experiences in large epidemiological datasets using advanced statistical modelling techniques. These studies have provided useful insights into the distribution of psychotic experiences in the general population. Their findings illuminated how paranoid ideation interacts with other psychotic experiences such as hallucinations and persecutory delusions. Examining these rich non-clinical samples has highlighted that paranoid ideation is an important experience during the early stages of psychosis and point towards it playing a central role in its development.

These studies centred around large-scale epidemiological datasets which contained rich and in-depth information on a wide range of psychological disorders, demographic factors, and other environmental and experiential factors. The main drawback to these datasets is that they are cross-sectional in nature. This means that temporal relationships between different psychotic experiences could not be explored in these studies. The question of whether or not paranoid ideation precedes the development of other psychotic symptoms has remained un-answered. Therefore, the next step in this thesis will be to explore this question by exploring the causal relationships between paranoia and other psychotic experiences.

5.1.1. Existing longitudinal studies of psychosis.

There are numerous studies in the existing literature which have investigated the development of psychosis over time. The longitudinal examination of psychotic symptoms rapidly increased in popularity following the emergence of continuum models of psychosis. As such, a large body of this research aimed to explore why some individuals who experience subclinical psychotic symptoms go on to develop clinical psychosis. For example, research carried out by Kwapil and Zinser (1994) followed a group of psychosis prone individuals for 10 years in order to identify effective indicators of psychosis-proneness. Their sample was made up of 508 undergraduate students attending the University of Wisconsin who had been identified as psychosis prone based on their responses to an interview assessing psychotic like experiences. Everyone completed a range of questionnaires including a perceptual aberration scale and a magical thinking questionnaire. The study aimed to assess the predictive power of these two factors. Participants were re-interviewed between 10 and 15 years later. In total, 14 participants had developed a psychotic disorder during this time-period. As predicted, transition was more common among those who scored highly in perceptual aberration and magical thinking compared to those who did not.

A study carried out by Yung et al., (2002) followed a group of individuals who were experiencing prodromal psychotic symptoms to examine how well these subclinical symptoms predicted future development of a clinical disorder. Their sample consisted of 49 participants aged between 14 and 30 who were referred to an outpatient clinical service. Individuals received a referral for experiencing attenuated psychotic symptoms, for experiencing brief, limited and intermittent psychotic symptoms, or for having trait or state risk factors for psychosis development. These participants were followed up over a 12-month period. Results found that 40.8% of the sample developed a psychotic disorder within the 12 months and the researchers used chi-square and T tests to examine differences between the transition and non-transition group on a number of variables. This was done to identify factors possibly linked to transition. Results identified a number of factors including duration of prodromal symptoms, level of functioning at referral, and depression as predictors of psychosis.

Poulton et al., (2000) examined the links between psychotic symptoms in childhood and adult schizophreniform disorder over a 15-year time period. Their analysis focused on data collected from 761 participants in a birth cohort study carried out in New Zealand. Psychotic experiences were assessed when the respondents were 11 years old and Schizophreniform disorder was diagnosed at 26 years. A significant linear relationship was found between psychotic experience at 11 years and positive and negative schizophrenia symptoms at 26 years. Of the 25 people diagnosed with schizophreniform disorder at 26, 42% had reported psychotic symptoms at 11.

A study conducted by Hanssen, Bak, Bijl, Vollebergh, and van Os (2005) explored the incidence and outcomes of subclinical psychotic experiences in the general population over a 2-year time period. The sample consisted of 7076 individuals aged between 18 and 64 who were part of a longitudinal cohort study. Data were collected at 3 time-points across 2 years. Information on a range of psychotic experiences was collected and compared across the 3 time-points. Individuals who reported a psychotic experience at baseline were 65 times more likely to present with a clinical disorder 2 years later. However, they also found that the majority of subclinical experiences are transitory, with only 8% of those reporting a psychotic experience at baseline reporting a clinical outcome at follow-up.

Zammit et al., (2013) carried out longitudinal research which explored subclinical psychotic experiences in young adolescence. Their sample came from a community-based birth cohort survey carried out in England. Psychotic experiences were assessed in 4724 participants at age 12 and again at age 18. Of those who endorsed a psychotic experience at age 12, almost 80% had remitted by age 18.

However, psychotic experiences at age 12 significantly predicted psychotic experience and clinical disorder at age 18.

A study conducted by Cannon et al., (2008) examined psychotic symptoms longitudinally in order to identify the risk of conversion to clinical psychosis and to develop an algorithm to identify those at greatest risk. A sample made up of 291 individuals who obtained high scores on a prodromal symptom questionnaire were followed for 2 ½ years. Of the 291 who experienced psychotic like experiences at baseline, 82 experienced a conversion to psychosis. Their results identified a number of indicators of conversion. These included paranoid cognition, social impairment, a history of drug use, and functional deterioration.

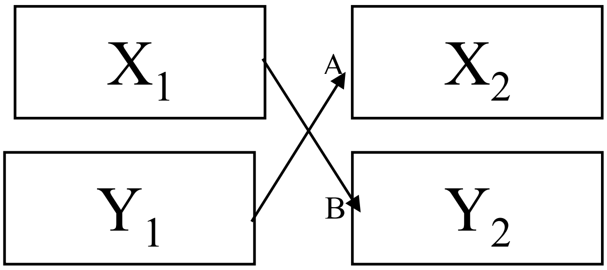
Research carried out by Woods et al., (2009) longitudinally explored the validity of the prodromal risk syndrome for predicting first onset of psychosis. Using a sample of 860 respondents from a general population database, they compared prodromal risk syndrome to a healthy control group as well as a group with schizotypal personality disorder and a group at heightened familial risk to identify which is the strongest predictor of future psychosis development. The prodromal risk syndrome group were found to be generally distinct from the other groups in a range of outcome measures. They obtained the most severe psychosis scores upon follow-up, they also scored higher in functional impairment and 40% of the prodromal group converted to psychotic illness within the 2.5 year follow up.

The studies discussed above provided useful insights into psychosis development and formed part of the evidence base for continuum models of psychotic disorders. The main analytic approach used in these studies involved comparing future transition rates in a group with subclinical psychotic experiences to those in a control group. The utility of this paradigm is limited however. It is not an appropriate technique for examining more complex causal relationships between multiple variables across time. In order to effectively study the role that paranoia plays in psychosis development, a more advanced statistical approach is needed.

5.1.2. Analysing panel data

The type of longitudinal data needed to answer these types of questions is called panel data. Put simply, panel data consists of multiple variables which have been recorded at multiple time points. In order to effectively explore possible causal pathways between these variables, careful consideration must be given to selecting an appropriate statistical paradigm. The most common analytical strategy employed in these contexts is cross-lagged panel analysis. This next section will provide an overview of what cross-lagged panel analysis is and how it works. It is mainly used to explain reciprocal relationships or directional influences between variables over time (Kearney, 2017). It examines relationships from one variable to another and vice versa (crossed) and relationships between variables at different time points (lagged). Consider figure 1 below which contains two variables (X & Y) measured at 2 time points (1 & 2). In basic terms, the aim of cross lagged panel analysis is to compare the effect of variable X at time 1 (X_1) on variable Y at time 2 (Y_2) to the effect of variable Y at time 1 (Y_1) on variable X at time 2 (X_2). Previously the main statistical technique used to achieve this focused on cross-lagged correlations (CLC). In other words, one would compare the correlation coefficient between X_1 and Y_2 to the one between Y_1 and X_2. These correlations are represented as A and B in figure 5.1.1. If these two coefficients were comparable it would indicate that a reciprocal relationship exists between variable X and Y. On the other hand, if one of these coefficients was larger than the other, for example, if the X_1 - Y_2 coefficient was larger than that of $Y_1 – X_2$, it would suggest that variable X had a bigger effect on variable Y and not the other way around (Kearney, 2017).

Figure 5.1.1. Sample cross-lagged correlation

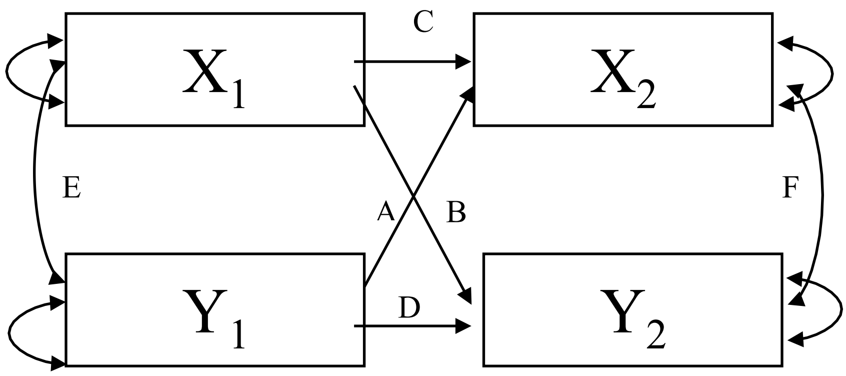


This approach to analysing cross-lagged panel data were used extensively in psychological research during the 1960s, 70s, and early 80s (Rogosa, 1980). Despite this popularity however, the use of cross-lagged correlations in this context has been since been heavily criticised for being a flawed technique (Kearney, 2017). One of the main issues with the approach is that it is unable to account for different levels of stability among the variables being analysed (Rogosa, 1980). It was discovered that if the cross-lagged correlations were examined between two variables which displayed different amounts of variation over time, it could lead to inaccurate conclusions regarding the causal mechanisms between them (Hamaker, Kuiper, & Grasman, 2015). Another weakness of the CLC approach is that it doesn't consider the possibility that correlations may exist between variables within the same time point. Failing to take these contemporaneous relationships into account could also result in dthe over or under-estimation of cross-lagged relationships between the variables (Rogosa, 1980). Due to these shortcomings, the use of CLC has been discarded in more recent times in favour of a more sophisticated approach called cross-lagged panel modelling (CLPM) (Kearney, 2017). The next section of this introduction will provide a more detailed description of CLPM and discuss how it has been applied in the literature to date.

5.1.3. Cross-Lagged Panel Models

Similar to CLC, CLPM (also referred to as cross-lagged path modelling and cross-lagged regression modelling) aims to explore causal pathways between variables in longitudinal data by examining the cross-lagged relationships between them. However, unlike CLC, CLPM also controls for correlations within time-points and stability over time, also known as autoregressive effects. In order to explain how a CLPM is interpreted, consider the sample model represented in Figure 2.

Figure 5.1.2. Sample cross-lagged panel model



Like figure 5.1.1, figure 5.1.2 contains the simplest example of panel data; two variables measured at two time-points. By comparing figure 5.1.1 and figure 5.1.2, the differences between CLC and CLPM are apparent. Both approaches obtain cross-lagged regression coefficients which are labelled as A and B. However, CLPM also obtains the regression coefficients C, D, E, and F. The linear coefficients C and D describe the autoregressive effects or the effect of these two constructs on themselves over time. In other words, they describe how stable the variables are from one time point to the next. To be clear, autoregressive effects do not measure the stability of scores over time but the stability of individual differences over time (Selig & Little, 2012). A small or zero autoregressive coefficient means that there has been significant reorganisation of the individuals' locations along the construct from time 1 to time 2. Conversely, a large autoregressive coefficient means that there has been very little change in individuals' relative locations on the construct over time. The regression coefficients E and F represent contemporaneous effects or the levels of correlation between variables X and Y within the same time point. In terms of interpreting the cross-lagged regression coefficients, A and B, a larger regression coefficient indicates a larger effect. So, if coefficient A was sizeable, it would indicate that variable X at time 1 has a strong effect on variable Y at time 2. On the other hand, a small or zero coefficient would indicate that variable X does not have an effect on variable Y. Clearly, CLPM provides a more robust structure for examining the causal relationships compared to CLC as it examines these relationships within the context of possible autoregressive and contemporaneous effects. These benefits have allowed CLPM to become one of the gold-standard analytic techniques for examining panel data.

A typical CLPM analysis involves specifying and estimating a number of models and then comparing them to determine which model is best fitting and most parsimonious. Fit statistics are generated for each model and these are used to identify which one fits the data most accurately. These competing models are generated by restricting and freely estimating different combinations of paths to focus on different causal avenues between variables. Generally, the first model to be estimated in a CLPM analysis is a baseline model. This involves restricting all autoregressive and cross-lagged paths (A, B, C, and D in figure 5.1.2.). If this model obtained the highest fit statistics in the analysis, it would indicate that the variables at T1 do not predict each other or themselves at T2. Next, a model would be estimated which freely estimates the autoregressive paths (A and B) while continuing to restrict the cross-lagged paths (C and D). If this model was identified as providing the best fit for the data, it would indicate that the variables at T1 have a causal impact on themselves at T2 but not on each other. Following this, a number of models would be estimated by freeing the different cross-lagged paths. Taking the overall model in figure 5.1.2 as an example, first, the autoregressive paths and the path from X1 to Y2 (A) would be freely estimated while the path from Y1 to X2 (B) is held constant. Then, the autoregressive paths and the paths from Y1 to X2 (B) would be freed while the path from X1 to Y2 (A) is held constant. These two models test different theories of causal predominance in the data. If the former model obtained the highest fit scores, it would indicate that X has a causal effect on Y and not vice versa. Conversely, if the latter model scored highest, it would indicate that Y has a causal effect on X. Another model which would be estimated is a fully unrestricted one where all paths (A, B, C, and D) are freely estimated. If this emerged as the best fitting model it would suggest that all variables influenced each other from one time-point to the next. The final type of model that could be estimated involves constraining multiple paths to be equal in magnitude. An example of this would be constraining the two cross-lagged paths in figure 5.1.2 (C and D) to be equal. If this model generated the highest scores on the fit statistics, it would indicate that a reciprocal relationship exists between the variables where each predicts the other at future time-points but neither has causal predominance over the other.

5.1.4. Applications of cross-lagged panel modelling

Over the last decade, CLPM has been applied in various contexts within the realms of psychological research in general. A number of researchers have utilised these CLPM techniques to enhance our knowledge of psychotic disorders and paranoia. The next section of this introduction will provide an overview of this research. As aforementioned, there is a body of work in the current literature which has used

CLPM techniques to learn more about psychosis. These studies can be divided into 2 broad groups based on their focus. The first of these categories contains studies which have attempted to explore the factors involved in the development of psychotic disorders. For example, Lincoln, Marin, and Jaya (2017) used CLPM to examine the mechanisms that link trauma to psychosis. The study used a community-based sample of 2350 participants living in 3 different countries (Germany, Indonesia, United States). Participants were aged 18 and up and completed 4 surveys spanning a 12-month time period. Results from the analysis suggested that impaired emotion regulation predicted more distressing psychotic symptoms in those who experienced childhood trauma. Additionally, they found that the frequency and severity of psychotic symptoms also plays a causal role in the impairment of emotion regulation. Their findings suggested that emotion regulation plays a role in the causal pathway from childhood trauma to psychotic experiences.

A study carried out by Zavos et al., (2016) explored the co-occurrence of psychotic disorders and depression in adolescence using CLPM. The analysis focused on a general population sample of 5059 monozygotic and dizygotic twins born in England and Wales who were assessed at 2 time-points 9 months apart. Results of the CLPM analysis indicated that a reciprocal causal relationship exists between paranoia and depression. Additionally, hallucinations and cognitive disorganization were found to predict later depression. A recent study carried out by Jaya, Ascone, and Lincoln (2018) utilised CLPM techniques to examine the causal pathways between negative self-schemas and positive psychosis symptoms. Their analysis utilised the same data that was used in Lincoln, Marin, and Jaya's (2016) study. They found that negative self-schemas predicted the later development of positive psychotic symptoms. Additionally, they found evidence that this causal link is mediated by negative affect.

The second category of psychosis research using CLPM contains studies which examined the factors involved in recovery from a psychotic disorder. An example of this is a study carried out by Velligan, Alphs, Lancaster, Morlock, and Mintz (2009) which examined the associations between negative psychotic symptoms and functional outcomes in individuals with schizophrenia using CLPM. They analysed data collected from 125 outpatients aged between 18 and 60 from the United States who were diagnosed with schizophrenia or schizoaffective disorder. The results of their analysis suggested that reductions in negative symptoms drive improvements in global functional outcomes (Velligan et al., 2009).

Research carried out by Richardson, Katsakou, and Priebe (2011) utilised CLPM to explore links between treatment satisfaction and psychotic sub-syndromes. Their sample contained 778 individuals who were involuntarily admitted to a UK psychiatric ward between 2003 and 2005. CLPM was carried out using data from 2 time-points a month apart. While the researchers were exploring the effects of treatment satisfaction on manic excitement, anxiety-depression, and positive symptom sub-syndromes, it was only found to significantly predict changes in positive symptoms. Specifically, they found that higher treatment satisfaction resulted in reductions in positive psychotic symptoms. A study carried out by Klaas et al., (2017) used CLPM when investigating the effects that an awareness of illness has on an individual's psychotic symptoms and psychosocial functioning. Their data sample was made up of 240 participants who were attending an early intervention program for people in the early phase of psychosis in the University Hospital of Lausanne in Switzerland. Participants were assessed at 8 time-points over 3 years. Their results did not identify clear causal pathways between insight and psychotic symptoms or functioning. Instead, they indicated that the links between these variables are more complex and that further research is needed to better understand the effects of insight in psychosis. McCleery et al., (2016) explored the stability of social cognition over time in people with schizophrenia and its possible links with community functioning using CLPM. The analysis was carried out on a small sample (N=41) of participants attending the Centre for Neurocognition and Emotion in Schizophrenia in UCLA. The sample was assessed at 2 time-points, approximately 5 years apart. While social cognition was found to be stable over time, it was not found to have a significant causal effect on later community functioning.

Research conducted by Fulford et al., (2017) made use of a CLPM approach when exploring the links between motivation and subsequent occupational and social functioning in individuals following an episode of Schizophrenia. The analysis utilised a sample of 404 individuals who had completed an early intervention program for the treatment of psychosis. Participants were assessed at 3 time-points across a 12-month period. Motivation was found to predict improved future participation in work and school. Additionally, social functioning was found to predict higher future motivation. A study carried out by Schoeler et al., (2016) used CLPM to examine the nature of the association between cannabis use after the onset of psychosis and the risk of psychosis relapse. The sample was made up of 220 participants who had attended early intervention services for psychosis in England between 2002 and 2013. Data were collected at 2 time-points, first, close to the onset of illness and second, at least 2 years after initial onset. Cannabis use following initial onset of psychosis was found to have a causative effect on subsequent relapse. A study which was recently published by Zaske et al., (2018) applied CLPM techniques to study how the experience of stigma affects the course of illness in individuals with first episode schizophrenia. Analysis was carried out on a sample of 173 individuals with first-episode acute schizophrenia who attended one of 13 psychiatric hospitals in Germany. Data were collected at 2 time-points, 1 year apart. The results suggested that stigma experiences predict later reductions in self-esteem and overall poorer clinical states.

As mentioned above, numerous papers have also been published which have studied paranoia using CLPM. Similar to the psychosis analyses, these paranoia studies can be divided into 2 broad categories. The first of these contains studies that explore factors which influence the development of paranoid ideation. A study carried out by Hesse et al., (2015) used CLPM to examine the roles that one's family atmosphere and self-concept play in the genesis of paranoid cognition. Analysis was carried out on a sample of 160 individuals diagnosed with Schizophrenia. Data were collected at 2 time-points, 12 months apart. Negative family atmosphere predicted later negative self-concepts. Paranoia was found to predict future negative family atmosphere. These findings suggested that a vicious cycle of family atmosphere, self-concept, and paranoia exists. In a study conducted by Oliver, O'Connor, Jose, McLachlan, and Peters, (2012), CLPM was utilised to examine the roles that negative schemas, mood, and psychological flexibility play in the development of delusions. The sample consisted of 700 university students recruited from 3 campuses in New Zealand. Two waves of data were collected, 6 months apart. Results suggested that anxiety predicts future delusional ideation. Furthermore, they found that the causal link between negative schemas and delusions was mediated by anxiety. A study conducted by Lim, Rodebaugh, Zyphur, and Gleeson (2016) used CLPM techniques to examine the links between paranoia and loneliness. The analysis was carried out on a community sample of 1010 individuals from the United States. The participants completed 3 surveys across 18-24 weeks. The researchers found that experiencing loneliness at an earlier time-point predicted future paranoid ideation (Lim et al., 2016). A study carried out by Fowler et al., (2011) utilized CLPM to investigate the causal links between negative cognition, depressed mood, and paranoia. The analysis focused on a sample of 301 participants living in London and Norfolk with a diagnosis of non-affective psychosis who were attending community mental health services. Their findings suggested that negative cognition and depressed mood played direct causal roles in the development and maintenance of paranoid ideation.

Some of the papers falling into this category looked at the causal pathways underlying the co-morbidity between paranoia and psychological disorders. A study carried out by Moritz, Goritz, McLean, Westermann, and Brodbeck (2016) studied the causal pathways between paranoia and depressive symptoms using CLPM. The sample used was general population based containing 2229 participants. These participants completed 3 surveys across 2.5 years. The analysis found evidence of reciprocal links between paranoia and depressive symptoms indicating that neither of the two experiences have causal predominance over the other but instead, may mutually interact and influence one another.

Another example of this is a recent study conducted by Saarinen et al., (2018) which also used CLPM to investigate the nature of the relationship between paranoid ideation and depressive symptoms. Data were analysed from a community-based sample of 2109 participants born in Finland between 1962 and 1977. Analysis focused on 5 time-points spanning 20 years. Findings suggested that depressive symptoms play a causal role in paranoia development. More specifically, negative attitude and performance difficulties were found to significantly predict future paranoid ideation. Overall, they found that depressive symptoms were involved in the course of paranoia from adolescence to middle age.

The second category of CLPM studies focusing on paranoia explored factors which are influenced by paranoia. There is a lack of studies exploring this however one example is an analysis carried out by van Quaquebeke (2016) which used CLPM techniques to explore the role that paranoia plays in an individual's advancement in organisations. The sample consisted of 441 employees across a number of different industries in Germany. Participants completed surveys at 2 time-points, 6 months apart. Their results demonstrated that there are complex interactions between paranoid cognitions, self-monitoring, and advancement within organisations. They found that paranoid ideation can be both a prerequisite for and consequence of getting ahead in organisations.

Evidently, CLPM has been effectively applied in numerous ways to learn more about paranoid ideation and psychosis in general. However, the vast majority of these studies have been concerned with the causal relationships between paranoia/psychosis and numerous external factors. There is still a lack of studies using CLPM to examine the temporal associations between specific psychotic experiences. Moreover, to the author's knowledge, no study has attempted to examine causal links between paranoia specifically and other psychotic experiences using longitudinal data. The results from the previous studies in this thesis have highlighted that paranoia is a core symptom of psychosis and they indicate that examining the temporal links between paranoia and other symptoms would be worthwhile. Additionally, CLPM provides an appropriate statistical framework for the comprehensive analysis of these temporal connections.

5.1.5. Study Aims and Hypotheses

The central aim of the current study is to examine the temporal relationships between paranoid ideation and other psychotic experiences. Moreover, based on the existing literature highlighting the increased risks associated with persistent psychotic experiences, this study also aims to explore the causal links between sustained paranoid ideation over a period of time and later development of additional psychotic symptoms. Finally, this study aims to examine the causal pathways between sustained paranoid ideation and specific psychotic symptoms (hallucinations and thought interference). Based on existing literature and the results of the analyses from the previous chapters, it is predicted that paranoia will predict the occurrence of other psychotic experiences more strongly than those psychotic experiences will predict paranoia.

5.2. Method

5.2.1. Sample

The current study examined data from the Avon Longitudinal Study of Parents and Children (ALSPAC), also known as the Children of the 90s. The ALSPAC is a large, community-based birth cohort study carried out by the University of Bristol. It is longitudinal and trans-generational in nature, collecting data on both parent and child. The aim of the study was to provide a rich resource for the study of the genetic and environmental factors involved in an individual's health and development. The initial cohort consisted of 14,541 pregnant women living in the Bristol area with expected delivery dates between 1st April 1991 and 31st December 1992. This sample contributed 14,541 pregnancies, which resulted in 14,062 live births (Williams, Thomas, Sidebotham, & Emond, 2008). To be eligible for the study, participants needed to be resident in Avon while pregnant and have an expected due date within the dates mentioned above. Some participants were originally enrolled but moved away from the area soon after and were therefore excluded. However, participants who moved away after completing the questionnaire during their third trimester of pregnancy were retained in the study (Golding, Pembrey, Jones, & ALSPAC study team, 2001).

A variety of methods were used during the initial identification and recruitment of eligible participants. The study received substantial media coverage. Posters were displayed in places such as chemists, libraries, and GP practices and the study was also featured in local press, radio, and TV (Golding, Pembrey, & Jones, 2001). ALSPAC staff also approached eligible mothers directly when they attended their local hospital for routine ultrasounds. Additionally, ALSPAC staff in the maternity hospital approached eligible mothers, who were not yet enrolled in the study, after they had given birth to be invited to participate (Golding, Pembrey, & Jones, 2001). Furthermore, hospitals in the area sent information about the study to eligible mothers through the post and midwives discussed the study with expectant mothers when they were interviewing them for the first time (Golding, Pembrey, & Jones, 2001).

Once the mothers were recruited, data collection began from early pregnancy onwards. Information was collected using a variety of different methods. The main source of data were a series of self-complete questionnaires. Beginning at 7 days after initial enrolment, the mothers completed up to 22 questionnaires over the next 19-22 years. These questionnaires were sent to participants through the post to be completed in their own homes (Fraser et al., 2012). In addition to the questionnaires, the mothers also had detailed information extracted from their medical and educational records. Biological samples were taken, and annual hands-on assessments were carried out on each mother. Furthermore, sub-samples of participants were selected for additional study. This included taking measurements of the home environment such as air pollution, noise, etc, and having more frequent hands-on assessments.

In addition to collecting information on the mothers, data were also collected on their children from birth onwards. By in large, the data sources were comparable between mother and child. Once again, the main source of information was collected using self-complete questionnaires which were sent out through the post to be completed at home. The children completed up to 35 questionnaires in total, completing the first questionnaire at the age of 5 and the last at the age of 24. Data linkage was used to access information from their medical and educational records and biological were also collected from each child. As was the case with the mothers, the child participants attended a number of clinical assessment visits (Boyd, et al., 2012). A 10% subsample of these children were selected to undergo 6 additional clinical assessments. This subsample is referred to as the Children in Focus group (Boyd et al., 2012).

5.2.2. Measures

While the ALSPAC contains 24 child-completed questionnaires in total, not all of these assessed psychotic experiences. For the purposes of this study, 4 of the questionnaires which did assess these types of experiences were chosen for investigation. The four time-points covered in these questionnaires are 140 months (11.5 years), 157 months (13 years), 169 months (14 years), and 198 months (16.5 years). Psychotic experiences were assessed in the ALSPAC using the Psychotic-Like Symptoms Questionnaire (PLIKS). It is crucial to note that the PLIKS was administered to the child cohort in 2 different formats. The first of these, the PLIKS interview (PLIKS-I) is a semi-structured interview designed to assess psychotic-like experiences over the previous 6 months. It consists of 12 core questions and was administered to the child cohort when they were 12.9 years old (Horwood, et al., 2008). The second of these, the PLIKS questionnaire (PLIKS-Q), is a self-report measure based on the PLIKS interview (PLIKS-i) which assessed respondents' psychotic-like experiences since their last birthday. The PLIKS-Q was administered at each of the 4 time-points detailed above and will therefore be used in the current study. While the PLIKS-Q was used at all 4 time-points, the specific questions which were asked varied slightly from one time-point to the next. At time 1, respondents were asked 7 probe questions and 39 follow-up questions. Time 2 consisted of 10 probe questions and 36 follow-up questions. Time 3 consisted of 10 probe questions and 46 follow up questions. Time 4 consisted of 10 probe questions followed by 35 follow-up questions. There were 6 probe questions which were used across all 4 time-points and these were therefore selected for use in the current study. The chosen items enquired about the presence of hallucinatory, delusional, and thought interference experiences. All 6 items used a 3-point response format: No, never / yes, maybe / yes, definitely and the content of these items has previously been shown to appropriate for investigating psychotic experiences during childhood and adolescence (Laurens et al., 2012). Table 5.2.1 below contains the items selected for analysis.

Table 5.2.1. Selected scale items from PLIKS-Q

Item 1	Some people believe that their thoughts can be read. Have other people ever read your thoughts?
Item 2	Have you ever believed that you were being sent special messages through television or radio, or that a programme has been arranged just for you alone?
Item 3	Have you ever thought that you were being followed or spied on?
Item 4	Have you ever heard voices that other people can't hear?
Item 5	Have you ever felt that you were under the control of some special power?
Item 6	Have you ever seen something or someone that other people could not see?

The current study examines data provided by a subsample of 8949 children who completed at least one of the 6 probe items from the PLIKS-Q at any one of these 4 time-points. For the purposes of the analysis, the items were recoded into binary variables (experience is present/absent). If a participant responded "no, never" or "yes, maybe", to an item, it was recoded as absent. A "yes, definitely" response resulted in the experience being recoded as present.

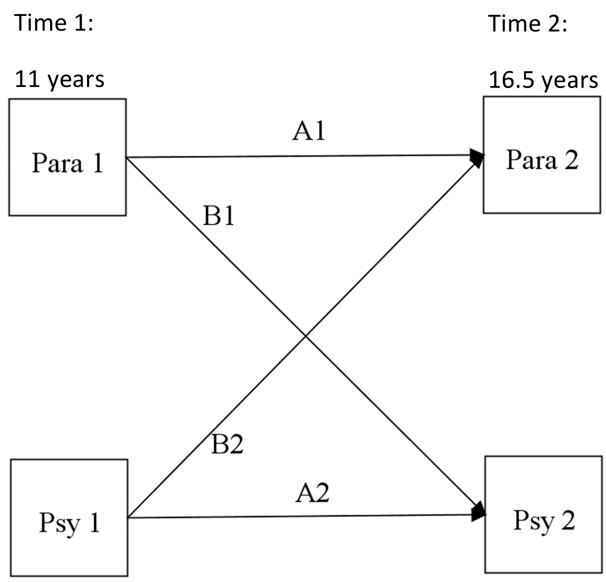
5.2.3. Statistical Analysis

Statistical analysis was carried out in 4 stages. During each stage, a number of cross-lagged panel models were specified and estimated. All models estimated during each stage of analysis examined psychotic experiences at 2 time-points. The time-points used and the coding of the 6 psychosis variables were changed from stage to stage. There were two reasons for this. The first was to ensure that the rich data present in this sample was explored effectively. The second was to ensure that the paranoia's effects on other psychotic experiences over time were adequately examined.

5.2.3.1. Stage 1

In the first stage of analysis, 6 cross lagged panel models were estimated. The 2 time-points examined were the first and last data-points available; 11 years and 16.5 years. The decision to use 16.5 years as the second time-point was informed by research which has found that the prevalence of psychotic disorders rapidly increases around 15-17 years (Kessler, et al., 2007). 11 years was chosen as the first time-point as it was believed that the 5.5-year gap between T1 and T2 would provide ample time for the endorsement of one psychotic experience to result in the experience of additional psychotic symptoms. Two binary variables were created for this first stage of analysis. First, a paranoia variable was created by combining responses from the 2 available paranoia items from the PLIKS-Q (receiving special messages through tv/radio, feeling followed/spied upon). A respondent was said to have experienced paranoia if they responded 'yes, definitely' to either of these 2 paranoia items. The second variable was labelled 'psychosis' and it was created by combining the 4 remaining available items in the PLIKS-Q (Thoughts being read, hearing voices others cannot, controlled by special power, seeing things others cannot). This psychosis variable was marked present if the respondent answered 'yes, definitely' to any 1 of the 4 aforementioned items. The decision to combine the remaining psychotic experiences into one variable was made so that paranoid ideation could be main focus of the analysis. It provided a parsimonious structure to explore if experiencing paranoia could result in the experience of subsequent additional psychotic symptoms. As aforementioned, the stage 1 analysis involved the specification and estimation of 6 cross-lagged panel models. These models were all based on the overall model in figure 5.2.1 below. The aim was to find the best fitting and most parsimonious model.

Figure 5.2.1. Overall model of the cross-lagged panel models for stages 1, 2, and 3



Note: Para = paranoia, Psy = psychosis

First, a baseline model was specified where all paths (A1, A2, B1, B2) were restricted to 0. Next, an autoregressive model was estimated where the autoregressive paths (A1, A2) were freed. Following this, two models were estimated by freely estimating the cross-lag effects. The first of these was a paranoia model where the cross-lagged path of paranoia predicting psychosis (B1) being freed. The second was a psychosis model where the cross-lagged effect of psychosis predicting paranoia (B2) being freely estimated. Next, a fully unrestricted model was estimated where all paths (A1, A2, B1, B2) were freely estimated. Finally, A model was run were the 2 cross-lagged paths (B1, B2) were constrained to be equal.

5.2.3.2. Stage 2

As was the case in the stage 1 analysis, 6 cross-lagged panel models were estimated at stage 2. The stage 2 analysis mirrors the stage 1 analysis in terms of the variables used and the models which were estimated. Once again, a paranoia variable and a psychosis variable were created. The 6 models which were estimated were 1) fully restricted, 2) autoregressive free, 3) paranoia free, 4) psychosis free, 5) fully unrestricted, 6) cross lags held equal. These models were also all based on the overall model in figure ? above. Stage 2 only differed from stage 1 in terms of the time-points which were used. 16.5 years was still used at T2, however, T1 was changed from 11 to 13 years. The reasons behind running a second set of analyses using the 13-year time-point are two-fold. First of all, because the ALSPAC contains this rich longitudinal psychosis data at multiple time-points, it would be foolish not to make use of it and explore it thoroughly. If this study only analysed data from 11 and 16.5 years it would be missing out on potentially useful information. There is still a gap of 3.5 years between the 13- and 16.5-year time-points which provide ample time for the endorsement of one psychotic experience to result in the experience of additional symptoms. Secondly, the onset of puberty is a critical developmental stage which drives marked changes in motivations, social life, and psychology (Blakemore, Burnett, & Dahl, 2010). Therefore, the differences in respondents' cognition and experience from 11 to 13 years could be dramatic. This provides a strong rationale for looking at psychotic experiences at both 11 and 13 years.

5.2.3.3. Stage 3

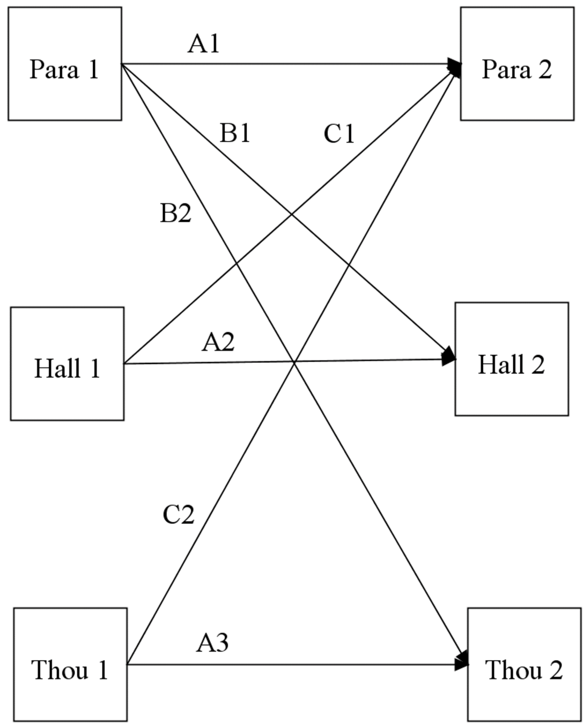
The analysis conducted in this stage shared a number of similarities with the 2 previous stages. Once again, 6 cross-lagged panel models were estimated using 2 variables across 2 time-points. Alterations were, however, made to the time-points used and the ways in which the variables were coded. There is a growing body of literature showing that the persistence of subclinical psychotic experiences is a key factor in predicting future need for care (Van os, Kenis, & Ruttenfe, 2010). As a next step therefore, stage 3 of the current analysis aimed to examine the specific effect of sustained paranoid experience on the development of subsequent psychotic symptoms. To achieve this, the two variables used at T1 were formed by combining data from the 11- and 13-year data points. As was the case in the previous analytic stages, a paranoia variable and a psychosis variable were used. As this analysis was focused on the effect of persistent paranoid ideation across time-points, a sustained paranoia variable was created for T1. Individuals were coded as experiencing sustained paranoia if they responded 'yes, definitely' to either of the 2 psychotic items at 11 years and either of the 2 paranoia items at 13 years. For the psychosis variable on the other hand, individuals were coded as experiencing a psychotic symptom if they responded 'yes, definitely' to any of the 4 psychotic experiences at either 11 years or 13 years. The 16.5-year time-point and format of the paranoia and psychosis variables used at T2 remained unchanged and are in keeping with those used in the previous 3 stages of analysis.

5.2.3.4. Stage 4

In the fourth and final stage of analysis, 4 cross-lagged panel models were estimated. The main purpose of is stage of analysis was to take a more detailed look at the results from stage 3 models. Specifically, the aim was to explore the causal pathways between sustained paranoid ideation and other specific psychotic experiences as opposed to psychosis in general. To achieve this, the ‘psychosis’ variable which was used in the previous analytic stages was broken down into 2 binary variables; a hallucination variable and a thought interference variable. At both time-points, The hallucination variable was created by combining 2 PLIKS-Q items (hearing voices that others cannot, seeing something or someone that others cannot). The remaining 2 PLIKS-Q items (thoughts being read, under control of a special power) were combined to create the thought interference variable. In both cases, the T1 variable was marked as present if the participant responded ‘yes, definitely’ to either item at either time-point (11/13 years). The T2 variable was marked present if the participant responded ‘yes, definitely’ at 16.5 years.

Statistical analysis involved the specification and estimation of 4 cross-lagged panel models. These models were all based on the overall model in figure 5.2.2 below. The aim was to find the best fitting and most parsimonious model.

Figure 5.2.2. Overall model of the cross-lagged panel models for stage 4



Note: Para = paranoia, Hall = hallucination, Thou = thought interference

In the first model, the autoregressive paths (A1, A2, A3) and paranoia cross-lag paths (B1, B2) were freely estimated. This allowed the causal pathways from paranoia to hallucinations and thought interference to be explored. In the second model, the autoregressive paths (A1, A2, A3) and the hallucination (C1) and thought interference (C2) cross-lag paths were freely estimated. This allowed for the exploration of the causal pathways from hallucinations to paranoia and thought interference to paranoia. In the third model, all autoregressive and cross-lag paths (A's, B's, & C's) were freely estimated. In the fourth model, the autoregressive paths were freely estimated while all cross-lag paths were constrained to be equal.

All analyses were conducted using Mplus 7.3. Robust full-information maximum likelihood estimation was used as it makes use of all available data to estimate the model. The model parameters were estimated using robust full information maximum likelihood (Yuan & Bentler, 1998). This method allowed parameters to be estimated using all available information and has been found to be superior to alternative methods such as listwise deletion (Enders, 2001; Schafer & Graham, 2002). The best fitting model was determined by comparing scores on 2 information theory based fit statistics. The first of these was the Bayesian Information Criterion (BIC; Schwarz, 1978) and the second was the sample size adjusted Bayesian Information Criterion (ssaBIC; Sclove, 1987). A model with a lower BIC is considered to be a better fitting model with a difference in scores greater than 10 considered to be indicative of a significant difference (Rafferty, 1996). It is important to note that the BIC and ssaBIC have a complexity penalty. This means that the value increases as more parameters are added to a model. This results in more parsimonious models being favoured. The difference is, the penalty increases with sample size for the BIC but decreases with sample size for the ssaBIC. Studies have suggested that the ssaBIC performs well at correct model selection (Tofighi & Enders, 2008).

5.3. Results

As outlined in the method section, the analysis was conducted in four stages. In the stage 1 model, the first time-point was at 11 years. In the stage 2 model, the first time-point was 13 years. In the stage 3 model, the first time-point used a combination of data from 11 and 13 years. The model obtained in stage 4 used the same time-points as stage 3 but explored the relationships between paranoia and the other psychotic experiences in more depth.

5.3.1. Stage 1

5.3.1.1. Descriptive Statistics

Table 5.3.1 below contains the frequencies of endorsement for the paranoia and psychosis variable at each of the 2 time-points. Both variables were less prevalent at the 16.5-year time-point compared to 11-year time-point. The psychosis variable obtained higher endorsement rates at each time-point.

Table 5.3.1. Frequencies of paranoia and psychosis variables at each timepoint.

	Yes	(%)	No	(%)	Missing	(%)
Paranoia 1	936	10.5	6398	71.5	1615	19.9
Paranoia 2	271	3.0	4676	52.3	4002	44.7
Psychosis 1	1098	12.3	6066	67.8	1785	19.9
Psychosis 2	441	4.9	4478	50.0	4030	45.0

The frequencies of endorsement for different temporal orderings of paranoia and psychosis (Para-Psy or Psy-Para) are contained in table 5.3.2 below. The rates of both temporal orderings were quite similar with para1-psy2 occurring slightly more frequently.

Table 5.3.2. Frequencies of temporal orderings of paranoia and psychosis variables

	Yes	(%)	No	(%)	Missing	(%)
Para1-Psy2	80	0.9	4168	46.6	4701	52.5
Psy1-Para2	71	0.8	4112	46.0	4766	53.2

5.3.1.2. Model Testing

Table 5.3.3 below contains the BICs and ssaBICs for the 6 models estimated using the 11- and 16.5-year time-points. Choosing the best fitting model was not a completely straightforward decision as 3 of the models obtained model fit statistics which were less than 10 points apart from each other. While freeing all paths resulted in a lower BIC and ssaBIC compared to when only the psychosis cross lag was freed, this drop was not significant. The psychosis free model would therefore be favoured as it is more parsimonious. Holding the cross lags to be equal resulted in the lowest fit statistics. While this model was just shy of 10 points lower than the psychosis free model, it was still chosen as the best fitting model from stage 1.

Table 5.3.3. Model fit statistics for cross-lagged panel models

Model	BIC	ssaBIC
Fully restricted	3955.733	3949.378
Autoregressive free	3837.313	3824.603
Delusion free	3834.732	3818.844
Psychosis free	3824.499	3808.611
Fully unrestricted	3821.918	3802.852
Cross lags equal	**3815.083**	**3799.195**

The results from the best fitting model from the first stage of analysis are shown in figure 5.3.1 below. The odds ratios and associated 95% confidence intervals (CIs) can be found in table 5.3.4. All four of the paths were statistically significant at the 0.01 level.

Figure 5.3.1. Chosen model from first stage of analysis.

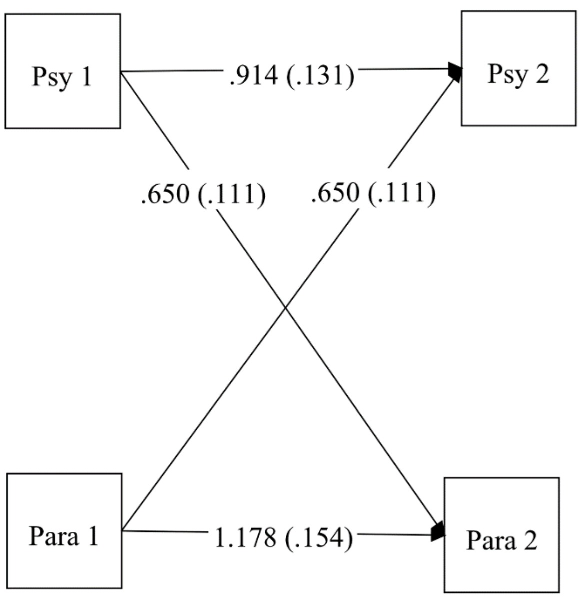


Table 5.3.4. Odds ratios and 95% confidence intervals for the final model.

Path	OR	CI
A1	3.247**	2.403 – 4.389
A2	2.495**	1.929 – 3.227
B1	1.915**	1.540 - 2.381
B2	1.915**	1.540 - 2.381

5.3.2. Stage 2

5.3.2.1. Descriptive Statistics

The frequencies of endorsement for the paranoia and psychosis variable at each of the 2 time-points are displayed in table 5.3.5 below. As was the case in stage 1, both variables showed a decrease in prevalence from the 13-year time-point to the 16.5-year time-point. Once again, the psychosis variable obtained higher endorsement rates at each time-point. It is also worth noting that the paranoia and psychosis endorsement rates at 13 years were lower than at the 11-year time-point used in the stage 1 analysis.

Table 5.3.5. Frequencies of paranoia and psychosis variables at each timepoint.

	Yes	(%)	No	(%)	Missing	(%)
Paranoia 1	524	5.9	6428	71.8	1997	22.3
Paranoia 2	271	3.0	4676	52.3	4002	44.7
Psychosis 1	743	8.3	6092	68.1	2114	23.6
Psychosis 2	441	4.9	4478	50.0	4030	45.0

The frequencies of endorsement for different temporal orderings of paranoia and psychosis (Para-Psy or Psy-Para) are contained in table 5.3.6 below. Mirroring the results from stage 1, the rates of both temporal orderings were quite similar. Once again, Para1-Psy2 occurred slightly more frequently than Psy1-Para2.

Table5.3.6. Frequencies of the temporal orderings of paranoia and psychosis variables

	Yes	(%)	No	(%)	Missing	(%)
Para1-Psy2	68	0.8	4225	47.2	4656	52.0
Psy1-Para2	63	0.7	4179	46.7	4707	52.6

5.3.2.2. Model Testing

Table 5.3.7 below contains the BICs and ssaBICs for the 6 models estimated using 13 years as T1 and 16.5 years as T2. The lowest BIC and ssaBIC scores were associated with the model which restricted the cross lags to be equal. While the fit statistics for this model were lower than those associated with the fully unrestricted model, this difference was less than 10. Despite this, holding the cross lags equal was selected as the best fitting model as it's scores were the lowest and it is the more parsimonious of the two.

Table 5.3.7. Model fit statistics for cross-lagged panel models

Model	BIC	ssaBIC
Fully restricted	4111.478	4105.123
Autoregressive free	3865.835	3853.125
Delusion free	3858.029	3842.141
Psychosis free	3851.899	3836.011
Fully unrestricted	3844.093	3825.028
Cross lags equal	**3836.207**	**3820.319**

The results of the best fitting model from the second stage of analysis are shown in figure 5.3.2 below. The odds ratios and associated 95% confidence intervals (CIs) can be found in table 5.3.8. All four of the paths achieved statistical significance at the 0.01 level.

Figure 5.3.2. Chosen model from stage 2 of analysis

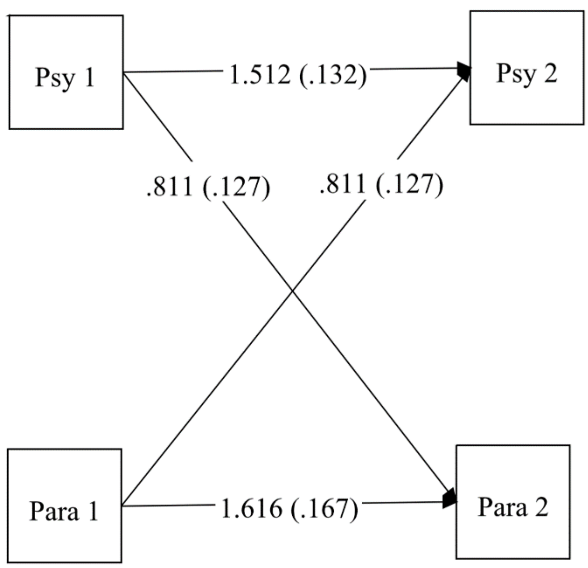


Table 5.3.8. Odds ratios and 95% confidence intervals for the final model.

Path	OR	CI
A1	5.034**	3.627 - 6.987
A2	4.535**	3.501 - 5.874
B1	2.249**	1.752 - 2.887
B2	2.249**	1.752 - 2.887

5.3.3. Stage 3

5.3.3.1. Descriptive Statistics

As a reminder, in the third stage of analysis, the first time-point consisted of a combination of scores from data collected at 11 and 13 years. Paranoia at this first time-point was marked present if the respondent endorsed a paranoia item at both 11 and 13 years. Conversely, psychosis was marked present if the respondent endorsed a psychosis item at either 11 or 13 years. The frequencies therefore look substantially different to those reported in stage 1 and 2. They are contained in table 5.3.9 below. The sustained paranoia variable at time 1 displayed relatively low endorsement rates compared to the psychosis variable at the same time point. Also, there was an increase in paranoia endorsement rates and a decrease in psychosis rates from time 1 to time 2. Psychosis displayed the highest endorsement rates at both time points.

Table 5.3.9. Frequencies of paranoia and psychosis variables at each timepoint.

	Yes	(%)	No	(%)	Missing	(%)
Paranoia 1	173	1.9	5682	63.5	3094	34.6
Paranoia 2	271	3.0	4676	52.3	4002	44.7
Psychosis 1	1164	13.0	4481	50.1	3304	36.9
Psychosis 2	441	4.9	4478	50.0	4030	45.0

The frequencies of endorsement for the different temporal orderings of paranoia and psychosis (Para-Psy or Psy-Para) are contained in table 5.3.10 below. In contrast to the results from stages 1 and 2, Psy1-Para2 was more frequently endorsed than Para1-Psy2. The former displayed higher levels of endorsement compared to previous stages while the latter showed a drop-in endorsement level.

Table 5.3.10. Frequencies of the temporal orderings of paranoia and psychosis variables

	Yes	(%)	No	(%)	Missing	(%)
Para1-Psy2	30	0.3	3835	42.8	5066	56.9
Psy1-Para2	86	1.0	3661	40.9	5202	58.1

5.3.3.2. Model Testing

Table 5.3.11 below contains the BICs and ssaBICs for the 6 models estimated using the combination of 11- and 13-year data at T1 and 16.5 years at T2. Restricting the cross lags to be equal resulted in the lowest BIC and ssaBIC scores. As was the case in the stage 2 models, the difference in fit statistics scores between this model and the fully unrestricted model was less than 10. Despite this, holding the cross lags equal was, once again, selected as the best fitting model as it's model fit scores were the lowest and it is the more parsimonious model of the two.

Table 5.3.11. Model fit statistics for cross-lagged panel models

Model	BIC	ssaBIC
Fully restricted	3442.294	3435.939
Autoregressive free	3283.554	3270.844
Delusion free	3279.389	3263.501
Psychosis free	3247.356	3231.468
Fully unrestricted	3243.191	3224.126
Cross lags equal	**3235.322**	**3219.434**

The results of the best fitting model from the third stage of analysis are shown in figure 5.3.3 below. The odds ratios and associated 95% confidence intervals (CIs) can be found in table 5.3.11. All four of the paths achieved statistical significance at the 0.01 level.

Figure 5.3.3. Chosen model from stage 3 of analysis

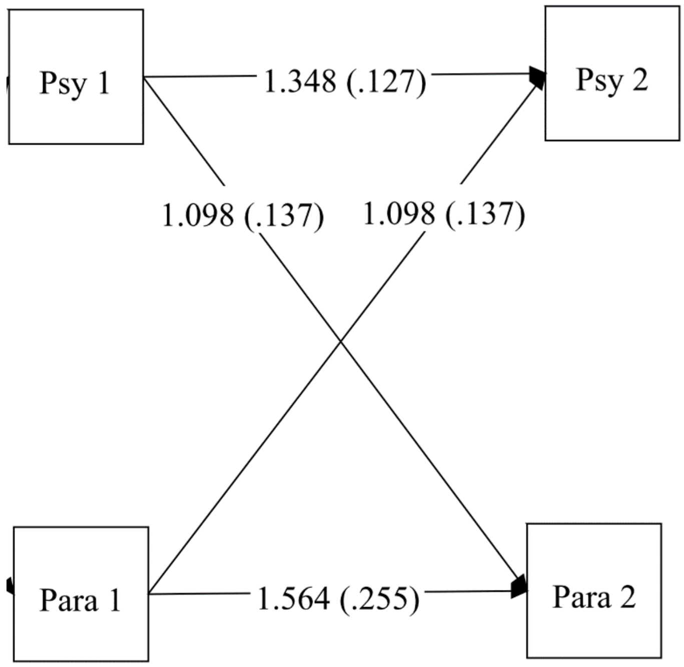


Table 5.3.11. Odds ratios and 95% confidence intervals for the final model.

Path	OR	CI
A1	4.780**	2.897 - 7.886
A2	3.851**	3.004 - 4.936
B1	2.999**	2.294 - 3.920
B2	2.999**	2.294 - 3.920

5.3.4. Stage 4

5.3.4.1. Descriptive Statistics.

As was the case in the previous stage, in stage 4, the variables at the first time-point consisted of a combination data collected at 11 and 13 years. Paranoia at T1 was marked present if the respondent endorsed a paranoia item at both 11 and 13 years. The psychosis variable from the previous stages was split into 2 variables; hallucination and thought interference. Hallucination and thought interference at T1 were marked present if the respondent endorsed a hallucination/thought interference item at either 11 or 13 years. There was an increase in paranoia endorsement rates from time 1 to time 2. Conversely, there was a decrease in endorsement rates of both hallucination and thought interference from time 1 to time 2. Hallucination was the most frequently endorsed variable at T1 followed by Thought interference and then paranoia. Hallucination also obtained the highest endorsement rates at T2, followed closely by paranoia. Thought interference obtained the lowest endorsement rates at T2. See table 5.3.12 below.

Table 5.3.12. Frequencies of paranoia and psychosis variables at each timepoint.

	Yes	(%)	No	(%)	Missing	(%)
Paranoia 1	173	1.9	5682	63.5	3094	34.6
Paranoia 2	271	3.0	4676	52.3	4002	44.7
Hallucination 1	889	9.9	4944	55.2	3116	34.8
Hallucination 2	321	3.6	4693	52.4	3935	44.0
Thought 1	562	6.3	5277	59.0	3110	34.8
Thought 2	180	2.0	4812	53.8	3957	44.2

The frequencies of endorsement for the different temporal orderings of paranoia, hallucinations, and thought interference (Para-Hall, Para-Thou, Hall-Para, Thou-Para) are displayed in table 5.3.13 below. The most common temporal ordering was Hall 1-Para2. This was followed by Thou 1-Para 2. Of the two orderings with paranoia at T1, Para 1-Hall 2 occurred slightly more frequently than Para 1-Thou 2.

Table 5.3.13. Frequencies of the temporal orderings of paranoia, hallucination, and thought variables

	Yes	(%)	No	(%)	Missing	(%)
Para 1-Hall 2	23	0.3	3906	43.6	5020	56.0
Para 1-Thou 2	14	0.2	3898	43.6	5037	56.3
Hall 1-Para 2	75	0.8	3791	42.3	5083	56.8
Thou 1-Para 2	43	0.5	3815	42.7	5091	56.9

5.3.4.2. Model Testing

Table 5.3.14 below contains the BICs and ssaBICs for the 2 models estimated using the combination of 11- and 13-year data at T1 and 16.5 years at T2. Constraining the cross-lag paths between paranoia, hallucinations, and thought interference resulted in significantly lower BIC and ssaBIC scores compared to the other 3 models. Therefore, this was selected as the best fitting model from the stage 4 analysis.

Table 5.3.14. Model fit statistics for cross-lagged panel models

Model	BIC	ssaBIC
Delusion paths free	3834.886	3809.466
Hall/thought paths free	3797.331	3771.911
Fully unrestricted	3795.285	3763.510
Cross-lags equal	**3775.433**	**3753.191**

The results of the best fitting model from the fourth stage of analysis are shown in figure 5.3.4 below. The odds ratios and associated 95% confidence intervals (CIs) can be found in table 5.3.15. All four of the paths achieved statistical significance at the 0.01 level.

Figure 5.3.4. Chosen analysis from stage 4 of analysis

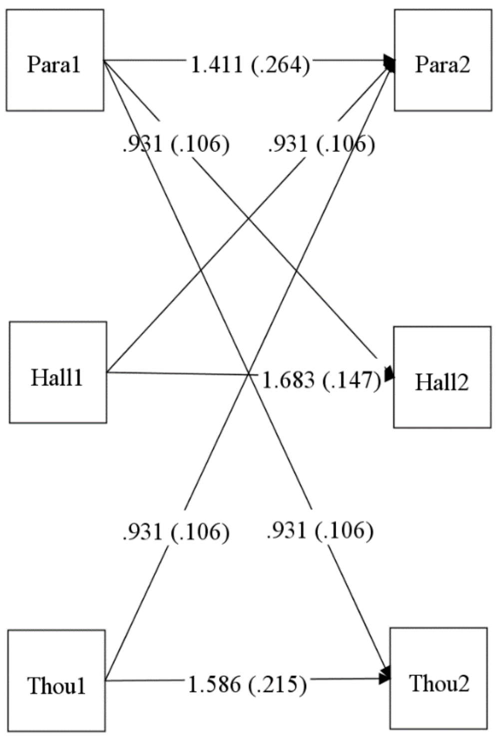


Table 5.3.15. Odds ratios and 95% confidence intervals for the final model.

Path	OR	CI
A1	4.101**	2.442 - 6.887
A2	5.381**	4.032 - 7.182
A3	4.882**	3.205 - 7.439
B1	2.536**	2.130 – 3.122
B2	2.536**	2.130 – 3.122
C1	2.536**	2.130 – 3.122
C2	2.536**	2.130 – 3.122

5.4. Discussion

5.4.1. Study Findings

To the author's knowledge, the current study was the first of its kind to use Cross Lagged Panel Modelling to investigate whether or not paranoia plays a causal role in the development of other psychotic experiences in the general population. It was hypothesised that paranoid ideation would predict the occurrence of other psychotic experiences more strongly than those experiences would predict paranoia. However, the results of the analysis were not in line with what was predicted. Instead, the causal links between paranoia and other psychotic experiences appeared to be reciprocal in nature. In other words, instead of identifying one causally predominant experience, they were all found to predict each other with equal magnitude over time. This pattern of causality was consistently present across the models obtained in the 1st and 2nd stage of analysis. A similar pattern was observed in the stage 3 analysis between sustained paranoia and other psychosis symptoms. Sustained paranoia and psychosis predicted each other's development over time with equal magnitude. In the fourth stage of analysis, which aimed to shed more light on the causal relationships between paranoia and other specific symptoms, a reciprocal relationship was once again observed. This indicates that paranoia, hallucinations, and thought interference predict each other over time, but that none of them exhibit causal predominance over the other. Once more, this finding did not provide support for the study hypotheses.

5.4.2. Within the Context of the Current Literature

It is important to discuss the current findings within the context of the existing literature as they provide support for the results from some previous studies and contradict some others. These findings also have implications for the existing theories of how psychosis develops. First and foremost, the current findings provide support for previous studies which have suggested that experiencing one psychotic symptom can lead to the experience of additional psychotic symptoms. Our analysis reinforces the idea that different subclinical experiences not only co-occur, but also dynamically interact and can precipitate each other's development which was put forward in a paper published by van Os and Reininghaus (2016). Also, the results from the fourth stage of the current analysis have implications for the body of research exploring the relationship between paranoid ideation and hallucinations. Due to how frequently delusions and hallucinations co-occur in both clinical and non-clinical populations, along with the increased likelihood of developing a need for care associated with their co-occurrence, there is a large body of research exploring the causal links between them. Within this body of research, there is much debate regarding the nature of this relationship. The prevailing theories posit that delusions develop as a consequence of hallucinations. Numerous studies have found evidence to suggest that delusions can form as a response to an anomalous experience (Bell, Halligan, & Ellis, 2006; Garety, Bebbington, Fowler, Freeman, & Kuipers, 2007; Freeman, 2007). However, some other studies have reported contrasting findings, indicating that paranoid ideation may precede delusion development (Lopes & Pinto-Gouveia, 2013). The findings of the current analysis do not support either of these explanations. Instead of either experience having causal predominance over the other, they appear to indicate that paranoia and hallucinations mutually predict each other's development over time. This provides support for theories which suggested that a more dynamic relationship exists between these two constructs (Bentall, Wickham, Shevlin, & Varese, 2012; Garety, Kuipers, Fowler, Freeman, & Bebbington., 2001).

5.4.3. Implications for the Overall Thesis Aims

The findings from the current study have a number of implications for the cascade of misinformation theory. On the surface, these results appear to be incompatible with an explanation of psychosis development with paranoid ideation at its core. It may be tempting to interpret the current findings as meaning that paranoia and other psychotic experiences reciprocally impact upon each other equally over time and therefore, all of these psychotic experiences may develop concurrently, resulting in the emergence of a psychotic disorder. However, this is only one of a number of possible interpretations of the observed causal patterns in this study. There may be more complex aspects to these relationships which the current analytic techniques could not pick up on. It may be that the nature of the causal relationships between paranoia and other psychotic symptoms changes as they increase in severity. For example, experiencing mild paranoid ideation could alter one's perception leading to the experience of other subclinical psychotic symptoms such as hallucinations. These subclinical experiences could then cause the development of more severe delusional beliefs. In other words, one psychotic experience may play a bigger role in the genesis of psychosis but as it continues to develop and increases in severity, this causal predominance may shift, leading to other symptoms becoming the driving force behind its development. Another possibility is that multiple distinct causal pathways to psychosis development exist concurrently. It may be the case that there are separate subgroups of individuals who exhibit different temporal orderings of psychotic symptoms. For example, there could be one pathway where paranoia plays the core role in the development of subsequent psychotic experiences as this thesis is suggesting. Another pathway could involve hallucinations precipitating the development of additional psychotic symptoms. There could be a number of these pathways occurring in the population and some may occur more frequently than others. If this were the case and there are multiple pathways to developing a psychotic disorder, it would mean that paranoid ideation is at the core of psychosis development for some, but not all. It's important to note that while the current study did not find that paranoid ideation is the causally predominant experience involved in subclinical psychosis development, it did still find that paranoia has the ability to predict the future development of additional subclinical psychotic experiences. Also, it should be pointed out that the current findings do compliment the idea of a cascade of paranoia and other psychotic experiences interacting and impacting on each other in the subclinical stages of psychosis development.

5.4.4. Limitations

One of the main limitations of the current analysis was that it explored the causal relationships between psychotic experiences in isolation. A range of factors have been identified in the existing literature as being associated with psychotic symptom development such as anxiety (Harrow, Jobe, & Fletcher, 2008), depression (Freeman et al., 2012), and trauma (Shevlin, Houston, Dorahy, & Adamson, 2007). These factors could potentially play mediating roles in the causal pathways observed in the current study. These factors should be taken into account in future studies aiming to further elucidate the links between different symptoms of psychosis over time. There are several potential limitations associated with how the variables were coded for the purposes of the current analysis. First, each psychotic symptom was only coded as present if the respondent said that they had definitely experienced it. An uncertain response resulted in the symptom being coded as absent. While the decision to focus on definite experiences was made to avoid the inclusions of false positives in the analyses, there could be important information contained in these uncertain experiences which was lost. For example, it may be that endorsing an uncertain paranoia experience at T1 may cause the endorsement of a definite hallucination experience at T2. These relationships could not be picked up on in the current analysis. Second, the way that sustained paranoia was operationalised in the stage 3 and 4 analyses could present some issues. For the first time-point, sustained paranoia was coded as present if a respondent had endorsed a paranoia experience at both the 11 and 13-year time-points. In comparison, the other variables at the first time-point (psychosis in stage 3 and hallucinations and thought interference at stage 4) were coded as present if they were endorsed at either 11 or 13 years. These coding choices were made to create a parsimonious paradigm to explore the predictive power of persistent paranoid experience. However, it meant that the sustained paranoia variable was not directly comparable to the other variables at T1. Therefore, the paranoia variable had a considerably lower endorsement rate compared to these other variables. These higher numbers may have artificially inflated the predictive power of the other T1 variables (psychosis at S3, hallucination and thought experience at S4). Another point worth noting is in relation to the scale used to measure psychotic experiences in the ALSPAC. The scale only contained 6 psychosis items which were asked at all time-points needed for this analysis; 2 relating to paranoia, 2 to hallucinations, and 2 to thought interference. It could be argued that using 2 items each to tap into paranoia, hallucinations, and thought interference is an oversimplified and ultimately inadequate measure of these constructs. Future research which uses more comprehensive scales would allow the relationships between these constructs to be explored in more detail. One benefit of using these more in-depth measures is that it would allow the content of different psychotic symptoms to be taken into account. It may be the case that considering the thematic content of different psychotic experiences is an essential step to truly understanding the causal links between them. For example, specific delusion content, such as believing you are under FBI surveillance may predict later hallucination content, like hearing voices talking about you over intercom or vice-versa. These are questions which could not be explored in the current analysis.

5.4.5. Clinical Implications & Avenues for Future Research

These limitations notwithstanding, the findings from the current study have a number of implications for clinical practice. The findings of the current analysis have highlighted that there are complex reciprocal causal relationships between different psychotic experiences. This result provides support for the use of interventions which target specific psychotic symptoms. Examples of this are the use of cognitive therapy for treating delusions (Turkington & Siddle, 1998), the use of AVATAR therapy for the treatment of auditory verbal hallucinations (Craig et al., 2018), and using cognitive behavioural therapy targeted at visual hallucinations (Wilson, Collerton, Freeston, Christdoulides, & Dudley, 2016). The causal links between symptoms suggest that treating one symptom would also lead to improvements in other symptoms or prevent their development entirely. In a more general sense, the current analysis has highlighted that subclinical psychotic experiences occur relatively frequently in adolescence. While studies have found that most psychotic experiences are transitory (Wiles et al., 2006), the current study demonstrated that these subclinical experiences can precipitate the development of future additional symptoms and existing research has reported that experiencing multiple psychotic symptoms increases one's risk of developing a clinical disorder (Hanssen et al., 2005). Taking all of this into account, our findings emphasise how beneficial information distribution initiatives directed towards adolescents would be. This information should aim to normalise and de-stigmatize these subclinical experiences in addition to outlining pathways to support for those who need it. For this age bracket, schools and social media could provide effective distribution pathways for this information.

The results of this study also have implications for avenues of future research. First and foremost, the findings in the current analysis should be replicated to see if the patterns of influence between paranoia and other psychotic symptoms are consistent in different samples. The sample used in the current study was made up of adolescents, so it would be particularly interesting to study these causal trends in an adult sample and compare the two. Secondly, as the findings of this study point towards a complex interplay of psychotic experiences driving psychosis development as opposed to any one symptom having causal predominance over the other, more detailed study of how psychotic symptoms interact over time is warranted. One step towards achieving this would be to use more comprehensive scales which capture a wider range of psychotic-like experiences. Future research studying these symptom interactions could also control for factors which are known to be associated with psychotic experiences such as anxiety, depression, stress, and drug use.

As previously discussed, one possible explanation for the reciprocal causal relationships observed in this study is that there are multiple distinct causal pathways occurring in the general population. Attempting to identify subgroups of people in the population who exhibit unique and separate temporal orderings of psychotic experiences could be a fruitful avenue for research. One thing which the current analysis did not focus on was whether or not any of the participants had developed a clinical psychotic disorder between baseline and follow-up. Since studies have shown that the majority of subclinical psychotic experiences do not result in the development of a clinical disorder (Hanssen et al., 2005; Wiles et al., 2006), taking transition to clinical states into account when studying these trends in symptom development is critical for future research. This is particularly relevant for any future studies which explore multiple pathways of causation between psychotic symptoms as pathways may be identified which are more associated with progression to a clinical state. For example, perhaps individuals who experience paranoid ideation which precipitates the development of hallucinatory experiences are at higher risk of developing a psychotic disorder or vice-versa.

5.4.6. Conclusions

The aim of the current study was to longitudinally explore the temporal ordering of subclinical psychotic symptoms in the general population in order to gain a better understanding of paranoia's role in psychosis development. While it was predicted that paranoia would be identified as playing a causal role in subsequent symptom development, results of the analysis indicated that paranoid ideation and other psychotic experiences predict each other with equal magnitude over time. These findings can be interpreted in a number of ways and therefore, more detailed longitudinal research is required to better understand paranoia's role in the genesis of psychosis. That being said, the current findings demonstrate that subclinical psychotic experiences can interact and mutually influence each-other's development over time.

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Chapter 6: Overall conclusion of the research

6.1. Literature review

The way in which psychosis is conceptualised forms the bedrock of how researchers study it and how Clinicians treat it. Therefore, it is of vital importance that these conceptualisations are reflective of the true nature of psychosis. Previous research in the field has demonstrated that psychotic symptoms, once believed to only occur in individuals with a clinical psychotic disorder, can also be found in relatively high numbers in the general population (Eaton, Romanoski, Anthony & Nestadt, 1991, Kendler, Gallagher, Abelson, & Kessler, 1996). It is now widely accepted that psychosis exists as a continuum of severity in the general population with mild psychotic-like experiences at one end and severe clinically relevant psychotic symptoms at the other. A large body of research has aimed to shed light on the nature of this continuum by studying subclinical psychosis in more detail. The majority of psychotic-like experiences are transient in nature however, they do confer an increased risk of developing a full-blown disorder (Van Os et al., 2009; Hanssen, Bak, Bijl, Vollebergh, & Van Os, 2000). Therefore, researchers set out to unravel the complex underlying mechanisms which drive transitions along the psychosis continuum. Some have made progress in this area by focusing their research on individual psychotic symptoms. (Owen, O'Donovan, Thapar, & Craddock, 2011). Persecutory delusions have emerged as a particularly fruitful target for this type of research (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001; Morrison, 2001). Similar to psychosis, persecutory delusions represent the severe end of a continuum in the general population. This continuum of delusional belief has enjoyed extensive research attention. Numerous theories have been developed to explain how mild paranoid thoughts can develop into clinically relevant delusions. These theories have discussed a range of factors including cognitive processes such as attentional biases, reasoning biases, and attributional styles (Garety & Freeman, 2013; Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002; Freeman, Lister, & Evans, 2012) and affective processes such as anxiety and self-esteem (Huppert & Smith, 2005; Thewissen, Bentall, Lecomte, Van Os, & Myin-Germeys, 2008). More recently, studies have begun to recognise the effects that social environments have on paranoid thoughts, pointing out that they could be viewed as an adaptive response to negative events such as trauma (Bebbington et al., 2013). Despite all of this research however, the role that paranoia plays in the development of psychotic disorders remains poorly understood. The current thesis aimed to shed light on the relationships between paranoia and the other symptoms of psychosis, thereby shedding light on how psychosis develops.

6.1.1. The cascade model

The author proposed a novel explanation of psychosis development around which the analytic plan for the thesis could be built. This line of investigation was called the cascade model. The model, which drew upon existing cognitive, evolutionary, and social literature in is area, centred on the premise that paranoia plays a key role in the early stages of psychosis development. The proposed developmental trajectory can be summarised as follows. First, exposure to threatening environments can precipitate the development negative beliefs about the intentions of others. If an individual believes that other people have malicious intentions, it can cause them to be more sensitive to negative information and to collect less social information before reaching negative conclusions. This combination of a hypersensitivity to threat and reduced reality-checking of negative beliefs can then lead to the rapid development of multiple paranoid beliefs about the intentions and actions of others. These thinking patterns can motivate behavioural changes like reducing pro-social behaviours towards others, which reinforces their paranoid beliefs. These behavioural changes then result in the people around them responding in kind, thereby reinforcing the paranoid beliefs. This combination of altered attention, perceptions, and behaviours then kick-starts a cascade of misinformation where existing paranoid thoughts spark the rapid development of multiple additional threat-based beliefs and this internal state creates the conditions needed for more severe psychotic symptoms such as hallucinations to emerge.

6.2. Chapter 2

Chapter 2 explored the underlying structure of subclinical psychotic symptoms by identifying latent subgroups of individuals in the general population who exhibited distinct symptom profiles using latent class analysis (LCA). Several existing studies which carried LCAs of psychotic experiences identified a latent class characterised by high likelihood of experiencing paranoia (Murphy et al., 2007; Castle, Sham, Wessely, & Murray 1994). One of these studies identified 4 latent classes with varying levels of psychotic ideation: a baseline class, an intermediate class, a paranoia class, and a diagnostic class (Murphy et al., 2007). The current study aimed to replicate these findings. The author was particularly interested in whether or not a class characterised by a high probability of experiencing paranoia similar to the ones observed in previous research would be found. To investigate this, an LCA was carried out on a sample taken from the same series of datasets as the one used in Murphy et al.'s (2007) study. Following the lca, a multinomial logistic regression was carried out to examine the relationships between class membership and a range of psychosis risk factors such including demographic risk factors, clinical variables, and childhood trauma experiences. A 4-class solution provided best model fit of the available data. The latent classes identified in the current analysis mirrored those found in Murphy et al.'s study in terms of number, size, and appearance. Most importantly, the paranoia class that was present in the original study was also found in the current analysis. The multinomial logistic regression analysis revealed that the paranoia class and diagnostic class shared a number of similarities in terms of their patterns of association with psychosis risk factors. Firstly, both the diagnostic class and the paranoia class were at increased risk of experiencing a number of psychological disorders compared to baseline. They shared associations with generalised anxiety disorder, alcohol dependence, mixed anxiety/depressive disorder, depressive episodes, and obsessive-compulsive disorder. Moreover, the diagnostic and paranoia classes were each more likely to have experienced childhood trauma compared to the baseline class. Both groups were at significantly higher risk of having experienced violence in the home, sexual abuse, running away from home, and bullying. First and foremost, these results suggest that the structure of subclinical psychotic experiences in the general population is consistent across different datasets. This observed structure could be interpreted in a number of ways. One possibility is that these four classes represent different stages of progression along the psychosis continuum. That the intermediate and paranoid groups are indicative of varying levels of increased risk of psychosis development and that over time, one can transition from one class to another. This explanation is supported by the regression analysis findings, which reported that the likelihoods of endorsing a range of psychosis risk factors including mental ill health and abuse in childhood increased from the baseline, to intermediate, to paranoid, to diagnostic group. However, another possibility is that these classes represent mutually exclusive groups. For example, the paranoia class may represent a subsection of the population who are experiencing paranoid ideation but will never transition along the psychosis continuum.

6.3. Chapter 3

Chapter 3 examined the relationship between psychotic symptoms and the psychosis continuum. In particular, the author wanted to know if different symptoms are related to different levels of psychosis severity and if some symptoms are more closely associated with the construct than others. It was predicted that this would be the case. Moreover, the author predicted that paranoia would share a strong connection with the underlying construct itself and would be associated with milder levels of psychosis severity. To explore this, an item response theory (IRT) analysis was carried out on schizotypal personality disorder (SPD) scales taken from 2 large-scale epidemiological datasets: the British Psychiatric Morbidity Survey (BPMS) and the National Epidemiological Survey of Alcohol and Related Disorders (NESARC). 2 IRT models were obtained from both samples. In each case, the 2-parameter model emerged as providing superior model fit. First and foremost, psychotic symptoms were found to be distributed along a continuum of severity. This outcome is in line with the first study prediction. Items measuring paranoia obtained some of the highest discrimination scores in both datasets. This result indicates that paranoia is closely related to the underlying psychosis construct, thereby supporting the second study prediction. The difficulty scores associated with paranoia items were slightly less straightforward. In the BPMS, paranoia obtained some of the lowest difficulty scores in the scale, placing them at the milder end of the psychosis distribution. This finding was in line with the third study prediction. In the NESARC on the other hand, items measuring disorganisation obtained the lowest difficulty scores followed by paranoia items. This result was not what was expected. However, when the NESARC analysis focused only on psychotic experiences which were distressing, paranoia items returned to the lower end of the distribution. Overall, the prediction that paranoia would be located at the milder end of the psychosis continuum was mostly reflected in the study findings. The differences in item structure between distressing and non-distressing psychotic experiences highlights the impact that negative appraisals of psychotic experiences can have. In a general sense, within the context of a continuum model of psychosis, the results of the current study could be interpreted as meaning that as an individual transitions along the psychosis continuum, they will experience paranoia before experiencing symptoms which were found to be associated with higher levels of psychosis severity such as hallucinations. While this is only one of a number of possible explanations for the observed findings, they do appear to suggest that paranoia holds a prominent position in the early stages of psychosis.

6.4. Chapter 4

In chapter 4, the author continued to investigate the structure of subclinical psychotic symptoms in the two datasets that were studied in chapter 3. While the previous chapter shed light on the relationships between psychotic experiences and the underlying psychosis construct, this chapter aimed to explore the relationships between the experiences themselves. The author believed that visualising psychosis as a network of interacting symptoms would provide valuable insights into paranoia's role in psychosis development. Coming from this network analytic approach, the current analysis modelled these relationships in each dataset through the generation of psychological networks. A number of predictions regarding the structure of these networks were made based on the cascade model. First of all, it was predicted that paranoia items would be located in the centre of the networks. Secondly, it was predicted that items measuring paranoia would obtain some of the highest centrality scores in the networks. Additionally, the author was interested in whether or not the network structures would be consistent across the two samples. Upon visual inspection, a number of parallels were identified between the different networks. First, groups of items were found to cluster together in consistent ways as the author expected. Importantly, the items measuring paranoia, which formed one of these clusters, were located towards the centre of the network in both samples. Overall, the visual characteristics of the networks were in line with the study predictions. Moreover, some of the highest scores on all 3 centrality indices were associated with items measuring paranoia. This was the case across both samples. These high scores supported the study predictions and indicated that paranoia items are highly connected to all other psychotic experiences in the general population. The current analysis demonstrated the utility of conceptualising subclinical psychosis as a network of interacting experiences. The current results highlight the central role that paranoid ideation is playing in this network. While directional relationships could not be directly observed due to the cross-sectional nature of the datasets being studied, the high levels of connectedness between paranoia and other subclinical experiences suggest that increases in paranoia could have extensive knock-on effects on other psychotic experiences.

6.5. Chapter 5

The analyses carried out in the previous chapters of this thesis employed sophisticated statistical techniques to explore the structure of subclinical psychosis in the general population using several large-scale epidemiological samples. The results of these studies indicated that paranoia is a particularly prominent psychotic experience in the general population. It was found to be closely connected to other subclinical psychotic experiences and was highly relevant at less severe levels of psychosis. Moreover, findings from these studies suggested that experiencing paranoia is likely to precede the development of other psychotic experiences such as hallucinations. This is particularly important in relation to the cascade model because one of its central facets is the proposal that experiencing paranoia can influence the development of other psychotic experiences. However, this could not be directly tested in these studies because the data they used was cross-sectional in nature. Therefore, in chapter 5, the author aimed to explore the development of paranoia and other psychotic experiences over time. To achieve this, a number of cross-lagged panel models were estimated to determine the temporal relationships between paranoia and other psychotic experiences. Furthermore, these techniques were used to investigate causal pathways between sustained paranoid ideation and other psychotic experience. These models were carried out using longitudinal data from a large community-based sample. It was expected that paranoia would predict the occurrence of other psychotic experiences more strongly than those psychotic experiences would predict paranoia. In general, the results did not concur with the study predictions. Instead, the causal links between paranoia and other psychotic experiences appeared to be reciprocal in nature. Rather than identifying one causally predominant experience, they were all found to predict each other with equal magnitude over time. These reciprocal relationships were also found in the models which studied the effects of sustained paranoia. On the surface, these findings appear to indicate that psychotic experiences impact on each other, develop concurrently over time, and are therefore, incompatible with the cascade model. However, they can be interpreted in a number of ways. It is possible that causal predominance shifts from one experience to another as psychosis develops. It is also possible that there are multiple distinct causal pathways present in the general population. That some individuals experience paranoia which precipitates the development of other experiences such as hallucinations, while others develop paranoia as a consequence of other psychotic experiences. Overall, these results highlight the complexity of the causal relationships between subclinical psychotic experiences.

6.6. Discussion of findings

Taken together, the findings from this thesis have significant implications for a number of existing bodies of research. Firstly, the current results are relevant to the literature surrounding delusions. There is an existing body of evidence suggesting that a continuum of delusional beliefs exist within the general population (Freeman & Garety, 2014). Results from the network analysis described in chapter 4 support the existence of this continuum. In one of the psychosis networks which were generated, the 4 items measuring paranoia appeared to form a pathway or ladder beginning with feeling nervous around others, followed by being suspicious of others, and ending in feeling watched. It is possible that this pattern was caused by different paranoid thoughts building on top of one another hierarchically as previous research has suggested (Bebbington et al., 2013). Results from chapter 2 also provide support for a continuum of delusional belief. The class of individuals characterised by extremely high likelihoods of experiencing subclinical paranoia were found to be at increased risk of experiencing a number of psychiatric disorders including generalised anxiety disorder and depression. They were also more likely to have experience childhood trauma. Previous research has identified anxiety, depression and trauma as factors associated with clinically relevant persecutory delusions (Freeman, 2007; Garety & Freeman, 2013; Read, Agar, Argyle, & Aderhold, 2010). Chapter 2 therefore supports the continuum of delusional belief as it indicates that there is continuity in terms of causal influence between subclinical and clinical forms of paranoia. Furthermore, the increased likelihood of childhood trauma associated with the paranoia class compliments several existing theories of delusion development. For example, more recently, researchers have begun to discuss the development of delusional ideation as an attempt to adapt to a hostile environment. These theories posit that within the context of traumatic experience, developing negative beliefs about others could help protect from danger (Gracie et al., 2007). The high frequencies of events such as bullying and witnessing violence in the home which were found in the paranoia class provide support for these theories. There is also research highlighting the role of social isolation in delusion development. This research suggests that being isolated limits opportunities to reality test unfounded beliefs about others, therefore exacerbating delusional thoughts (Cromby & Harper, 2009; Freeman, 2007). This link can be seen in the findings in chapter 2 as the paranoid class were more likely to be living alone compared to baseline.

The relevance of the studies carried out in this thesis is not confined to delusion research. Their findings also have significant implications for the current psychosis literature. First and foremost, a number these studies provided support for the existence of a psychosis continuum. In chapter 2, the increasing levels of subclinical psychotic experience from intermediate to paranoid to diagnostic class, were associated with increasing likelihoods of experiencing a number of risk factors associated with clinical psychotic disorder. In particular, the paranoia and diagnostic classes displayed an increased likelihood of being diagnosed with obsessive compulsive disorder, generalised anxiety disorder, or depression. They were also more likely to be alcohol or drug dependent. These results are in line with existing research which found that subclinical and clinical forms of psychosis share continuity in terms of their patterns of comorbidity (Fusar-Poli, Nelson, Valmaggia, Yung, & McGuire, 2012; Rossler et al., 2011). Similarly, the increased likelihood of experiencing childhood trauma associated with these classes compliments existing research findings which identified continuity in terms of environmental risk factors between subclinical and clinical psychosis (Bebbington et al., 2011; Kelleher et al., 2008). Results from the IRT analysis carried out in chapter 3 provides further support for the existence of a psychosis continuum. The finding that subclinical psychotic experiences could be represented as a distribution along a continuum of severity suggests that these experiences do not develop concurrently over time. Instead, this finding suggests that psychosis exists as a continuum which individuals can transition along. These individuals would therefore encounter different psychotic experiences as their level of psychosis severity increases over time.

In addition to indicating that the psychosis continuum exists, the research contained in this thesis also shed light on how an individual may transition along this continuum. Many researchers have explored the mechanisms which drive the development. A number of studies have investigated mood as a potential driver of psychotic experience. Much of this research has centred around anxiety and depression, reporting that they have a significant impact on psychosis (Krabbendam et al., 2005; Broome et al., 2005). The finding in chapter 2 that latent classes with higher levels of psychotic experience were also more likely to be anxious and depressed mirror the existing research in this area and suggest that mood is an important aspect of psychosis development. A large portion of existing psychosis literature has explored the cognitive mechanisms involved in its development. The studies in this thesis produced a number of insights which are relevant to these cognitive models. A number of these models have highlighted the importance of how abnormal experiences are interpreted. These models suggest that the way an individual responds to initial psychotic experiences can influence their chances of developing a clinical disorder. In other words, if an anomalous experience is interpreted in a paranoid way, it is more likely to be distressing, to be persistent, and to lead to a clinical disorder (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001; Morrison, 2001). There are a number of findings contained in this thesis which highlight the importance of these cognitive responses. Results from chapter 5 demonstrated that paranoid ideation can indeed emerge as a consequence of psychotic experience in general, and specifically, in response to hallucinatory experiences. Moreover, the psychosis networks generated in chapter 4 highlighted the importance of these cognitive responses in several ways. Firstly, the central roles that paranoia items played in these networks implies they are heavily involved in the maintenance of the other psychotic experiences in the network like the hallucinatory items. Secondly, in one of the networks, a tendency to interpret irrelevant things as being personally meaningful was found to bridge hallucinatory items and paranoia items. This suggests that interpreting random social information as being directed towards the self could exacerbate other psychotic experiences as these cognitive models predict. Finally, when the psychosis network which was generated using all psychotic experiences contained in the NESARC dataset was compared to its counterpart which only included the psychotic experiences that were distressing, a number of structural differences were observed. The effect of distress was explored in a similar way in chapter 3 through the estimation of 2 separate IRT models. As was the case in the network analysis, structural differences were present between the model of distressing experiences and the model of non-distressing experiences. These differences demonstrate that psychotic experiences perform differently based on whether or not they elicit distress. Taken together, all of these findings concur with the claim made by cognitive models of psychosis development that cognitive and attentional anomalies may be better predictors of a need for care than the presence of anomalous experience (Brett, Peters, & McGuire, 2015).

While results from this thesis provide support for some aspects of these cognitive models, they contradict some of their other aspects. One of the main characteristics of these models which this thesis does not support is the assertion that paranoid ideation emerges as a consequence to anomalous experience. Numerous observations made across the current studies indicate that this is not always the case. Firstly, while the investigation of the temporal relationships between psychotic experiences carried out in chapter 5 demonstrated that paranoia can emerge as a consequence to psychotic experiences such as hallucinations, the opposite was also found to be true. Paranoid ideation was also found to predict the development of subsequent psychotic experiences. This finding is at odds with cognitive explanations of psychosis development. The LCA carried out in chapter 2 also produced findings which are incongruent with the idea of paranoia being a consequence of hallucinatory experiences. The structures of the 4 latent classes which were produced appeared to suggest that the development of multiple psychotic experiences could be preceded by a period of heightened paranoid ideation. This therefore suggests that paranoia can develop before the experience of other psychotic events instead of after them. This pattern can also be seen in the IRT models contained in chapter 3. In these models, the paranoia items were located towards the lower end of the distribution of psychosis severity. Within a continuum model of psychosis development, this finding indicates that paranoia would develop before other psychotic experiences which were associated with more severe levels of psychosis. Once again, this finding is incongruent with the cognitive models being discussed.

In a more general sense, a number of overarching recommendations can be drawn from the studies contained in this thesis regarding how researchers should approach the study of psychosis going forward. Firstly, the current thesis underscores the utility of studying psychosis at the symptom level. In more recent years, as potential flaws were being highlighted in the diagnostic labels currently used in the study of psychosis, some researchers proposed that the construct would be better conceptualised as a constellation of co-occurring experiences (Owen, O'Donovan, Thapar, & Craddock, 2011). These researchers are beginning to suggest that these experiences do not share a single common cause, nor do they develop concurrently. Instead, they can dynamically interact and impact on each other's development (van Os & Reininghaus, 2016). There are a number of findings in this thesis which provide evidence for this. Firstly, the investigation of temporal relationships between psychotic experiences carried out in chapter 5 demonstrated that these experiences can precipitate each other's development over time. In other words, this demonstrates that endorsing one psychotic experience can increase the chances of developing other experiences. Moreover, the causal relationships between these experiences were reciprocal in nature which could indicate that different people exhibit different temporal orderings of psychotic events. If this were the case, a symptom-based approach would be appropriate as it would allow for the exploration of multiple separate pathways to psychosis development. The network analysis carried out in chapter 4 illustrated the high levels of dynamic interaction taking place between different psychotic experiences. The output from this chapter emphasises the need for more symptom level research of this type. Furthermore, it demonstrates that psychosis can be effectively represented as a psychological network of interconnected events. The IRT analysis outlined in chapter 3 found that psychotic experiences vary in terms of how closely they are connected to the underlying psychosis continuum and in terms of the level of psychosis severity at which they become most relevant. These findings demonstrate that it is inappropriate to treat psychotic experiences as interchangeable markers of an underlying disease entity. They are in fact, distinct stand-alone phenomena, each with different causes and consequences and they should be handled as such by researchers going forward.

In simple terms, the overarching motivation for studying psychosis is to understand its epidemiology. Researchers want to understand how psychosis is distributed in the population, to identify which factors are involved in its development, and to identify its associated outcomes. Ultimately, when this epidemiology is understood, it aids identification of individuals who require care or who are at increased risk of developing a need for care in the future. It can also inform the development of treatment and prevention strategies. In the field of psychology, no matter what construct is being studied, a conceptualisation of its form must be generated to guide research into its epidemiology. The way in which psychosis is conceptualised shapes every aspect of how researchers study it. It affects the samples within which it is explored, the psychometric scales which are used to measure it, and the statistical paradigms which are used to analyse it. If this conceptual foundation is not sound, it has extensive ramifications for the validity of any of the insights gained from any subsequent research which has been built upon it. Crucially, studies in this thesis have highlighted a number of flaws within existing conceptualisations of psychosis. These issues must be addressed to ensure psychosis research continues to progress.

The current thesis makes a number of practical recommendations which can be implemented by researchers going forward. The first recommendation is in terms of the samples within which psychosis is being investigated. Traditionally, researchers focused solely on psychotic symptoms in clinical samples. More recently, the development of continuum models of psychosis prompted the investigation of its subclinical forms in non-clinical samples. However, the research in this thesis suggest that clinical and subclinical forms of psychosis should not be studied separately. When forming datasets for the study of psychosis in the future, data should be collected from individuals who are spread along the continuum, both above and below the clinical threshold. The existence of a dataset such as this, which has measured clinical and non-clinical forms of psychosis in ways which are consistent and comparable would be an incredibly useful tool for researchers in the field. The second recommendation for future research is in relation the measurement of psychosis. Currently, the majority of studies use an individual's pattern of responses to a self-report scale to determine their location on the psychosis continuum. Different psychotic experiences are treated as interchangeable markers of disease and their unweighted sum score represents the individual's level of psychosis severity. Findings from this thesis demonstrate that this is an inappropriate way to measure psychosis. In reality, different psychotic experiences are associated with different levels of severity and therefore cannot be treated as interchangeable. Aside from the issues surrounding the use of these sum scores, current psychosis scales are problematic because they attempt to measure psychotic experiences in oversimplified ways. This thesis highlighted a number of associated factors which should be taken into account when measuring psychotic experiences. The first of these is whether or not an experience causes distress. Psychotic experiences were found to perform differently depending on whether or not they were distressing. Another factor which should be considered when measuring these experiences is the context within which they were developed. An example of this would be delusional beliefs which were developed within the context of a traumatic childhood. By contextualising these psychotic experiences, it will provide a deeper insight into their meaning and impact and by ignoring it, one runs the risk of treating two experiences which are actually quite different as being equal. A final factor which should be considered when measuring psychotic experiences in the future is their content. Existing psychosis scales do not enquire about the content of specific experiences like hallucinations or delusional thoughts. For example, a scale item may ask if a person believes other people are talking about them behind their back, but it will not ask what they believe these people are saying. Similar to ignoring the context of a psychotic experience, ignoring its content is also problematic because it can result in very different experiences being treated as equal or comparable. Ultimately the findings from this thesis call for the development of more sophisticated methods of assessing psychotic experiences which take these factors into account. The third and final recommendation for future research concerns the statistical paradigms used to examine psychosis. As discussed in the previous paragraph, when studying any psychological construct, selection of an appropriate statistical technique is determined by the how the construct is being conceptualised. It makes sense therefore, that the limitations which have been identified in the current conceptualisations of psychosis would be reflected in the statistical paradigms which are currently used to study the construct. Namely, many of these statistical paradigms treat different experiences as being interchangeable, assume the presence of a latent underlying construct which drives the development of these observable experiences, and cannot capture multiple pathways of psychosis development. This thesis has identified a number of analytic techniques which are appropriate for the exploration of psychotic experiences. The first of these is LCA.

LCA's ability to identify underlying subgroups of individuals who exhibit different patterns of psychotic experiences means it could be employed to explore multiple distinct pathways to psychosis development. The second statistical approach which has proven to be effective is IRT. Its ability to recognise differences between different items in a scale make it a useful paradigm for studying psychosis at the symptom level. This thesis has also highlighted the benefits of network analysis for the study of psychosis. A key benefit of network analysis is that it does not assume the existence of a latent underlying construct. Instead, it allows psychological disorders to be visualised as a network of interacting experiences. This makes it a particularly appealing paradigm as it is theoretically complimentary with symptom level psychosis research. The last technique which this thesis identified as being a useful tool for psychosis researchers going forward is CLPM. This paradigm is useful as it can identify and describe complex causal relationships between multiple variables across time. Its ability to explore reciprocal relationships such as those that exist in networks of psychotic experiences where no one factor holds causal predominance over the others means that CLPM is well suited to psychosis research. Taking these recommendations on board will open up a number of promising avenues for future research which will produce new insights into the epidemiology of psychosis.

6.7. Implications for the overall thesis aims

The studies carried out in this thesis were built around the cascade model. This model, which gave an account of how paranoia could play a central role in the early stages of psychosis development, was developed to provide a clear line of investigation for this thesis and to guide the formulation of study predictions. Therefore, the results of these studies must now be discussed in relation to the cascade model. To do this, the findings will be considered in relation to 3 questions which must be answered in order to ascertain whether or not this model provides a plausible account of psychosis development.

Is paranoia an important experience in psychosis at the subclinical level?

The first question which needed to be answered is whether or not paranoia is a relevant and central experience at subclinical levels of psychosis. This thesis produced a number of findings which are relevant to this question. In chapter 2, a latent class of individuals were found in the general population sample characterised by extremely high likelihoods of experiencing paranoia. Moreover, this class was at increased risk of endorsing a number of known risk factors for psychosis. This pointed towards paranoid ideation being a prominent subclinical psychotic symptom which is present in relatively high numbers in the population. In the IRT analysis carried out in chapter 3, items measuring paranoia obtained some of the highest discrimination values in the distribution. This indicated that they were closely related to the underlying psychosis construct and therefore underscores paranoia's significance in relation to psychotic experience. Perhaps the most relevant finding in relation to this question came from the network analysis carried out in chapter 3. Items measuring paranoia were found to play central roles in the networks obtained. They also obtained high scores on the 3 measures of centrality indicating that they were strongly connected to the other experiences in the networks. This demonstrates that paranoia is one of the most influential experiences related to subclinical psychosis. Overall, the studies in this thesis established that paranoid ideation is an important experience in relation to subclinical psychosis.

Does paranoia precede the development of other psychotic experiences?

The second question which needed to be answered is whether or not individuals develop paranoid ideation before other experiences emerge. Once again, this thesis provided a number of insights into this topic. The first of these insights comes from the LCA carried out in chapter 2. The fact that the paranoia class was associated with several risk factors related to clinical psychosis indicated that the people in this class could be predisposed to developing other psychotic experiences in the future. This therefore supports the notion that paranoid ideation can precede the development of other experiences. The performance of paranoia items in chapter 3's IRT analysis is also relevant to this question. These items were found to be associated with lower levels of psychosis severity compared to items measuring other psychotic experiences such as hallucinatory events. Within the context of the psychosis continuum, it stands to reason that as an individual's level of psychosis severity increases, they would encounter less severe experiences before they encounter those associated with higher levels of severity. Therefore, this finding would also suggest that paranoia can develop before other psychotic experiences. Finally, and most importantly, the CLPM analysis carried out in chapter 5 found that paranoia can predict the development of subsequent psychotic experiences, thereby providing further support for this question. Ultimately, these findings demonstrate that paranoia can precede the development of other psychotic experiences.

Does paranoia play a causal role in the development of other psychotic experiences?

The third question which needed to be answered is whether or not paranoia can precipitate the development of additional subsequent experiences. The datasets used in chapters 2, 3, and 4 were cross-sectional in nature and therefore cannot provide insights into the causal mechanisms between psychotic experiences. The results from the CLPM analysis in chapter 5 are therefore most relevant to this question. Paranoia was found to predict the future development of additional psychotic experiences, suggesting that it did play a causal role in their emergence. However, other psychotic experiences were found to predict the future development of paranoia as well. At first glance, this appeared indicate that no one psychotic experience holds causal predominance over the others. Instead, these relationships are reciprocal in nature, with paranoia and other experiences impacting on each other over time. However, it could also be possible that there are multiple distinct causal pathways present in this data which CLPM is incapable of detangling. Therefore, while these findings show that paranoia has the ability to precipitate the development of other psychotic experiences, they also suggest that the causal relationships between psychotic experiences are more complicated than one may expect.

While the studies in this thesis provided a range of new insights into the early stages of psychosis, the understanding of paranoia's role in psychosis development is by no means complete. Questions remain which must be addressed in future research. For example, the reciprocal relationships observed between psychotic experiences in chapter 5 could be reflective of multiple separate pathways to psychosis development. Analyses which are capable of exploring the possibility of heterogeneous developmental pathways are required in future. The studies carried out in this thesis do not represent an exhaustive account of paranoia's role in psychosis development by any means. However, this thesis did succeed in studying many aspects of this role through the utilisation of a range of innovative statistical techniques and ultimately, when taken together, the results from these studies establish that the cascade model provides a plausible account of the early stages of psychosis development and should be explored further in future research.

6.8. Methodological considerations

There are a number of overarching considerations and limitations in relation to the methods employed within this thesis which must be discussed. Firstly, this thesis only examined psychotic experiences which fall under the positive dimension of psychosis. It did not take experiences associated with the negative dimension into account. Existing research has demonstrated that subclinical forms of these negative symptoms convey an increased risk of developing a psychotic disorder (Piskulic et al., 2012). Therefore, it could be argued that these experiences should have been taken into account in the current thesis. However, the decision to focus solely on positive dimension experiences was made because it was expected that the nature of the relationships between these experiences would be highly complex. It was therefore decided that these relationships needed to be elucidated in isolation before the wider constellation of psychotic experience can be studied as a whole. The second limitation of the studies in this thesis is in a similar vein to the first one. The studies in chapters 3, 4, and 5 could be criticised for not taking possible effects of comorbid disorders into account when examining the relationships between psychotic experiences. This is potentially problematic as psychiatric co-morbidities have been found to be common among individuals diagnosed with a psychotic disorder (Buckley, Miller, Lehrer, & Castle, 2009). The existing literature has identified a range of diagnoses which are associated with psychotic symptom development such as generalised anxiety disorder, major depression, and obsessive-compulsive disorder (Harrow, Jobe, & Astrachan-Fletcher, 2008; Freeman et al., 2012; Meyer et al., 2005). However, the author decided not to include comorbid disorders in these analyses so that the complex relationships between psychotic experiences could be examined in isolation. Thirdly, rates of transition to clinical psychotic disorder were not included in any of the analyses in this thesis. Considering that one of the key focuses of this thesis is exploring how individuals move along the psychosis continuum, some may expect that the emergence of a clinical diagnosis would be a vital factor to consider. However, there are two main reasons why the author decided not to analyse these transition rates. First, the thesis was concerned with understanding psychosis development in its very early stages. The subclinical experience interactions which were being explored were theorised to occur long before the development of a need for care. It therefore was not believed to be a relevant factor for the aims of this research. Second, one of the central reasons for the research contained in this thesis to be carried out has been the shortcomings of the current diagnostic approaches to psychotic disorders. This thesis did not explore rates of clinical diagnoses as it wanted to explore psychotic experiences without being confined by potentially flawed diagnostic labels.

Finally, some aspects of the scales which were used in this thesis to measure psychotic experiences were potentially problematic. As has already been pointed out in some existing studies, the types of psychometric scales which are currently employed to assess positive psychotic experiences limit the researcher's ability to measure specific psychotic experiences in detailed ways (Steel et al., 2007). One criticism of these instruments is that they use very few items to measure some of the most relevant hallmarks of psychosis such as hallucinations and delusions (Steel et al., 2007). An example of this is can be seen in the longitudinal dataset used in chapter 5 of this thesis. In it, paranoid ideation was assessed using only 2 binary items. Another criticism of these types of scales is that they fail to recognise or capture the multidimensional nature of psychotic experiences. Existing research has demonstrated that there are a range of factors which are involved in how well an individual copes with a given experience and how much distress it elicits. It has been recommended that these factors should be taken into account when assessing these experiences. For example, one study recommended that when assessing delusions, the instrument used should consider the degree to which the belief is implausible, preoccupying, strongly held, not shared by others, distressing, and unfounded (Freeman, 2007). These findings ultimately mean that the ways in which psychotic experiences have been assessed in this thesis may be inadequate. However, it's worth pointing out that this was not something the author could control as the studies in this thesis made use of secondary datasets and to the author's knowledge, there are currently no available large-scale epidemiological datasets containing multi-dimensional assessments of subclinical psychosis. Indeed, these issues surrounding assessment can be seen as a criticism of the current body of psychosis research in general because such a large majority of the studies carried out in this area to date are based on these psychometric scales.

6.9. Implications for clinical practice

The research contained in this thesis has provided a number of insights which have significant implications for how clinicians should approach psychosis going forward. First, this thesis highlighted that subclinical psychotic experiences are relatively frequent in the general population. Furthermore, while the majority of these experiences are transient in nature, they do convey an increased risk for future development of a clinical disorder (Hanssen et al., 2005). These findings suggest that educational initiatives targeting the general population which aim to normalise and de-stigmatise these subclinical experiences would be beneficial. These types of initiatives are particularly vital considering the findings from chapters 3 and 4 which highlighted the impact that distress can have on the progression of psychosis. Normalising these experiences could be an effective way of reducing the distress they elicit which would ultimately result in better outcomes. The findings from this thesis also have a number of significant implications for how clinicians assess and measure psychotic experience. The findings from chapters 3 and 4 regarding the structure of these experiences demonstrate that they should no longer be treated as interchangeable markers of disease. Instead, a multi-dimensional approach to their assessment would be more appropriate. When measuring a psychotic experience, clinicians should consider a number of relevant factors. The first of these factors which should be taken into account is the level of distress associated with the experience. Output from the network analysis as well as the IRT analysis suggested that distressing experiences and non-distressing experiences have different meanings. Additionally, when assessing psychotic experiences, clinicians should not ignore the context within which they were developed. Findings from the LCA in chapter 2 reflected existing literature which demonstrated that some psychotic experiences can have their origins within dangerous or hostile contexts such as traumatic events during childhood. Finally, the assessment of psychotic experiences should include an assessment of their content. Failing to acknowledge the content of experiences such as delusional beliefs for example could result in very different experiences being treated as if they're equal or comparable. In contrast, if this content is explored, it could allow for the identification of potentially meaningful patterns and connections across different experiences. For example, an individual could have a delusional belief that their neighbour wishes to harm them. That same individual could also be experiencing auditory hallucinations where they hear whispers coming from their neighbour's garden. The connection between these two psychotic experiences would be missed if their content is not considered. Furthermore, the current findings suggest that clinicians may want to consider abandoning the traditional dichotomous separation between clinical and non-clinical psychosis. This proposition may seem impractical and inappropriate on the face of it as this dichotomy forms the foundation of clinical practice and is required to inform decisions surrounding who requires treatment and who does not. However, the current thesis findings have shown that the psychosis continuum is complex and deciding whether or not an individual requires treatment by quantitatively measuring how many psychotic experiences they report and then placing them above or below an arbitrary cut-off point is an over-simplified solution to this problem. Adopting the above recommendations in relation to multi-dimensional assessment would provide a practical alternative framework to guide decision-making surrounding diagnosis and intervention. The findings from this thesis indicate that by gaining an understanding of the psychotic experiences an individual is dealing with, the context within which they have been developed, and how these experiences are impacting on their life, clinicians can make informed decisions about the level and type of care required and formulate treatment plans which are targeted, tailor-made, and ultimately more effective. The findings from chapter 4 demonstrated that the positive dimension of psychosis can be effectively represented as a network of interconnected experiences which have the ability to interact and influence one another. Clinicians should consider adopting a network-based approach when thinking about psychosis. The current findings indicate that doing so would have a number of associated benefits. For example, they demonstrated that psychotic experiences appear to cluster together in ways that are relatively consistent and predictable. An awareness of these patterns of connection could enhance clinicians' ability to understand how their patient's experiences are connected. This information could be used to inform decision-making surrounding interventions. The benefits of this network approach are closely tied to the final recommendation for clinical practice in this thesis. This last recommendation is in relation to the treatment of psychosis. The network analysis carried out in chapter 5 underscored the utility of a symptom-based approach to intervention. The high levels of connectedness between experiences indicated that improvements in one experience would have knock-on effects for the network as a whole. This indicates that the use of interventions which target specific psychotic symptoms could be effective. The analysis from chapter 5 which demonstrated that psychotic experiences reciprocally predict each other over time further supports the utility of symptom specific interventions. Moreover, the findings from this thesis identify paranoia as a potentially fruitful target for intervention. In chapter 2, a subgroup of paranoid individuals was identified in the general population who were at increased risk of developing a clinical disorder. This could mean that paranoia plays an important role in the development of these disorders and targeting it in its subclinical stages could improve outcomes. In chapter 3, paranoid ideation was found to be closely related to the underlying psychosis continuum and associated with less severe levels of psychosis compared to other experiences such as hallucinations. This further indicates that paranoia may precede the development of other psychotic experiences and therefore should be targeted. Items measuring paranoia were among the most central in the psychosis networks generated in chapter 4. Their high levels of association with the other experiences indicate that their treatment would also have widespread positive effects on these experiences. This is further evidenced in chapter 5 which found that experiencing paranoia predicts the future development of other psychotic experiences. Taken together, these findings show that the use of interventions aimed towards reducing paranoid cognitions could lead to global reductions in psychosis severity and should be incorporated into treatment plans where appropriate.

6.10. Conclusion

The findings from this thesis have provided a number of key insights into the role that paranoid ideation plays in the early stages of psychosis development. First, this thesis demonstrates that paranoia is arguably the most prominent psychotic experience during the early stages of psychosis. It is closely related to the underlying psychosis continuum, as well as other psychotic experiences. Not only this, paranoid ideation was also found to be associated with a number of factors which confer heightened risk of developing a psychotic disorder. Second, this thesis has demonstrated that different psychotic experiences are associated with different points along the psychosis continuum. Finally, the current thesis has found that psychotic experiences can interact and can precipitate each other's development over time. Taken together, these insights shed light on the nature of psychosis itself. In doing so, they highlight a number of flaws in how the construct is currently approached by researchers in the field. The first of these relates to how an individual's level of psychosis is assessed. The current findings show that paranoid items are unique and separate in many ways. They vary in terms of how they are distributed in the population, how they relate to each other, and how they relate to psychosis itself. This underscores that these experiences are not a series of interchangeable markers of an underlying disease entity and should no longer be treated as such. The second flaw relates to how these individual psychotic experiences themselves are currently assessed. The findings from this thesis found that these experiences are complex and multifaceted in nature. They vary in terms of their thematic content, the context within which they were formed, and the levels of distress they elicit. However, the assessments of these experiences in the existing literature are, all too often, devoid of this information. As well as highlighting existing flaws, this thesis also illuminates a brighter path for psychosis research going forward. Indeed, the recommendations surrounding how psychosis should be approached applies across the fields of research and clinical practice. First, this thesis supports the use of multi-dimensional assessments of psychotic experiences. Recognising how these experiences were formed and the impact that they are having could provide the kind of insight needed to help those who are suffering. Second, this thesis highlights the utility trying to understand psychosis at the symptom level. Psychosis development is a highly complicated process. Focusing on how individual psychotic experiences develop within this larger machine could provide a structured way of navigating through these levels of complexity. Finally, this thesis outlines the benefits of approaching psychosis from a network perspective. Thinking about the phenomenon of psychosis as a constellation of interconnected and interacting experiences, without requiring the existence of a latent construct driving their mutual development, is an approach which can bring us closer to understanding its true nature. Taking these recommendations on board will result in research which captures psychosis dynamically and comprehensively, and a clinical approach which focuses on individual experience instead of diagnostic categories. How we approach psychosis in the future no longer needs to be held back by how it was approached in the past.

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